

The Philosophy and Physics of Relationality and  
Inherent Nature:  
*Śūnyatā* and *Svabhāva* in *Madhyamaka* Buddhist Philosophy,  
Western Analytic Metaphysics, Philosophy of Science and Physics

by

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Submitted in partial fulfillment of the requirements  
for the degree of Doctor of Philosophy

at

Dalhousie University  
Halifax, Nova Scotia  
February 2013

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DALHOUSIE UNIVERSITY  
INTERDISCIPLINARY PH.D. PROGRAM.

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DALHOUSIE UNIVERSITY

DATE: February 18, 2013

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TITLE: The Philosophy and Physics of Relationality and Inherent Nature: *Śūnyatā* and *Svabhāva* in *Madhyamaka* Buddhist Philosophy, Western Analytic Metaphysics, Philosophy of Science and Physics

DEPARTMENT OR SCHOOL: Interdisciplinary Ph.D. Program

DEGREE: PhD CONVOCATION: May YEAR: 2013

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## DEDICATION PAGE.

This dissertation is dedicated to the Buddhas and Acharyas of all Buddhist lineages from all cultures, and to their transcendent motivation to teach in order to free sentient beings from suffering, through transmission of wisdom and skillful means based on compassion. It is also dedicated to those seekers of truth in the disciplines of Western philosophy and physics: May all of their activities benefit beings. Lastly, this dissertation is dedicated to all who have interest in the path of study of the true nature of reality. May that interest be combined with compassion and skillful means in all their activities.

This dissertation is especially dedicated to the health and well-being of my wife, Kathie, in this life and the next, and my children Stephen and Annie.

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## ABSTRACT

Proponents of *Middle Way* (Sanskrit: *Madhyamaka*) Buddhist philosophy argue that all phenomena lack inherent nature. This dissertation provides an analysis of the meaning of inherent nature and the lack of inherent nature in the basic physical character of non-living physical phenomena as indicated by certain interpretations of ancient and contemporary Middle Way Buddhist philosophy, contemporary Western analytic metaphysics, philosophy of science, and physics. The primary intellectual focus in the dissertation is Madhyamaka. I explicate an interpretation of Madhyamaka that is both amenable to discourse and dialogue with the other disciplines, and also consistent with at least some extant Madhyamaka interpretations. The discourse and dialogue with other disciplines results in a revision of some of the arguments of Madhyamaka—specifically making it consistent with modern physics. However, that revision does not deny the foundational view of Madhyamaka that there is no inherent nature in phenomena, but rather supports it within the revised interpretation. Additionally, I also find that this foundational view provides at least heuristic guidance in development of a generic interpretive framework ('contextualization' and Physics Pluralism) that I then apply in criticism and revision of some arguments in modern analytic metaphysics and in philosophy of science. That generic interpretive framework is used within this dissertation in examination of Western analytic metaphysics and philosophy of science. While I find independent support for that framework within contemporary philosophy, the framework also reflects an interpretation of Madhyamaka that I develop as a variation of the classic *two truths* view of Madhyamaka. My interpretation of the classical expression of the two truths is that there is relative existence of inherent nature that may be reflected in our conventions of discourse and habit, while ultimately no inherent nature can be found when the phenomena are analyzed more fully. In my modified interpretation of the two truths that corresponds to modern physics, for some phenomena inherent nature is found within specific ('local') contexts of discourse or domains of physics theory applicability, yet when we take a 'global' view that acknowledges many domains and relationships between domains we find an ultimate relationality rather than inherent nature.

## LIST OF ABBREVIATIONS USED.

### Physics Theories

ADM: general relativity formalism developed by Arnowitt, Deser and Misner, see

Arnowitt et. al, 1962

EFT: effective field theory

GTR: general theory of relativity

GUT: grand unified theory

HVT: hidden variables theory in quantum mechanics interpretations

QFT: quantum field theory

QG: quantum gravity

RG: renormalization group.

SEP: <http://plato.stanford.edu/>.

SM: Standard model of particle physics of STR-based QFT

STR: special theory of relativity.

### References.

AKBh: *Abhidharmakosabhāsyam* by Vasubandhu, translation into English by Leo M. Pruden, Asian Humanities Press, an imprint of Jain Publishing Company, from the French translation by Louis de La Vallée Poussin, *L'Abhidharmakośa de Vasubandhu*, Institut belge des hautes études chinoises, Bruxelles, 1971.

EPR: Einstein, A., Podolsky, B. and Rosen, N., 1935, "Can quantum-mechanical description of physical reality be considered complete?" *Physical Review*, 47:777-780. Reproduced in Wheeler and Zurek, 1983.

GRW: Ghirardi, G., Rimini, A., and Weber, T., 1986, "Unified dynamics for microscopic and macroscopic systems" *Phys. Rev. D* 34, 470.

- Lankara: <http://www.holybooks.com/wp-content/uploads/Heart-Diamond-and-Lankavatara-Sutras.pdf>.
- LRCM: Lamrim Chenmo Translation Committee, tr. 2002 *The Great Treatise on the Stages of the Path to Enlightenment: Lam Rim Chen Mo* by Tsong-kha-pa Volume 3 (Boston: Snow Lion Publications).
- MAL: Padmakara Translation Group, tr. 2005 (MAL) *Adornment of the Middle Way: Śāntarakṣita's Madhyamakalankara with Commentary by Jamgön Mipham* (Boston: Shambhala Press)
- MAV: Padmakara Translation Group, tr. 2002 *Introduction to the Middle Way: Chandrakirti's Madhyamakavātarā with commentary by Jamgön Mipham*, (Boston: Shambhala Press).
- MAVb: Chandrakirti *The Auto Commentary of the Supplement to the Middle Way: Madhyamakavatara Bhashya* Translated by Gelong Thubten Tsultrim (George Churinoff).
- MMK: Garfield, Jay L., tr.1995 *The Fundamental Wisdom of the Middle Way: Nāgārjuna's Mūlamadhyamakakārikā*, with commentary by Jay L. Garfield, Oxford University Press.
- Ocean: Samten, Geshe Ngawang and Garfield, Jay L., tr. 2006 *Ocean of Reasoning: A Great Commentary on Nāgārjuna's Mūlamadhyamakakārikā* [Ocean] by rJe Tsong Khapa, Oxford.
- RPP: *Review of Particle Physics* 2010. *Journal of Physics G: Nuclear and Particle Physics* 37.
- SEP: <http://plato.stanford.edu/>.
- WBT: Witmer, D. Gene, William Butchard and Kelly Trogden 2005 "Intrinsicity without naturalness" *Philosophy and Phenomenological Research* 70(2):326-350.

## ACKNOWLEDGEMENTS.

I acknowledge the assistance and caring provided by all my professors and fellow students at Dalhousie University and from away who have supported my sometimes heretical and frequently confused fumbling in my search for what is true: my committee members past and present, including Tom Vinci, my supervisor, who almost always demonstrated extreme patience and support, and assisted me in various teaching settings prior to agreeing to supervise me in this latest effort; Jay Garfield, who guided my initial scholarly studies in Madhyamaka and tried desperately, though with limited success, to help me see the light as he knew it—he taught me more than he realized; Letitia Meynell, who supported my studies in philosophy of science and argued incessantly with me, to my everlasting benefit; John Taber, who stepped in to assist in my final work in Madhyamaka; and Mark Siderits who kindly agreed to work as my external examiner. Additionally, I would like to acknowledge the many people who taught and argued with me during my studies at the department since 2002, who found the patience to put up with my efforts, especially at the beginning of my recent studies of Western philosophy, including especially Duncan Macintosh and Michael Hymers. and also Steven Burns for guiding my Master’s Degree study of Schopenhauer and Buddhism.

I also acknowledge the assistance provided by my Sangha: the Shastris, Acharyas, and other fellow travelers who put up with my incessant questions and challenges to doctrine; they served to refine my understanding and helped me seek inside for the truth borne of decades of meditation practice. Of course, my root gurus guided me always, and guide me still, and I have been blessed to know them: Chogyam Trungpa, Kenpo Tsultrim Gyatso, Dilgo Khyentze, HH Gyalwa Karmapas 16 and 17, Dzogchen Ponlop and Sakyong Mipham.

I also acknowledge my Grade 11 teacher who first introduced me to the teachings of Buddha, Socrates and Sartre.

And, of course, I acknowledge the constant care, support, and transcendent patience provided by my loving wife over all of these 10 years of study (LOL).

While each of these who helped me in my studies, research and writing, it is clear that my stubbornness got in the way of my absorbing so much of what they offered, hence all errors and nonsense found in these pages are my own, while any wisdom that may be found is clearly due to the persistent efforts of others.

## CHAPTER ONE. INTRODUCTION

### A. *Introduction*

This introductory section of the Introduction chapter contains three parts: *A.1 Summary Introduction* briefly summarizes the dissertation ; *A.2: Detailed Introduction* provides more detail to the concepts and issues discussed in the dissertation; and *A.3 Synopsis*, briefly presents the chapter topics in sequence.

#### *A.1. Summary Introduction*

Proponents of *Middle Way* (Sanskrit: *Madhyamaka*) Buddhist philosophy argue that all phenomena lack inherent nature. This dissertation provides an analysis of the meaning of inherent nature and the lack of inherent nature in the basic physical character of non-living physical phenomena as indicated by certain interpretations of ancient and contemporary Madhyamaka philosophy, contemporary Western analytic metaphysics, philosophy of science, and physics. The primary intellectual focus in the dissertation is Madhyamaka. In *Chapter Two: Madhyamaka* I explicate an interpretation of Madhyamaka that is both amenable to discourse and dialogue with the other disciplines, and also consistent with at least some extant Madhyamaka interpretations. The discourse and dialogue with other disciplines results in a revision of some of the arguments of Madhyamaka—specifically making it consistent with modern physics. However, that revision does not deny the foundational view of Madhyamaka that there is no inherent nature in phenomena, but rather supports it within the revised interpretation.

Additionally, I also find that this foundational view provides at least heuristic guidance in development of a generic interpretive framework (‘contextualization’ and Physics

Pluralism<sup>1</sup>) that I then apply in criticism and revision of some arguments in modern analytic metaphysics and in philosophy of science.

That generic interpretive framework is used within this dissertation in examination of Western analytic metaphysics and philosophy of science. While I find independent support for that framework within contemporary philosophy, the framework also reflects an interpretation of Madhyamaka that I develop as a variation of the classic *two truths* view of Madhyamaka. My interpretation of the classical expression of the two truths is that there is relative existence of inherent nature that may be reflected in our conventions of discourse and habit, while ultimately no inherent nature can be found when the phenomena are analyzed more fully.<sup>2</sup> In my modified interpretation of the two truths that corresponds to physics, for some phenomena inherent nature is found within specific ('local') contexts of discourse or domains of physics theory applicability, yet when we take a 'global' view that acknowledges many domains and relationships between domains we find an ultimate relationality rather than inherent nature. These two versions of interpretations of the two truths do not correspond in a one-to-one fashion: In the first interpretation, the conventional truth is false, yet in the second interpretation I argue that inherent nature is found in some domains for some physical entities. Hence, in one sense I am substantively modifying this concept to correspond to a different

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<sup>1</sup> Contextualization is summed up as 'we must know precisely the context of what we are talking about', and Physics Pluralism is summed up as 'there are well-defined, objectively domains of physical phenomena in which certain theories apply, and general theories must adapt to the specific circumstances of those domains in order to explain the phenomena represented in them, and there is no necessity for an all-encompassing, generally applicable theory in all domains.'

<sup>2</sup> There are many differing interpretations of the two truths. See Newland (1992) and Thakchoe (2007). I initially use the following: "For Tsong-ka-pa, the perceiver is a conventional valid cognizer, incontrovertible or undeceived ... with regard to a conventional object. A conventional object is a falsity because it presents the conventional valid cognizer with a deceptive appearance of inherent existence, while in fact it lacks inherent existence." (Newland, 96) However, I provide a unique interpretation (discussed below) that I argue must be used if the concept is to be relevant to contemporary physics.

interpretation that identifies the relative truth as a truth, not a falsehood. My modified two truths interpretation is an expression of a fundamental pluralism that I identify in Madhyamaka reasoning, and this pluralism is utilized throughout the dissertation.

Specifically, debates between proponents of Madhyamaka and proponents of Buddhist and non-Buddhist reductionist-eliminativist philosophies during the historical development of Buddhism are seen as relevant to current debates in Western metaphysics, physics and philosophy of science. The modern manifestation of the reductionist-eliminativist position is denial of the ontological primacy of composite objects in favor of atomic (or sub-atomic) entities. The argument is that since atomic simples exist and have all causal efficacy of any phenomena, and from knowledge of their properties we can derive properties of all composites, then the composite objects should not be elements of our ontology. I call this view reductive fundamentalism, and find it to be very similar to the Abhidharma Buddhist reductionist views, against which Madhyamaka argued over the past two thousand years. The former views argue that atoms exist as a basis for commonplace objects. Atoms in those views are whole and indivisible, hence with inherent nature, and what we normally perceive as whole commonplace objects are actually collections of atoms. In modern physics and philosophy of science reductive fundamentalism states that the properties of macroscopic entities are due to the elementary particles and fields of quantum field theory and general relativity<sup>3</sup> or will someday be constructed from the elusive quantum gravity as soon as it is established. I argue against this fundamentalism.

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<sup>3</sup> Reliance on general relativity is reductively fundamental in a different sense than reliance on quantum field theory. Both say that macro-phenomena are due to fundamental theories and rely on intertheoretic reduction, yet for relativity it is not reductive in the sense of relying on the properties of micro-phenomena.

One major argument of Madhyamaka against the eliminative-reductionist view of other philosophies—*neither one nor many*—relies on details of atomic theory, and typically utilizes ancient and inaccurate atomic theory. One purpose of this dissertation is therefore to revise and correct that argument using modern physics. A more general understanding that I glean from Madhyamaka is that a semantic, epistemic and ontic relationality is exhibited throughout aspects of philosophical discourse and physical phenomena. This relationality is cashed out in the current context in the following way, respectively: (1) terms and concepts used in philosophical discourse as designations referring to physical entities are relational to each other and to the context of discussion; (2) what evidence is accepted as knowledge and how knowledge of physical entities is integrated into structures called scientific theories are relational within the theory structures (as isomorphisms between models of the theory) and in the fact that theories apply only within certain contexts (called domains of applicability); and (3) the ontological natures of physical entities is determined by their properties, but they it is also relational, in that a demonstration of inherent nature in one domain can be found to be result of relationality in other domains.<sup>4</sup> We therefore find relationality within metaphysics and physics in terms of meaning, knowledge and being, as embodied in my modified interpretation of the two truths.

Madhyamaka is discussed in *Chapter Two: Madhyamaka*. The general Madhyamaka view of relationality in all phenomena is reflected within philosophical discourse as contextualism that entails a pluralism of specific truths, and in philosophy of science as what I call Physics Pluralism that incorporates the semantic conception of

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<sup>4</sup> Note therefore that some form of intertheoretic reductionism is not denied, while ultimate reductive fundamentalism is.

scientific theories with structural realism (both explicated below). In our interpretation of Madhyamaka we also find relationality in three components: causality, composition and change over time. These components are the topics of each of the next three chapters (Chapters Three through Five), respectively, in examination of Western analytic metaphysics, and the three physics chapters (Chapters Seven through Nine), respectively. We begin an examination of contemporary Western analytic metaphysics in *Chapter Three: Metaphysics of Causality* I apply the contextualism aspect of Madhyamaka semantic relationality allied with Physics Pluralism in order to provide an explication of intrinsicity in physical entities as an embodiment of causal independence. We find that what is intrinsic must be defined in terms of what is necessary and essential to an entity within a specified domain of physics. In *Chapter Four: Metaphysics of Composition* we examine the perennial metaphysical puzzles of composition and vagueness concerning physical entities. I indicate how the puzzles may be solved with the use of the contextualization aspect of Madhyamaka semantic relationality and Physics Pluralism to specify the particular physical properties being discussed within a specific domain. In *Chapter Five: Metaphysics of Change* I address the problem of change of physical properties through time and determine that it is important to distinguish the contexts of the domains of components (e.g. water molecules) from the contexts of the domains of wholes (e.g. Heraclitus' river). These two contexts are different in many ways, and as we shall see those differences demonstrate Madhyamaka relationality and the structural realism aspect of Physics Pluralism, along with significant physics differences (e.g. quantum mechanics vs. Newtonian mechanics).

In *Chapter Six: Physics Pluralism* we discuss details of that epistemic framework which embodies what I call epistemic relationality applied to physics theories. This framework is then applied within the following three chapters to the physics of those same topics discussed during the previous examination of analytic metaphysics. In *Chapter Seven: Physics of Causality* we examine physical causality, which has been criticized as a plastic and unnecessary concept. In light of Madhyamaka relationality embodied in Physics Pluralism I argue against this fundamentalism and find that same plasticity that was the source of criticism as a productive example of pluralism that should not be discarded. In *Chapter Eight: Physics of Composition* I demonstrate Madhyamaka ontic relationality as the objective, ontological basis for physics domain contextualization and also provide detailed arguments in opposition to physics reductive fundamentalism and in support of pluralism. In *Chapter Nine: Physics of Change* I argue against the view that there is no change, finding flaws in the static deterministic world labeled as ‘the block universe’, a view that is supported by some interpretations of special relativity. I invoke quantum mechanics to demonstrate that there is undetermined change in some domains, and I also examine the relevance of quantum gravity theories. This discussion provides further examples of Madhyamaka relationality and contextualization that is embodied in Physics Pluralism.

The newly interpreted Madhyamaka, which is not really that different from many other interpretations, is therefore projected into discussions of the physical nature of physical phenomena found in the literature of contemporary Western analytic metaphysics, philosophy of science, and physics. We find feedback to revise some

aspects of Madhyamaka, and heuristic support for a framework that assists in resolving some of the problems and puzzles discussed in that literature.

## ***A.2. Detailed Introduction***

This investigation ignores most of the motivation for Middle Way philosophy, which has direct relevance to human minds, lives and society; its core relevance is soteriological, to relieve the suffering of human beings wandering in samsara. I will not address this motivation. However, during the course of discussions about minds and lives, reference in the Middle Way literature is frequently given to physical phenomena, indicating that they also have no inherent nature. Additionally, arguments concluding that physical phenomena have no inherent nature are used to justify the lack of inherent nature in minds and lives. That philosophy is understood by its proponents to incorporate general principles that apply to all phenomena.

In Sanskrit, inherent nature is *svabhāva*; and the lack of *svabhāva* is *śūnyatā*. At times it may seem that we characterize both Madhyamaka philosophy and its ‘predecessor’ (at least according to some philosophic reconstructions) Abhidharma as if they were each a monolithic philosophic school, yet they certainly are not. Most nuances discussed over centuries of debate are not discussed here; I provide clarification and justification of the choices of interpretations later in this chapter and in *Chapter Two: Madhyamaka*. Note that ‘Middle Way’ should not suggest it is a view that is in the middle between extremes. One interpretation is that the correct way is not to be found in any view concerning inherent nature, since any view concerning inherent nature necessarily entails one of the many possible extremes. The suggestion that Madhyamaka offers a Middle Way is to reify its view into a fixed perspective, and there are certain tensions in the Madhyamaka literature that work against any such clearly specified view.

I will address some of these tensions below. From now on, however, we leave *Madhyamaka* untranslated to avoid misunderstanding. *Śūnyatā* is usually translated as ‘emptiness’, hence phenomena are said to be ‘empty’ of inherent nature. However, I argue that this translation frequently leads to severe misunderstanding, since statements frequently lack the clause that specifies what they are empty of: ‘Emptiness’ means ‘nothingness’ in our language, and that is not the intended meaning. Translations, meanings and interpretations of all three of these Sanskrit terms have been and are topics of ancient and contemporary debate. Our understanding of them will be refined throughout the dissertation.

In this dissertation the lack of inherent nature is characterized in a positive fashion as relationality, yet we must first address the problematic and quite controversial consequences of making such a positive characterization. It is frequently said that use of positive statements and tenets are rejected by Nāgārjuna and the Prasāngika philosophic school, which are both considered by most contemporary Tibetan Buddhists to embody the epitome of Madhyamaka thought (see Section C.4 of this chapter). I defend an interpretation of Madhyamaka as a rejection of the use of positive statements about inherent nature, rather than a rejection of the use of any positive statements in characterizing the nature of reality at all. Thus, as long as the characterization is divested of any reference to inherent nature then I argue that it is consistent with the literature.<sup>5</sup> The utility of a positive characterization is significant, hence we refine our understanding of both the negative and positive characterizations throughout the dissertation. If we are quite careful about what we mean by ‘relationality’ or other positive characterizations,

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<sup>5</sup> See Oetke (1991) and Ruegg (2000) for relevant analysis and support for my position, especially the latter for extensive exegetic analysis on positive statements, and Dreyfus and McClintock (2003) concerning Prasāngika.

and are sure to divest them of any hidden assumptions of inherent nature, then I argue that such characterizations may be both consistent with the Madhyamaka literature and defensible in light of modern Western analytic philosophy, philosophy of science and physics.

Thus, I argue that the central Madhyamaka understanding of the nature of reality is that all phenomena not only lack inherent nature, but also are relational. I also decompose that relationality into *three components*: causal interdependence with other phenomena (which we call simply interdependence or mutual dependence); mereological interdependence on parts (which we call being composite); and temporal impermanence. Hence, the three components of inherent nature are causal independence of other phenomena; lack of dependence on parts, or rather lack of parts (which we call being unitary); and persistence. I call it ‘persistence’ instead of ‘permanence’—the latter being the more common identification—because of some Madhyamaka arguments that any persistence at all—even for a moment—entails permanence, and because ‘permanence’ has some unfortunate implications lacking in ‘persistence’. These three components become a main organization of the dissertation: See *Section B.2* of this chapter.

However, throughout the dissertation we discuss both the negative and positive characterizations of the nature of things (their properties, relations, structures, etc.), and find that both types are difficult to justify in light of contemporary philosophy and physics if they are taken as universal characterizations regardless of context. Consideration of context requires a pluralist interpretation that distinguishes between *local* and *global* characterizations. A local characterization, for example, may be that in some contexts an entity, process or other kind of phenomenon has inherent nature and in

other contexts it lacks inherent nature. Hence, universally (globally), such a phenomenon may not be characterized as purely lacking local inherent nature or being purely relational. I argue that the requirement to consider context and the finding of different characterizations in different contexts is an indication in this case of a *global* lack of inherent nature and *global* relationality. Hence, we say that such a phenomenon has inherent nature only in relation to certain contexts, while it lacks inherent nature and is relational within other contexts and also lacks it globally in a universal characterization. This is not to say that there are no instances of global, or universally characterizable inherent nature, yet I find that most instances of what is normally considered to be inherent nature may be identified as being of relational origins in particular contexts. This is perhaps a strange way to talk about inherent nature—as dependent on context. One might think that to have inherent nature makes it independent of context. However, we find that this is not the case. It is a major conclusion of this dissertation that global relationality in this pluralist interpretation is a contemporary and justifiable understanding of śūnyatā.

I introduce contextualization in *Section B.5* of this chapter as a basic view embodied in model-theoretic semantics (and suggested by Madhyamaka). Both contextualization specifically and model-theoretic semantics generally are used throughout the dissertation. Contextualization is summarized neatly by the simple requirement to understand and utilize the context of discussion. The variety of meaning theory that we use to emphasize contextualization is a model-theoretic semantics rooted in Tarski's (1935) statements that the truth value of a sentence is indexed to the language used, and a different language may entail a different truth value. Thus, the language in

this sense defines and/or reflects the context of discourse. Model-theoretic semantics is significantly distinguished from a fundamentalist view based on universal truths. Our form of semantics is based partly on da Costa and French (2003), which unifies Tarski's views with Pierce's pragmatics, especially in our treatment of physics theories. The notion of contextualization becomes—with more or less complexity and formality—the pluralist notions of *domains of discourse* for philosophical inquiry, and in application of the semantic conception of scientific theories (see Suppe 1989) it becomes *domains of validity* or *domains of applicability*.

I define *fundamentalism* as the idea that there is one true answer to any question regardless of context. Our requirement for contextualization entails a rejection of fundamentalism in favor of pluralism, both in philosophical discourse and also in physics. Physics forms of fundamentalism come in several varieties. The most innocuous form of physics fundamentalism, with which we will have little argument, is that there are governing principles that apply in all domains, even though the implementation of those general principles in each domain may be quite different from one another. The fact that implementation is different in different contexts is only a mild form of pluralism. The most extreme form of fundamentalism, against which I present many arguments, entails the requirement, partly justified conjecture or (in most cases it seems) unreasonable hope that the answers to all questions in all domains may be obtained from understanding the functioning of the most basic microscopic constituents of spacetime, matter and energy. That understanding of fundamental processes will be embodied in what is now envisioned to be a form of a *grand unified theory* (GUT), a theory of quantum gravity such as string or loop theory. Current versions of those theories attempt to unite the

principles of quantum physics with those of general relativity at the very small, very high energy Planck scale domain of microphysics. The search for GUTs and other unification efforts since the time of Newton has resulted in incredible advances to our knowledge. However, work since the middle of the 20<sup>th</sup> century on renormalization group research in both quantum field theory and condensed matter physics, plus results in the decoherence programme of quantum physics (all of which are discussed in further chapters),<sup>6</sup> has resulted in what might be called a *pluralist turn* in physics epistemology and ontology. In *Chapter Six* we discuss a pluralist epistemic framework to replace fundamentalism, named Physics Pluralism.<sup>7</sup> Physics Pluralism synthesizes perspectives from model-theoretic semantics, the semantic conception of scientific theories and structural realism with the aforementioned perspectives in modern physics.

One of the major themes of this dissertation is a criticism of the extremes of Western metaphysics literature that either ignores physics or attempts to integrate only a high-school level of chemistry and physics, a criticism that is echoed by Ladyman and Ross (2007), and emphasized throughout *Part II: Metaphysics*. Ignoring physics altogether is something that results in confusion and incoherence when attempting to understand physical phenomena. I argue that inclusion of some physics but not the most complete and modern theories is pathological. Much of the mistrust of physics by some philosophers is due to their rejection of older theories. However, due to the mistrust they use rejected theories. My more complete argument for considering this mistrust as

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<sup>6</sup> Specifically, the effective field theory programme—see Cao and Schweber, 1991 and the introduction in Cao, 1999 and for decoherence see Schlosshauer, 2004 for an extensive technical summary.

<sup>7</sup> ‘Scientific Pluralism’ might be an alternative label, and is one that is used in different contexts. See Kellert et al (2006). I use the current label to emphasize the fact that it is not yet designed for application outside of physics topics, and is only somewhat similar to other forms.

pathological is provided in Section B.5 of Chapter Three. I also argue that the pathology can be treated with use of physics, contextualization in general and Physics Pluralism in particular, as explained and demonstrated throughout the dissertation.

Among the central conclusions of this dissertation—and to rephrase some of my previous remarks as summary itemizations—are the following: (1) in order to be coherent and both internally and empirically consistent, it is necessary to include contextualization and pluralism in philosophic perspectives that analyze the physical nature of non-living physical phenomena; (2) specifically, Physics Pluralism, as explicated in some detail in Chapter Six, provides such features of coherence and consistency; (3) Physics Pluralism is also consistent with the general Madhyamaka view that phenomena lack inherent nature, as long as it is interpreted as I have done here, acknowledging the possibility of local inherent nature yet finding few instances of global inherent nature. However, some of the Madhyamaka arguments require revision, as mentioned below; (4) my interpretation of Madhyamaka philosophy is a defensible interpretation of the core meanings of Madhyamaka texts and commentaries and the intended meaning of the general principle of *sūnyatā*. Thus, we are not distorting the original expressions of Madhyamaka simply in order to make it consistent with modern views, nor are we artificially transforming contemporary philosophy or physics in order to match Madhyamaka, even though some of the ancient arguments using ancient atomic theory, for example, will require revision, as discussed below. (5) Additionally, we see that my interpretation of Madhyamaka can inform contemporary philosophical and scientific thought to assist discovery of new insights, mainly as heuristics for providing better explanations of certain metaphysical puzzles and phenomena. The way that this is

accomplished is through the motivation to examine the general utility of pluralism in metaphysical discourse and in philosophy of physics.

In support of these conclusions, the dissertation provides the following discussions. The lack of inherent nature in all phenomena as determined by Madhyamaka arguments has interrelated semantic, epistemological (epistemic) and ontological (ontic) dimensions (not to be confused with the three components of relationality mentioned above, which relate to dependence, composition and persistence). If the fundamental view of Madhyamaka philosophy is correct, then meaning, knowledge and being each and together lack inherent nature. According to Madhyamaka, these three—what we call *dimensions of relationality*—are all interrelated—as is both what we know and how we know what is the nature of reality as embodied in these three dimensions. Hence, the actual being of an entity is interrelated with our knowledge of it and those are interrelated with the meanings that we as human beings and communities ascribe to such knowledge and understanding about the nature of the entity. These dimensions are called semantic relationality, epistemic relationality, and ontic relationality, respectively. We examine those dimensions in contemporary Western philosophy and physics through several interrelated processes of investigation.

The main general Madhyamaka view that no phenomena have inherent nature is supported by the pluralism that I develop here. However, I argue that some of the specific Madhyamaka arguments and fundamental approaches to argument are not consistent with some Western philosophical approaches and views and especially are found to be inconsistent with some of the approaches, views and content of modern physics and philosophy of physics. Since Madhyamaka is designed to be a living tradition, it is

appropriate to enhance its ancient views with the best of the Western views and approaches unless there are significant reasons not to do so. I conclude that we should do so—that some of the arguments should be revised—and I provide some revisions here. My revisions are not in conflict with conclusion (4) above, since I believe—and argue—that I am not generally violating the central view of Madhyamaka (that nothing has inherent nature), just revising the arguments with modern perspectives and physics, and therefore finding conclusions that are more consistent with those latter views. One of the most significant reasons why these revisions should be made is because most Madhyamaka arguments are presented as metaphysical puzzles to be solved by rational analysis that does not integrate modern empirical perspectives, scientific understanding and science content. While this may seem to be an anachronistic criticism, I argue that empirical grounding of rational analysis is necessary to acquire knowledge of physical phenomena. However, we must clearly understand the relationship between rational and empirical approaches from the Madhyamaka point of view in order to make them consistent, and much of this dissertation is guided by the intention to do just that. Therefore, before we proceed to the physics, we start by discussing metaphysical puzzles posed and answered in Madhyamaka text and commentaries and then proceed to analyze similar puzzles from contemporary Western metaphysical points of view. I argue that many of those puzzles can be solved (or rather seen as non-problems) by judicious use of pluralist contextualization and specifically the physics context. I find many arguments in Western analytic metaphysics and in Madhyamaka literature confused or fallacious due to lack of use of that context. The application of contextualization to those puzzles and their solution is an instance of semantic relationality.

The epistemic and ontic dimensions are mainly discussed in *Part III: Physics*. In the epistemic dimension we apply the semantic conception of scientific theories to synthesize and apply a credible epistemological interpretive framework that represents how many (although not all) contemporary philosophers of science and physicists actually understand the nature of physical theories and their content. The semantic conception of scientific theories is closely related to model-theoretic semantics, and especially to the contextualization aspect. The semantic conception of theories identifies a theory, or what we call a *theory system* in the context of Physics Pluralism, with a collection of formal structures or models. The latter are collections of sentences that are true and closed under logical implication in the language of the theory. However, as we shall see in Chapter Six, even though the models are collections of sentences, minor changes in the language that then entail a change in the sentences does not necessarily entail changes in the models. These formal models are related to the physical world through partial isomorphisms that provide meaning to terms, phrases, sentences and propositions of the language used by the theory and its models. Partial isomorphisms may be provided from the formal models to informal models and finally to data models of the empirical data. Use of the semantic conception of theories, especially in the hands of da Costa and French through use of their form of model-theoretic semantics, formalizes the intuition that scientific theories are non-linguistic entities, hence are independent of specific languages. This result is explicated in *Section B of Chapter Six*.

Physics Pluralism is the epistemic framework that I synthesize from the da Costa and French's model-theoretic semantics, the semantic conception of theories, structural realism and the content of modern physics. Physics Pluralism was initially inspired by the

pluralism proposed by Rohrlich and Hardin (1983) who responded to instrumentalist arguments of Laudan (1981) against realism, as part of the perennial arguments concerning realism and anti-realism found in the literature of philosophy of science. One of the main concepts that Physics Pluralism utilizes is ‘domains of validity’, which have two basic types: *merely pragmatic* and *ontic*. The distinction between the two and justification for ontic domains is explicated in some detail in *Chapter Six* and shown to be plausible in the physics chapters, *Chapter Seven, Eight and Nine*. Briefly, if a mature and accepted theory pertains to only a merely pragmatic domain then it may be judged as empirically adequate, while if such a theory pertains to an ontic domain then it may be judged as true in that domain. *Chapter Six* should be seen as the technical core containing the main conclusions of the dissertation. However, only in *Chapter Eight* will we find the complete technical description of how an ontic domain is determined, although various summaries are provided throughout the dissertation.

Concerning the ontic dimension of relationality, I argue that the properties of an entity vary among different domains. Specifically, entities may have inherent nature in some domains, yet their nature may be found to be relational in other domains, which is an example of global ontic relationality corresponding to the ‘ultimate truth’ of my modified interpretation of the two truths. To again reiterate the chapter structure of this dissertation in this context, justification for this conclusion requires first understanding Madhyamaka objections to the existence of inherent nature (*Chapter Two*), understanding concepts of independence, intrinsicity, essence, necessity, etc. that are used to understand inherence (*Chapter Three*), metaphysical analysis of composition (*Chapter Four*) and of temporal processes (*Chapter Five*), plus finally application of Physics

Pluralism (*Chapter Six*) to demonstrations of the plausibility of ontic relationality in many physics domains (*Chapters Seven through Nine*).

There are several further issues that are discussed throughout the dissertation, not confined to one chapter or another. One of the major issues discussed here is the whether there is an objectively known reality described by physics theories. My interpretation is that Madhyamaka argues that there is such a reality and that it can be described by realistically interpreted theories. However, we must understand what Madhyamaka describes about that reality. Against one extreme, Madhyamikas argue against nihilism (that nothing exists) and idealism (that all phenomena are mere manifestations of mind). At an opposite extreme Madhyamikas argue against the ultimate truth of naïve realism (that all phenomena are in actuality just as they are perceived and cognized, i.e. to have inherent nature). Sentences deemed ultimately true by a naïve realist are, in this simplistic definition, classified as a conventional or relative truth, one of the *two truths* discussed further below, while the ultimate truth according to Madhyamaka is that phenomena are not just as they are generally perceived and cognized and actually lack inherent nature. Madhyamikas also argue against the extremes of substantialism (that an entity is distinct from its properties and generally entities ‘are’ actually instantiations of a singular, monistic entity), and eternalism (that things are permanent). Some of these so-called ‘extremes’ are closely allied with essentialism (that there are eternal, necessary and substantial essences in things). Those essences are frequently equated to intrinsic properties. Without intrinsic properties, some contemporary Madhyamikas further deny the existence natural kinds, which are defined loosely as classes of individuals distinguished by their inherent, common, essential and intrinsic properties. Without

intrinsic properties, how can there be natural kinds? Without such classes, Madhyamaka has been used to argue for a Humean regularity theory of causality.<sup>8</sup> In the context of physical non-living phenomena, since I argue that there are intrinsic properties (yet which are domain specific) I also argue that it is untenable to suggest that there are no such kinds (yet they also are domain specific). With the natural kinds of physics come also natural laws that explain the regularities, hence I also offer an alternative to Humean causality. Since the sort of natural kind that I promote acknowledges differences in domains, it may turn out that the intrinsic properties of entities that are classified as natural kinds in some domains are relational in other domains, thus exhibiting global ontic relationality.<sup>9</sup>

An immediate objection to the idea that there is no inherent nature, an objection that I had and which became an original motivation for my own investigation that resulted in this dissertation, is that there are natural physical kinds identified by their

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<sup>8</sup> See Garfield (1995, 103-123; 2002, Chapter 1)

<sup>9</sup> A detailed discussion of the controversies pertaining to natural kinds will require consideration of a vast literature which will take us too far afield. In any event, I promote a view of them which is perhaps somewhat unique compared with that literature. In general, the term in my usage here will be as follows: A natural kind in a particular domain--if such a kind exists--is a class of objects defined by their intrinsic, necessary and essential properties within that domain--if such properties exist. I take it as an intuitive notion (if not formally proven) in physics, substantiated (as we shall see) in several domains, that such kinds exist. The property predicates used here are discussed in detail in Chapter Three; domains are discussed in detail in Chapter Six; the localization of these properties to particular domains is discussed throughout the dissertation but worked out technically in Chapter Eight. It may turn out that some natural kinds have the same properties in all domains; that situation is not excluded from possibility. The term is used—albeit with different denotations and connotations—in the literature that we examine here, hence use of the term cannot be avoided. Note, however, that different people mean different things by that same term. I argue that undeniable examples of natural kinds are found in the familiar periodic table of the elements, naturally distinguished from each other somewhat imprecisely by their physical and chemical properties, but very precisely by the number of protons in their atomic makeup, which also is the number of electrons in their stable configurations which determine their properties. A further distinction is their numbers of neutrons determining the isotope classification, thus indicating a further set of natural kinds. These criteria are discrete, and cannot be considered vague or conventional. That they are ‘just one classification from the community of physicists’ and other classifications are certainly possible does not detract from my usage here, which concerns physics. Hence, if the reader likes, she may substitute all references to natural kinds with ‘physics natural kinds’.

inherent nature. Before we proceed with a detailed examination of this situation, which will take up much of the dissertation, an introductory summary may be helpful. As an example, the chemical elements are typically considered natural kinds, characterized by intrinsic chemical and physical properties, one of which is density: rest mass per unit volume. Is this not inherent nature? Yet, looking closely we find that the mass of a given block of iron, for example, while a conserved property governed by conservation of mass and energy, is the result of a number of intrinsic and relational characteristics. These include the mass-energy of inter-atomic bonding, of intra-atomic bonding, the relativistic mass-energy of the quarks that are composita of neutrons and protons of each atom, plus the intrinsic rest mass-energy of the quarks themselves, etc. Additionally, the elementary particles of quantum field theory are typically considered as natural kinds, with intrinsic properties: what are called ‘state-independent properties’, including rest mass and charge. However, considered within higher energy domains (and in application of the renormalization programme of effective quantum field theories) mass can be shown to be relational with the newly discovered Higgs field and charge can be shown to be relational with polarization of the background quantum vacuum field. For reasons further discussed in *Chapter Eight*, elementary particles have essential relational natures that are called ‘intrinsically relational’ (Teller, 1989). This does not represent solely an epistemic issue of, for example, operationalizing the charge of an electron by its interaction with an ambient field. Rather, such particles are considered by many to be relational *according to their ‘inherent’ nature*. This additional predicate ‘inherent’ added to ‘relational’ is used by Teller to emphasize the idea that the relational properties of such entities are not accidental, contingent, and modifiable without drastically destroying the entity, but are

rather part-and-parcel of the ultimate, intrinsic, essential and necessary nature of the entity. I also argue that these natural kinds are described by natural physical laws that describe more than simple regularities,<sup>10</sup> and that are discovered by physics and interpreted by physics and philosophy. I compare these views favorably with pluralist view of Madhyamaka, and find them to justify global relationality, which is an example of śūnyatā.

I developed Physics Pluralism to enable understanding of how such things as natural kinds and state-independent properties may be interpreted. At the center of this investigation is how model-theoretic semantics, Physics Pluralism, physics theories and content, and Madhyamaka offer arguments against the related views of fundamentalism and material mereological reductionism. Material mereological reductionism is a cluster of views based on the idea that understanding of a whole physical entity or other type of phenomena (e.g., process, event, relation) can only come from an understanding of its parts, and is the basis of fundamentalism as previously introduced. We find mereology used in many Buddhist arguments and is generally denied by Madhyamikas if we are talking about discrete parts with inherent nature, in favor of śūnyatā.

Physics Pluralism is both epistemically and ontically plural. It is epistemically plural in being able to accommodate different types of instrumentalisms and realisms, depending on our judgments concerning a theory's mere empirical adequacy or truth in its domain. Closely related to that pluralism is its ontic pluralism, which is its ability to

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<sup>10</sup> This statement may open me up to being identified as a Platonist about physical laws; that such laws exist *out there* as entities which are instantiated *here*. To clarify my stance, I say that the way the world is must be considered the object of investigation. That is simply the way the world is. Not much we can do about that except to discover and articulate its nature, and the latter are the laws—the laws are not out there waiting to be discovered, but are rather the articulation of our understanding of the nature of the universe. The point being made here is more about regularities not being the terminus of explanation, but rather the terminus is way things are which explain the regularities. More on the terminus problem later.

accommodate different ontological elements depending on the nature of phenomena in different domains. In some domains entities are well known, hence we can justifiably say that they exist, yet in others only structural relations may be justified.

To summarize, application of Physics Pluralism entails that some phenomena have what could be interpreted as inherent nature when we are restricted to certain domains of applicability. However, that nature does not withstand analysis that examines other domains or compares results in each domain within a larger context of meaning, knowledge and being. I argue that analysis of local domains corresponds to ‘relative truth’ in the Madhyamaka conception of *two truths* as discussed in *Chapter Two*, and analysis across domains corresponds to ‘ultimate truth’. The ‘middle way’ of Madhyamaka is thus interpreted as follows: There are local domains in which some phenomena have inherent nature. However, this cannot confirm the extreme of substantialism, because when we look at the source of the phenomena in other domains we find that the supposed inherent nature results from relations between different components. Hence, globally, we conclude that there is no inherent nature. The inherent nature in certain domains cannot be thoroughly eliminated, because in those domains the nature is inherent. The inherent nature is reduced in other domains to relational interactions, but that relational nature cannot be the sole manifestation of the phenomena due to the inherent nature in other domains. Ultimately, our major conclusion is that we find a global lack of inherent nature of phenomena in the relationships concerning meaning, knowledge and being within and between domains, and thus our findings correspond to semantic śūnyatā, epistemic śūnyatā and ontic śūnyatā. Here is the middle

way of pluralism: relative, local inherence and ultimate, global relationality, each of which must be confirmed in their own contexts.

We now have two dichotomies: instrumentalism vs. realism of science theories, and conventional vs. ultimate in the two truths of śūnyatā. We may be tempted to identify the instrumentalist view of science theories with the conventional view of the two truths of śūnyatā, and identify the realist view of science theories with the ultimate view of two truths. Briefly, we might summarize the instrumentalist/conventionalist views as stating that a theory, or an idea about reality, is false yet useful, and the realist/ultimate view as stating that a theory, or a view about reality, is true—yet this would be an incomplete characterization. In the ultimate truth of śūnyatā, what is true is that all things lack inherent nature, while the realist view of theories is merely that the theory truly represents reality, regardless of what the theory states about the nature of that reality. If the theory identifies inherent nature in its domain, then this would be classified by the two truths of śūnyatā as conventionalist or instrumentalist. Therefore, if we have a theory interpreted realistically that identifies inherent nature, then that theory might conflict with an interpretation of śūnyatā. Here is where the local/global domain distinction comes in: My interpretation of śūnyatā is that while a realistically identified theory, judged as true by the credibility scale itemized in Chapter Six, may identify inherent nature in a local domain, in at least many cases (leaving as a hypothesis whether a universal attribution can be made) a global characterization of relationality rather than inherent nature will be found. This global relationality with local inherent nature is described in Chapter Six and shown to be plausible in several instances in the succeeding three physics chapters.

### A.3. *Synopsis*

This dissertation is divided into three parts plus *Chapter One: Introduction* and *Conclusion*. *Chapter One: Introduction* is composed of several summary presentations of relevant information that can guide the reader through the dissertation. These summary presentations include the preceding *Introduction (Summary and Detailed)*, this *Map*, plus a *Preliminary concepts, taxonomy and terminology* section. The latter includes listing of Madhyamaka texts and commentaries; the three dimensions and three components of inherent nature and the lack of inherent nature; brief explanations of some relevant schools Buddhist thought; and a chart of the dissertation chapter structure. Additionally, there are three more extensive discussions in Chapter One concerning the contextualization concept from model-theoretic semantics; reductionism; and quantum entanglement. Next is *Part I*, which has just one chapter, *Chapter Two: Madhyamaka*, where we have an explication of major relevant Madhyamaka arguments, relying heavily on exegesis and explication of ancient texts with the help of both ancient and contemporary commentaries. Inherent nature is decomposed as mentioned into its three components, corresponding to the three components of relationality. We postpone detailed critique of Madhyamaka arguments, and use the presentation of Madhyamaka as a further map of issues that we examine in later chapters. In *Part II: Western Metaphysics* we discuss the three components of inherent and relational nature from various contemporary Western analytic metaphysics points of view in *Chapters Three: Metaphysics of Dependence*, *Chapter Four: Metaphysics of Composition*, and *Chapter Five: Metaphysics of Change*. In *Part III: Physics* we begin with *Chapter Six: Physics Pluralism* in order to establish an epistemic framework from which we can discuss the three components from viewpoints of physics and philosophy of physics in *Chapter*

*Seven: Physics of Dependence, Chapter Eight: Physics of Composition and Chapter Nine: Physics of Change.*

In *Chapter Three: Metaphysics of Dependence* we discuss causal independence and dependence as a conceptual analysis of various related terms that have been used in the contemporary Western metaphysics literature, including independent, intrinsic, extrinsic, relational, necessary, essential and relevant. Madhyamaka argues that there are no phenomena with causal independence, but we must know what it is to be independent before we can test those arguments and that conclusion. There are two problems that form the focus of discussion in this chapter: (1) How do we formally express the intuitive notion of ‘intrinsic’ and ‘independent’ as predicates of a property that is had in virtue of the entity alone? This is accomplished more easily when we ground our metaphysics in physical relevance, which essentially means causal relationships. This grounding is analyzed in some detail in Chapters Three and Eight, the *Metaphysics* and *Physics of Dependence*, respectively. (2) How do we determine what properties are intrinsic and what are not—and if there are any of the former? The second question remains a significant problem which will require physics to answer, hence will await *Part III: Physics*. From Chapter Three it is determined that an independent entity (if one exists) would have intrinsic properties that are necessary and essential to it being that entity, whether or not there are any other entities in the universe. The latter is called ‘independence of accompaniment’. From the Madhyamaka point of view, the properties of a completely independent entity cannot result in any causal interaction, cannot be known, and should not be considered to exist. From the analytic metaphysics point of view examined in this chapter, independence relates intimately to intrinsicity and once

that concept is clarified then it is left to physics to provide an inventory of intrinsic properties (since it is assumed that they exist). By this method, the only way to determine if a property is intrinsic is to make sure that there are no relations to other entities. Yet, the only way to determine what an entity is without relations is to duplicate only the intrinsic properties, hence we are caught in circularity. Much of the literature describes attempts to get out of that circularity. I argue that grounding in physical science provides a solution.

In *Chapter Four: Metaphysics of Composition* we discuss the composition problem, reductionism, and especially several contemporary ‘eliminativist’ arguments that reductively analyze whole physical objects into their assumed mereologically independent atomic parts and attempt to eliminate them from any viable ontology in favor of atoms. Conclusions from these arguments support certain views of Abhidharma, contrary to Madhyamaka reasoning. The major Western arguments are from Unger (1979), van Inwagen (1990) and especially from Merricks (2001). The latter eliminates the whole object from our ontology by parsimony and causal overdetermination, claiming that atoms hold the entire causal efficacy. I critically evaluate those eliminativist arguments, demonstrating two problems. First, the Madhyamaka anti-reductionist critique applies: Elimination of partite or composite entities assumes a metaphysical atomic simple, but does not establish that such a thing exists—and it is doubtful that such a thing exists. Therefore, the elimination should continue to include even the atoms and their parts, etc., which shows how this reductionism is absurd. Note, however, that I will later argue that even the Madhyamaka arguments use similarly fallacious mereological assumptions. The second problem with these eliminativist arguments—Western,

Abhidharma and Madhyamaka—is that the elimination of composite entities, i.e. rejection of any inherent nature in those entities, may not be justified according to our current physics, thus bringing into question both the Madhyamaka view as well as the Western eliminativist view. One problem common to many Abhidharma, Madhyamaka and Western arguments (even though they come to many different conclusions) is that they treat a solid object as a collection of independent atoms. However, a solid object is not such a collection, but is rather a physical structure that has parts that are bound by very tight electromagnetic forces. I argue here, and especially with more detail in *Chapter Eight: Physics of Composition* that we should conclude from this situation that for some phenomena the object is not a reducible collection of independent things, but is a unitary whole.

In *Chapter Five: Metaphysics of Change* we turn to contemporary attempts at solutions to the perennial problem of change, which comes down to the question of change in intrinsic properties. According to the literature that is examined, intrinsic properties cannot change, since there would be no relation to something that could cause change (if there were, then the properties would not be intrinsic). This view is consistent with Madhyamaka reasoning. Yet some properties that some analysts intuitively consider to be intrinsic do change. Applying the analysis in *Chapter Three: Metaphysics of Dependence*, the properties that were presumed to be intrinsic actually are not essential to the identity of the entity under examination (at least in some domains). To be intrinsic requires that the properties are internal and essential, hence simply because a property is internal does not necessarily entail that it is intrinsic. In this case, the property may be secondary or relational, and its change is not problematic. Hence analysis of intrinsic

properties must be limited to the internal *and* essential properties (and further predicates discussed in Chapter Three), and we again are left with the problem of determining if there are any properties which might qualify, and if so which ones. We find fuel against mereological essentialism in this analysis, in that the parts which change are not always found to be essential to an entity when interpreted with structural views, and in certain domains structural realism of some sort seems appropriate. One contemporary answer to the problem of change is four-dimensionalism, which is the view that nothing changes since the object as we see it in the present is just a temporal part, and one part may be different from another, just as spatial parts are different, while the nature of the whole 4D object does not change. The 4D-stages variation postulates infinitesimally small limit-moments of time as temporal parts in order to explain apparent change, and we find this similar to the radical momentariness of Abhidharma. Transforming the discrete momentariness of the stages to continuous flows will take us closer to Madhyamaka impermanence.

In *Part III: Physics* we examine our fundamental questions from viewpoints in philosophy of science and physics. In *Chapter Six: Physics Pluralism* we outline a synthesis of pluralist views that apply in the epistemological and ontological dimensions of the lack of inherent nature. A basically realist perspective applied to many domains of physics is required, while an instrumentalist perspective may be appropriate on the boundaries of our understanding. Properties of entities—such as independence, unitarity, persistence, and their lack—in a domain described by a theory and model, are understood as dependent on the phenomena that is examined, and an entity may have different properties in different domains. This is the core observation of ontological relationality.

In Chapters Seven, Eight and Nine we reexamine the topics of Chapters Three, Four and Five, but through philosophy of science and physics in an application of Physics Pluralism. In *Chapter Seven: Physics of Dependence* we evaluate various concepts of causality relating to the independence vs. dependence component, and different concepts that challenge and/or support Physics Pluralism and my view of relationality. We look at production and dependence theories of causality, and note Madhyamaka allegiance to the latter. However, regularity theory—the form of dependence proposed by some analysts as aligning with Madhyamaka—is found wanting from a physics point of view. Rather, a different dependence theory is proposed: the conserved quantities approach. The conserved quantities approach, as interpreted by Physics Pluralism, suggests the existence of domain-specific inherent properties and domain-specific laws of nature. Yet, when such properties are compared over different domains we see an ontic relationality which is consistent with śūnyatā. We find causality to be a flexible concept, with significant differences in meaning in different domains. Rather than interpreting causality in terms only of regularity, and understanding this to mean that there is no necessity in natural laws, we find causal necessity to be domain specific. Thus causal relations have no global inherent nature either. We take the domain specificity of causality to be an example of global relationality that corresponds with our interpretation of śūnyatā.

In *Chapter Eight: Physics of Composition* we discuss the unitary vs. non-unitary component of the problem. Thus, as conceptually examined in Chapter Four, for domains in which classical mechanics and dynamics, even relativistic theories, are applicable, some entities relating to some phenomena are unitary. We find additional justification for this view in condensed matter physics (which is a synthesis of classical and quantum

theories and models of the solid state of matter). The renormalization programme within quantum field theory determines that particles with state-independent properties (mass, charge, spin which are the conserved quantities discussed in relation to causality) are posited to exist, but their existence must be interpreted within a context of energy levels (which serve to distinguish domains) that are indexed to the phenomena being examined. Here we discuss symmetry and spontaneous symmetry breaking which determine the boundaries of effective field theories, providing a central criterion to define what is required for a domain to be classified as ontic. We determine the ontological component of the lack of inherent nature: Phenomena and their properties arise interdependently, but through application of the epistemic dimension of relationality in analysis of the results of different physics theories we obtain justification for the idea that ontological properties of what we might call the same object (e.g. atom, electron, proton, quark) are frequently different in relation to different phenomena in different domains described by different theory-systems. How this situation is described and understood is discussed in Chapter Eight.

In *Chapter Nine: Physics of Change* we turn to time, persistence and impermanence in the context of both the special and general theories of relativity and also quantum mechanics, quantum gravity and the emergence of classical domains. Partly since mereological essentialism is rejected in favor of different forms of structuralism, we discuss a perspective that acknowledges the existence of persisting objects in certain domains of applicability. However, in other domains some entities are impermanent while conserved quantities persist (e.g. electron-positron pairs are annihilated and

photons appear, while mass-energy, momentum and spin are conserved).<sup>11</sup> Since exchange of conserved quantities might be interpreted as instances or sources of causal relations, we could say that relations persist while entities are impermanent, thus demonstrating a significant alignment with Madhyamaka views. The latter indicate that even causal relations also have no inherent nature, and we see how this can be cashed out in the physics. We also discuss the emergence of classical domains from quantum domains during the globally-defined finite-durational present of decoherence from different local entangled states that define an instantaneous local present. Thus the undetermined future emerges from the known past through the present.

Many of the particular results in particular domains that we have examined seem to conflict with many of the particular arguments and conclusions of Madhyamaka as we now understand them, and it seems that there is a lack of inherent nature relating to particular phenomena in some domains, while there is inherent nature in other domains. Yet, more generally, the meaning of a proposition must be indexed to a language and context of discourse, which is semantic relationality. Different physical theories must be used in order to achieve understanding of different phenomena in different domains of applicability of scientific theories, an example of epistemic relationality. While in a particular domain an entity may be determined to be independent, unitary and/or persistent, in other domains it is more plausible to identify it as composite, dependent and/or impermanent. This is an example of ontological relationality and local inherent nature vs. global relationality indicated by my pluralist interpretation of the two truths of Madhyamaka śūnyatā. Thus, my analysis provides several examples of phenomena with

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<sup>11</sup> Indeed, some quantities, such as those listed here, are conserved in all domains. Conservation of mass-energy and charge, for example, are fundamental and universal principles, as described in Chapter Six, even in domains of quantum fluctuations.

inherent nature when our analysis is confined within local domains of discourse or applicability. Yet, when analyzed in other domains those ‘same’ phenomena are found to lack inherent nature. Hence, in a more global context they lack inherent nature. I argue that this is a general feature of our reality. This is a further way to interpret the lack of inherent nature in the lack of inherent nature, which we summarize as the relationality of relationality, or śūnyatā of śūnyatā, and which I argue is the ultimate meaning of śūnyatā.

## ***B. Appendices***

We begin this section with four short summary appendices. In B.1 I offer a summary of the main texts and commentaries from the classical Madhyamaka literature that are used, especially in Chapter Two, in order to establish a baseline interpretation of śūnyatā. Second in B.2 there is a listing of the triads of triads of the dimensions, components and arguments of relationality and inherent nature. Third, in B.3, we have a summary identification of some of the relevant Indian schools of thought that are referenced within the dissertation. Section B.4 is a chart mapping the dissertation chapter structure. After these short summaries, In Section B.5 I then briefly explicate some key concepts and perspectives used throughout the dissertation: contextualization as adapted from model theoretic semantics in Section B.5.a; reductionism in B.5.b; and quantum entanglement in B.5.c.

### ***B.1. The classic Madhyamaka texts and commentaries***

The major classic texts and commentaries used in this dissertation are the following. While there may be many different translations to the Sanskrit or Tibetan title, I use the one provided by the specific, currently available translations designated by the acronym in parentheses which corresponds to the entry in my Bibliography.

Nāgārjuna (1<sup>st</sup> – 2<sup>nd</sup> C. AD India) *Mūlamadhyamakakārikā (MMK) The Fundamental Wisdom of the Middle Way* .

Candrakīrti (7<sup>th</sup> C. AD India) *Madhyamakavātarā (MAV) Introduction to the Middle Way*

Śāntideva (8<sup>th</sup> C. AD India) *The Bodhisattvacharyavatara (BCA) The Way of the Bodhisattva*.

Śāntarakṣita (8<sup>th</sup> C. AD India) *Madhyamakalankara (MAL) Adornment of the Middle Way*.

Tsong-kha-pa (14<sup>th</sup> C. AD Tibet) *Lam Rim Chen Mo: (LRCM) The Great Treatise on the Stages of the Path to Enlightenment*

Tsong-kha-pa *Ocean of Reasoning: (Ocean) A Great Commentary on Nāgārjuna's Mūlamadhyamakakārikā*

Vasubandhu (2<sup>nd</sup>-3<sup>rd</sup> C. AD India) *Abhidharmakosabhasyam* (title left untranslated in the translation used here, and which could be translated as *Commentary on the Treasury of Abhidharma*).

## ***B.2. Dimensions and components of inherent nature***

We distinguish three interdependent *dimensions* of the lack of inherent nature (śūnyatā):

- Semantic
- Epistemological (epistemic)
- Ontological (ontic)

We distinguish three *components* of inherent nature and the lack of inherent nature and three corresponding argument types:

- Independence/dependence (causality)
  - Madhyamaka causality arguments
- Unitarity/non-unitarity (mereology)
  - Sevenfold reasoning

- Neither-one-nor-many
- Persistence/impermanence (temporality)
  - From the universality of change
  - From mereological essentialism
  - From eventual destruction.

We examine these three types of Madhyamaka arguments which deny inherent nature that correspond to the three components. In each argument, each component will exhibit one or more dimensions of the lack of inherent nature.

### ***B.3. Some relevant schools of Buddhist thought***

*Vaibhāṣeka* is a Buddhist Abhidharma philosophy, and one of the two sub-schools of *Sarvāstivāda* whose views are summarized by Vasubandhu in his *Abhidharmakośa*. Among other things, the latter analyses the elements of psychological makeup into its many elements (*dharmas*). One classification of dharmas is the five aggregates (*skandhas*). The term *skandhas* is also sometimes translated as ‘heap’. Note the similarity with Hume’s comment: “I would remark that what we call ‘a mind’ is nothing but a heap or collection of different perceptions, held together by certain relations and wrongly supposed to be endowed with a perfect simplicity and identity” (Treatise, Book 1, Part 4, Section 2, paragraph 39, SP206). *Skandhas* also refer aggregates of material form, which concern us here, not just to mind, which does not.

*Abhidharma* is one of the three major ‘baskets’ (*tripitaka*) of Buddhist teachings.

Abhidharma is the collection of philosophically and psychologically

oriented discussions and analysis of doctrine. The other *pitakas* are *sutras*, discourses of the Buddha, and the *vinaya*, a code of monastic conduct.<sup>12</sup>

*Sautrāntika* is another school of Abhidharma thought whose views are often favored by Vasubandhu over those of the Vaibhāṣikas in a commentary he wrote on his own Abhidharmakośa titled the Abhidharmakośabhāṣya.

*Cittamātra*, *Yogācāra*. *Cittamātra* means ‘consciousness-only’. *Yogācāra* is a yoga (practice)-oriented phenomenological school of thought that is frequently identified with *Cittamātra*. It is, alongside *Madhyamaka*, one of the two main Mahayana Buddhist schools of Mahāyāna philosophy. It was also systematized by Vasubandhu, together with his brother Asanga who, it is said, converted him to Mahāyāna.

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<sup>12</sup> Abhidharma—based on sutras, the *Abhidharmakośabhāṣya* by Vasubandhu and further texts, especially by Dharmakīrti—is the basic Buddhist philosophy of perception and self. See Ronkin (2010). Much of Abhidharma is also accepted provisionally by *Madhyamika* scholars, and then they proceed to refine it through intense criticism, divesting it of any suggestion that there is inherent nature in phenomena. Hence, the psychological aggregates of ego, for instance, are examined by Nāgārjuna (MMK 24) and shown to not be denied conventionally, yet to not be ultimately substantial; rather they also are relational—they are *śūnya*. There are different schools within Abhidharma as well. Some schools think *Madhyamaka* heretical. In Abhidharma, all things—experience, self, perception and physical objects—are constructed from different kinds of elements called *dharmas* (with a small-d; with a capital-D Dharma refers to *Buddhadharma*, or Buddhist truth.) Therefore, the composite object has no self-identity at all, independent of its parts. For *Madhyamaka* even the parts have no self-identity. Ronkin writes at the end of section 1.2: “The Abhidharma exegesis thus attempts to provide an exhaustive account of every possible type of experience—every type of occurrence that may possibly present itself in one’s consciousness—in terms of its constituent *dharmas*. This enterprise involves breaking down the objects of ordinary perception into their constituent, discrete *dharmas* and clarifying their relations of causal conditioning.” According to some, *Nyāya-Vaiśeṣika*, a Hindu philosophy, might be interpreted as having some similar views. See Narayan (1977) for an introduction to *Vaiśeṣika* physics. Here, I am ignoring many nuances of differences and simply citing one feature of both of these, which is their atomism. Narayan provides an excerpt from the *Vaiśeṣika* sutra: “That which is existent and has no cause (i.e., an atom) is eternal. It is not perceived but is inferred from its effect. [10]. (iv.1.1-5)” and explains “Atoms are the primordial infinitesimal particles of everything except space or *Akasha*. To a certain extent terms like atom and space tend to give us the picture of current-day atom or space, but there are some differences. Atoms in *Vaiśeṣika* are essentially of four kinds: Earth, *Āpa*-water, *Tejas*-Fire and *Vāyu*-air. These atoms are characterized by their characteristic mass, basic molecular structure such as dyad, triad, etc, fluidity (or its opposite), viscosity (or its opposite), velocity (or quantity of impressed motion- *Vega*) and other characteristic potential color, taste, smell or touch not produced by chemical operation. It is these four kinds of atoms involved in all chemical reactions while the space remains unaffected.” (4-5)

*Madhyamaka* schools:

*Svātantrika* (autonomous reasons) is a sub-school of *Madhyamaka* which emphasizes direct views and statements about the nature of reality.

*Prāsangika* (consequentialist) *Madhyamaka* does not technically promote any views, yet extensively disputes views of others. Therefore, it is used widely in debate to show fallacies in the consequences of opponent's arguments.

#### ***B.4. Dissertation structure***

Table 1: Dissertation Structure

<b>Parts</b>	<b>Introduction / General Topic Chapters</b>	<b>Dependence Independence Causality</b>	<b>Composition</b>	<b>Persistence Impermanence</b>	<b>Integration- Evaluation- Summary</b>
	One: Introduction				
<b>Part I Madyamaka</b>	Two: Madhyamaka				
<b>Part II Western Metaphysics</b>		Three: Metaphysics of Dependence	Four: Metaphysics of Composition	Five: Metaphysics of Change	
<b>Part III Physics and Philosophy of Physics</b>	Six: Physics Pluralism	Seven: Physics of Dependence	Eight: Physics of Composition	Nine: Physics of Change	
<b>Conclusion</b>					Conclusion

#### ***B.5. Explication of key concepts***

##### ***a. Contextualization***

In this section I explicate a general minimal commitment concerning meaning which is fundamental to much of the dissertation. This commitment can be called *contextualization*, or simply understanding the context of the conversation, or

understanding what we call (in different contexts) the domain, the domain of philosophic discourse or the domain of applicability/validity of physics theories. Speaks (2010) identifies several theories of meaning and categorizes two sorts, one called a *semantic theory* and another a *foundational theory* of meaning. The former is based on the language as a given and the latter seeks personal, cultural and societal sources of the language. Semantic theories can be divided into propositional and non-propositional sorts, and the former takes a theory of reference as a basis. Since we will be analyzing philosophical discourse concerning physical non-living phenomena and will not be concerned with nuances of culture, and because we will be aiming at analysis of a discourse based on physics, use of the propositional model-theoretic semantics which utilizes a theory of reference is appropriate, as offered by da Costa and French (2003). This variety of theory of meaning is related to a model-theoretic version of the semantic conception of theories that we use in analysis of physics. The semantic conception seeks references to physical conditions from models rather than from isolated linguistic elements, although such models are of course constructed from those elements.

We will not defend all aspects of model-theoretic semantics, which in da Costa and French's version is ultimately based on Tarski (1935) combined with Peircean pragmatics. In terms of scientific theories, the semantic conception of theories based on model-theoretic semantics demonstrates the foundational understanding of how theories are extra-linguistic entities, and that is discussed in detail in Chapter Six, Section B. Throughout the dissertation, and especially in Chapters Three through Five, we use the conception that is central to model-theoretic semantics that I call contextualization: In my interpretation of Tarski, the meaning of terms in a proposition must be defined to be

consistent with a specific and well-understood language (also called the context) if the proposition is to have meaning and truth value. This idea has a long history, and the modern version that we apply has a basis in developments in mathematical logic which followed Russell's Paradox that can be subsumed under what has been called Hilbert's Program (see Zach 2003) to formalize and show mathematics as consistent (a program that was, of course, not entirely successful). Mathematical logic utilizes a concept called a *well-formed function* (wff). What is well-formed is found from an application of rules within a system of language and axioms. In arithmetic, '1+1=2' is a wff, while '1+1=' is not. But we don't just judge this by looks on the fly; our judgment as to whether it is a wff relates to a system, or in other words has a context. For example, confining ourselves to mathematical symbols, for '1+1=2' to be true requires that the language contain a relevant axiomatic set theory, theory of arithmetic and base for counting. For example, with a base 2 counting system '1+1=10', but of course the normal reference of '2' in base 10 is the same as the reference of '10' in base 2. And, as pointed out, in those systems '1+1=' has no meaning, and therefore no truth value.

However, these are simply abstract symbols without further reference until an interpretation is provided. To show that interpretation is not trivial, consider the interpretation with the numbers representing rabbits, and the formula expressing the sum of 'one rabbit plus another rabbit = two rabbits'. Addition of numbers requires a context which involves us in a system of arithmetic, set theory and logic. Addition of rabbits requires a context of space, time, biology, and ecosystems. Since this proposition is about physically real objects, a physically real context must be used, and therefore time(s) and other conditions must be specified because given enough time and other physical and

biological conditions the sum may be many rabbits, not just two. Hence, in this interpretive context, without specifying those other conditions the formula is ill-formed and therefore meaningless.

In another context, the language of comparison statements such as ‘Barack Obama is tall’ requires a comparison parameter such as ‘compared to politicians’ or ‘compared to professional male basketball players’. Without that parameter the original statement should be considered ill-formed because incomplete. Only well-formed formulae can have meaning, and the formula must be well-formed within the context of the language of discourse, be it a formal mathematical system, metaphysical puzzle or scientific theory.<sup>13</sup>

Some formalities concerning sentences, models, theories and structures as used in mathematical logic are relevant to sentences whose content is metaphysics and physics, and we find some formal notions in Chapter Six, Section B. While explications of the relevance of those formalities are found throughout the dissertation, a quick read of that section first may inform the reader’s understanding of the foundations of model-theoretic semantics.

***b. Reductionism, foundationalism and structuralism***

I argue that while reductionism is explicitly criticized by classical Madhyamaka arguments, their anti-reductionist *intent* is not always faithfully adhered to. We also show how modern quantum physics has demonstrated the fallacies of ‘local realism’—the idea that a composite of multiple things takes on the properties of its parts (see the next

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<sup>13</sup> This contextualist perspective referenced here links the theory of meaning and pluralism which I use with a broader context of contextualist epistemology, which we will not, however, discuss.

section)—which is the general principle which informs reductionism.<sup>14</sup> Before we proceed to those arguments and demonstrations, preliminary establishment of the terminology of reductionism is in order, which will allow understanding of foundationalism and, in contrast, pluralism.

Silberstein defines reductionism and identifies its intimate relationship with foundationalism. Reductionism is...

...the view that the best understanding of a complex system should be sought at the level of the structure, behavior and laws of its component parts plus their relations. However, according to mereological reductionism, *the relations* between basic parts are themselves reducible to the intrinsic properties of the relata. The implicit ontological assumption is that the most fundamental physical level (whatever that turns out to be) is ultimately the “real” ontology of the world, and anything else that is to keep the status of real must somehow be able to be “mapped onto” or “built out of” those elements of the fundamental ontology. (Silberstein 2002, 81).

Fundamentalism (also called foundationalism by, e.g. Norton, 2007) is general idea that: “...fundamental theory, *in principle*, is deeper and more inclusive in its truths, has greater predictive and explanatory power, and so provides a deeper understanding of the world” (Silberstein 2002, 81). By ‘fundamental theory’ in the physics context is meant the scientific theory about the most ‘basic parts’, also called the ‘ultimate constituents’. By application of the model-theoretic theory of meaning, for reductionism to be true means that all aspects of a complex system must be amenable to understanding by the most fundamental theory.

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<sup>14</sup> However, reports of the death of local realism continues to be premature, even after 40 years of experimentation, due to what are called ‘detector loopholes’. See Afriat and Selleri (1999) for a comprehensive critique, plus Santos (2007) and Genovese (2004) for recent reviews. We therefore do not depend entirely on a rejection of local realism at the extreme quantum level, but rather demonstrate how reductionism fails even at a more classical and macroscopic level.

There are several kinds of analysis which are designed to understand the relationship between a whole and its parts:<sup>15</sup>

- (1) Mereological analysis is the general term for any kind of analysis which examines the whole in relation to its parts.
- (2) Mereological reductive analysis is a methodology which examines what is found by applying iterative mereological analysis to a composite object until an object with no proper parts is found, or until an object that cannot be mereologically analyzed is found. In this context, the atomic proper parts are analyzed to determine their nature, the nature of their properties and (in the present context) to see if there are any inherent or non-inherent properties, or if either characterization has meaning. Atomic proper parts might not be found.
- (3) Epistemological reductive analysis provides knowledge of composite objects through knowledge of ultimate parts. This type of analysis describes efforts at *intertheoretic reduction* of one scientific theory (e.g. thermodynamics or classical mechanics) to another (e.g. statistical mechanics or quantum mechanics, respectively).
- (4) Ontological or metaphysical reductionism is the basis of foundationalism in its presumption that whatever is found through methodological reductive analysis is—in some sense—ultimately real, while the composite that has been so analyzed does not necessarily share that sense of ultimate reality.
- (5) Strong reductionism (also called supervenient determinism) is similar to ontological reductive analysis in assuming that there are ultimately basic proper parts and their nature *determines* the nature of their whole.

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<sup>15</sup> Taken from Silberstein (2002) and Healey (2008)

(6) Very strong reductionism states that the nature of a whole is relevantly *the same* as the nature of its ultimately basic parts.

Abhidharma philosophy accept strong reductionism by arguing that there are ultimately basic proper parts of matter and time with inherent nature from which composite wholes and perceived durations are merely ‘conceptually constructed’, i.e. with merely conventional existence, while the parts have actual and ultimate physical reality. Hence, the parts are primary elements of our ontology while composites are merely derivative. Abhidharma rejects very strong reductionism in arguing that the composite wholes have no inherent nature. In the component of unitarity, the *sevenfold reasoning* Madhyamaka argument explicitly rejects the idea that any kind of mereological and reductionist perspective can achieve understanding if it is based on an assumption that either parts or whole have inherent nature. Only by realizing that there is no inherent nature can understanding result, but then there is no basis for any standard reductionism, i.e. no ultimate parts on which to base the analysis. To establish this, Madhyamaka proponents argue that there are no ultimately basic proper parts with inherent nature in either matter considered in one time (*neither-one-nor-many*) or through time (Madhyamaka impermanence arguments against Abhidharma momentariness). In some commentaries, however, Madhyamaka scholars argue from this by saying that *since* there is no inherent nature in any ultimately basic parts, i.e. there are no ultimately independent parts, *therefore* the whole also has no inherent nature.<sup>16</sup> This argument could be interpreted as an application of very strong reductionism. However, an alternate interpretive gloss is that it promotes a lack of basis for any reductionism, since that would

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<sup>16</sup> See my Section C.2 in *Chapter Two: Madhyamaka*.

require some inherent nature in the parts from which to base the imputation of any kind of nature in the whole.

Ontological, strong and very strong reductionist views entail entity realism. In the context of physics analysis—which is the appropriate context for discussing the basic physical character of non-living material objects—I argue that Madhyamaka may be interpreted as a structural realist position, taking the causal relational properties of objects to have primary importance while entities are—in some sense—ill-defined, non-existent or derivative of those relations. However, there are two major issues entailed by this comparison. First, as with structural realism, Madhyamaka must understand how relations relate with entities. In some structural realist views which exclude entities altogether this is called the problem of relations without relata. The second issue is that as far as Madhyamaka is concerned, both relations and relata exist in a relational sense of existence, that is, neither have inherent nature, and neither are therefore ultimately ‘real’ if reality is interpreted as something with independent nature; both relata and relations themselves are relational. I argue that this is cashed out by the semantic, epistemic and ontic relationality between domains that was mentioned previously. Structural realist positions suggest that relations are primary, while the non-relational properties of objects may be either ill-defined, lacking entirely or perhaps merely derivative. Epistemic structural realism says that

...one can know structural aspects of reality, but nothing about the natures of those things whose relations define structures in the first place...[ontic structural realism positions], more radically, do away with entities altogether; proponents hold that at best we have knowledge of structural aspects of reality, because there is in fact nothing else to know. (Chakravartty 2007, 34).

Chakravartty's own middle way 'semi-realism' argues that knowledge of entities is built into knowledge of the structural relations. I work out the details of the correspondence between structural realism and Madhyamaka in later chapters.

***c. Local realism, quantum indiscernibility and entanglement***

The phenomenon of entanglement provides both supportive and challenging perspectives for śūnyatā. In support, one could argue that a whole entity with entangled parts is a structure made from the relations between those parts, and in this way the lack of inherent nature might be justified. However, another way of looking at an entangled system is that there are no proper parts—the entangled system is a unitary and undivided whole. That it easily decoheres is not an argument against its unitary nature. I argue that the latter interpretation has merit and challenges the idea that phenomena lack inherent nature. However, entanglement only exists in quantum domains, and as we have mentioned the extrapolation from the character of one domain to all is problematic if not clearly false. Use of contextualization enables us to see how the idea that phenomena *lack* inherent nature in *one* domain yet *have* inherent nature in *another* domain must be interpreted across domains as a global lack of inherent nature.

There are two problems with an interpretation of quantum particles as individual things, hence these have impact concerning unitary vs. composite natures. First, when counting macroscopic objects of our commonsense experience, they obey what is called Maxwell-Boltzmann statistics, which is the counting method employed for distinguishable and independent objects in a collection that obeys local realism. Local realism is the general view upon which both reductionism and classical extensional mereology are based. Briefly, local realism is the view that something with physical

extent can be understood as some combination of whatever is happening in the different physical locations within its extent. The problem is that local realism has been effectively denied in quantum domains due to experiments that demonstrate violations of Bell's inequality for quantum entangled systems. By distinguishability is meant that one can meaningfully say 'this teacup' is different from 'that teacup', beyond their different spatiotemporal locations. However, quantum particles obey different counting statistics, either Bose-Einstein for integer spin particles, such as neutrons and protons, or Fermi-Dirac statistics for half-integer particles such as electrons, because quantum particles are not distinguishable. Hence, one cannot meaningfully say 'this electron' is different from 'that electron', although one can say that there are two identical electrons.<sup>17</sup> Identity is defined in terms of all state-independent, i.e. intrinsic, properties (as discussed in the body of this paper) such as rest mass, spin, charge, etc. Otherwise identical particles may differ in terms of state-dependent properties, such as location or momentum.<sup>18</sup>

A further issue with interpretation of quantum particles as individual entities arises in terms of entanglement. Entanglement is a phenomenon which is described in the formalism of quantum physics and has been extensively verified empirically during the last 30 years. According to quantum physics formalism, two or more quantum particles that have interacted in certain ways will be in a superposition called an entangled state that is calculated from the states of each particle. The entangled state then cannot be logically or physically separated into the separate states of its constituents. Once a

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<sup>17</sup> The Hilbert space formalism has an artifact that seemingly allows a separable identification of individual identical particles that is then discarded in the statistical counting procedures, which is why the Fock space formalism, which allows only knowledge of the number of identical particles from the start. See Teller (1995) for a complete philosophic, though mathematically challenging, analysis.

<sup>18</sup> See Castellani 1998, Redhead and Teller (1991, 1992), Teller and Redhead (2000)

measurement has occurred in order to measure the state-independent properties of each particle, or perhaps due to some environmental interaction such as with the background quantum vacuum field, the entanglement will be destroyed, but that measurement or interaction will not indicate the state of the constituents prior to the new measurement or interaction while the particles were entangled.

More formally, we use the Dirac bra-ket formalism,<sup>19</sup> in which  $|S_i\rangle$  represents the Hilbert space expression of the state of particle  $i$ . An unentangled, non-interacting composite state might be represented as:  $|S_{ij}\rangle = |S_i\rangle \times |S_j\rangle$  where ‘ $\times$ ’ is the tensor product. Unentangled composite states are separable into the states of their respective constituents, thus the particles of these composite states retain their individuality, i.e., each can be identified as being unique in comparison with another particle in the composite state. A composite state obeys local realism requirements. An example of an entangled state, however, might be represented by

$$|S_{ij}\rangle = (1/\sqrt{2}) * ( |S_i\rangle \times |S_j\rangle - |S_j\rangle \times |S_i\rangle )$$

For entangled states, it is impossible to separate the system into its components, and there is no way of knowing the state of each particle separately. In the standard (approximately Copenhagen)<sup>20</sup> interpretation, there *is no state* of each individual particle when the system is entangled, and therefore, confined as we are in quantum domains, it is

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<sup>19</sup> See [www.users.csbsju.edu/~frioux/dirac/dirac.pdf](http://www.users.csbsju.edu/~frioux/dirac/dirac.pdf) for an introduction.

<sup>20</sup> While ‘standard’ or equivalently ‘orthodox’ interpretations are frequently identified as ‘Copenhagen’ interpretations, I follow Schlosshauer (2005) in distinguishing the two. Also see Howard (2004). Both postulate wave function collapse due to measurements, but the Copenhagen adds the necessity for classical physics concepts to describe quantum phenomena, such as measurements. This is based on the fact, promoted by Bohr, that concepts are human constructions, and human constructions are postulated to correspond to classical physics. The fact that most people, even quantum physicists, acknowledge that quantum concepts are weird, supports this view. We will not examine non-standard, e.g. Bohmian, interpretations here, except briefly.

hard to justify saying that there are even individual particles. The phenomenon of entanglement both violates local reality<sup>21</sup> and also generates the famous quantum measurement problem that has inspired many philosophical interpretations, including what we call the emergence of properties that are not reductively supervenient on the properties of constituents. One conclusion of this situation is that we can't assume naïve realism about quantum objects, nor any reasonable correspondence between our intuitions and the actual, physical situation, since so many of those intuitions are based on local realism.

Entanglement is popularly used to justify belief in the interdependence of all things, that one entangled particle is dependent on the other. However, one cannot separate or distinguish entangled particles, either analytically or empirically, and cannot even infer the separate characteristics of each particle while they are entangled. Hence, there is no meaning to the statement that 'one' particle is dependent on 'the other'. Rather, they are in a single entangled state, a single whole. Similarly, one cannot justifiably analyze the entangled unit as a whole dependent on its parts, since we cannot identify separate parts.

It is because we cannot identify separate parts that several authors cite correspondence with Madhyamaka, since separateness implies independence, hence inherent nature. If such independence cannot be found, then one could conclude that there is no inherent nature in the parts. Alternately, if there are no parts, then the entangled system is a unitary entity. Hence, we identify a tension in using entanglement to determine that the phenomenon lacks inherent nature, since for that to be true it should lack both independence and unitarity.

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<sup>21</sup> Although, as mentioned in previous footnote 10, this observation is controversial.

## CHAPTER TWO. MADHYAMAKA

### A. *Introduction*

#### A.1. *Introductory comments*

Madhyamaka philosophers argue that all phenomena lack inherent nature, hence are *śūnya*. *Śūnyatā* is the lack of *svabhāva*. *Svabhāva* is variously translated as nature or property which is inherent, intrinsic, essential, substantial, true or real. We shall use ‘inherent nature’ in this chapter, and examine alternatives and synonyms in the following chapter. Hence, we say that Madhyamaka argues that all phenomena lack inherent nature. Inherent nature traditionally has three components or aspects: causal independence, mereological unitarity, and temporal persistence.<sup>22</sup> *Śūnyatā* is usually translated as ‘emptiness’, i.e. that phenomena are empty of inherent nature. We shall avoid this term due to unintended connotations, and instead characterize *śūnyatā* as ‘relationality’.<sup>23</sup> Hence, the corresponding *three components of relationality* are that phenomena are causally dependent, mereologically composite and temporally impermanent. Understanding what these three pairs of terms mean and entail is the task of the entire dissertation, beginning with further discussion in Section A.2, below. One of the most important things to remember while using the shorthand of calling *śūnyatā* relationality is

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<sup>22</sup> I use *unitarity* for the more commonly used *singularity* due to the unintended (or at least complicated) mathematical and physics connotations of the latter term, and *persistence* instead of *permanence* since as far as Madhyamaka is concerned if phenomena persist then they will continue and be permanent. Ābhidharmikas argue that all things are impermanent, persisting only for a moment, but Madhyamikas argue that persistence even for a moment entails permanence, hence denying the Abhidharma view. More on this below.

<sup>23</sup> There are many different ways to interpret *śūnyatā*, see Newland (1992) and Thakchoe (2007) for the basics of some of those arguments. See Dreyfus and McClintock (2003) for more on the positive and negative characteristics and different schools of thought about using them or not. See also Oetke (1991) and Ruegg (2000).

that relations must not be hypostatized any more than their relata; relations are relational also.

I use a triad of triads to explain Madhyamaka, which may seem artificial, but which I think is appropriate. First is the paired triad of (1) *components* of inherent nature and relationality listed above. Next is the triad of types of (2) *arguments* which correspond to each component. Finally, (3) Madhyamaka argues that relationality permeates all phenomena and experience, categorized as our conceptual designations and the meanings of our words; our philosophic and by extension our scientific explanatory schemes applied to understand phenomena; and the physical nature of all phenomena. Thus we have relationality of meaning, knowledge and being, respectively, which is the third triad. All three of these are also interrelated, mutually dependent and entailing. We designate this triad as *dimensions* and identify them as semantic relationality, epistemic relationality and ontic relationality, respectively. Their explication begins with this chapter and progresses throughout the dissertation. These three triads are summarized conveniently in Section C.2 of *Chapter 1: Introduction*.

All three components of inherent nature and relationality may be understood as examples of independence and dependence, respectively. The first component pair is causal independence and causal dependence: phenomena with inherent nature are causally independent of other phenomena and phenomena that lack inherent nature are causally dependent on, relationally interactive with, and mutually dependent on other phenomena. The second component pair is mereological independence and mereological dependence: phenomena with inherent nature have no proper parts and phenomena that lack inherent nature have relationally interactive proper parts. The third component pair

is that phenomena with inherent nature are persistent over time without change of any sort, while phenomena without inherent nature are impermanent and do not persist as the same phenomena even any finite moment. We could call the latter dimension temporal independence and temporal dependence, as long as this use does not imply that there is an entity such as ‘time’ of which something can be independent or dependent, or that temporal independence implies that something is ‘outside of time’ in some way. But we must be careful with the other dimensional categories also, since (as we shall see) Madhyamaka denies that there are entities such as ‘cause’ and ‘part’ from which something can be independent or dependent if we hypostatize these terms by imbuing them with inherent nature, nor, as I argue, does it deny that there is cause or part as long as we understand them as being entirely relational.

The separation of inherent nature and relationality into three components does not imply that there are independent components; rather, they are interrelated and mutually entailing. However, the understanding of inherent nature and relationality, and realization through intellectual reasoning of the fact that all phenomena are relational are traditionally obtained through understanding Madhyamaka arguments and becoming convinced by them. These three components are mutually entailing, as explicated in Section A.2, below.

The three types of arguments each pertain to one of the three component pairs of inherent nature and relationality. The *Madhyamaka causality arguments* discussed in Section C examine causal independence and dependence between one object or process and other objects or processes. There are many different interpretations of these arguments in the Indian, Tibetan and Western commentarial literature. A common

interpretation is that they deny that there is causality of any sort, without offering any positive account. However, I argue that this interpretation is difficult to justify based on texts, as well as difficult to understand. Rather, I argue that the Madhyamaka causality arguments deny any substantive causality between substantive entities. They deny not only that different entities can be causally independent, but also deny that causality itself is a kind of ‘monadic’ process of arising which is inherent in individual substances or in the universe as an independent ‘power’, arguing instead that causality must be understood as mutual dependence<sup>24</sup> that is integral with dependence relations between phenomena which themselves have no independence. We will see how this is cashed out to be consistent with some contemporary philosophy and physics throughout the dissertation. Independence and causality are further discussed in other contexts in *Chapter Three: Metaphysics of Dependence* and *Chapter Seven: Physics of Dependence*.

The mereological component of the nature of entities is analyzed by two arguments discussed in Section D: (a) *sevenfold reasoning* denies the coherence of reductive mereological relationships between a composite whole and its still composite proper parts if we invest either with inherent nature; and (b) *neither-one-nor-many* argues against the possibility of atomic simples with inherent nature as proposed by Ābhidharmikas and other atomists as a basis for reductive mereological relationships from which a composite entity can be built. These arguments suggest that instead of having inherent nature, all entities are composite, but not composed of atomic simples; rather they are composed of mereologically interdependent composite proper parts, and mereologically interdependent relational ‘atoms’. A significant task of this dissertation is

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<sup>24</sup> The term ‘mutual dependence’ is from Taber (1998) in his response to Hayes’ (1994) interpretation of Nāgārjuna’s MMK.

adapting this argument to modern physics. Whether we would identify the ancient atoms with the atoms of contemporary atomic theory (composed of electrons, neutrons and protons) or with the elementary particles of the standard model of particle physics (the quarks, leptons and gauge bosons which have no further parts), and how the argument form would proceed, will be analyzed in further chapters, especially *Chapter Four: Metaphysics of Composition* and *Chapter Eight: Physics of Composition*.

Solutions to the problem of change are offered by several streams of argument discussing momentariness and impermanence discussed in Section E in order to show that no entities persist in time. Ābhidharmikas argue that entities do not persist for even two small moments, and Madhyamikas argue that they do not persist for even one finite moment, if existence involves inherent nature. We are told that since entities with inherent nature must be permanent, and all entities are impermanent, no entities have inherent nature. There are two related arguments for this radical impermanence: (a) one argument proposes that even if the outward appearance of an object seems to be unchanging, some of its parts are impermanent. This argument, problematically, then invokes mereological essentialism and its related mereological reductionism which stipulates that change of any part entails change of the whole, and thus all whole composite objects are impermanent. (b) The other argument problematically assumes that any object which is produced will eventually be destroyed, and further argues, also problematically, that *eventual* destruction entails its impermanence as a characteristic throughout *all* of its existence—that because things will eventually be destroyed they must always be considered lack any kind of persistence, even from one moment to the

next, even prior to its eventual destruction by millenia. Change is further discussed in *Chapter Five: Metaphysics of Change* and *Chapter Nine: Physics of Change*.

In Section B we present a preliminary explication of the general meaning of Madhyamaka relationality. This chapter is not only an introduction and explication of the basic principles and arguments of Madhyamaka, but also is a further guide to the rest of the dissertation. Therefore, we provide indications of where the components, arguments and dimensions will be further discussed in the context of Western analytic metaphysics and physics.

### ***A.2. The positive thesis: relationality and their three components***

As mentioned, there is some resistance, and a certain tension, between the Madhyamaka view that no definitive positive statement can justifiably be made characterizing phenomena and the need to say something about the nature of phenomena.<sup>25</sup> It is tempting to glibly interpret the lack of inherent nature as some

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<sup>25</sup> Oetke (1991) identifies seven “apparent tensions and inconsistencies in Nāgārjuna’s writings as well as in Madhyamaka philosophy generally which have to be taken into account by any attempt at a satisfying interpretation” (315). One of these is the tension between the rational argumentation which is found throughout his writings vs. his insistence that he holds no position. This is the tension that I mentioned previously between holding a positive position and insisting on only denying the opponents’, and is a basis of the distinction between Svatantrika (autonomous arguments) and Prasangika (consequential arguments) schools of thought. See Dreyfus and McClintock (2003). Oetke (2003) also comments on this tension, and criticizes a view of Ruegg’s (2000) which promotes the interpretation that by denying that he has any position of his own Nāgārjuna means “I have no propositional thesis asserting a hypostatized entity (*bhāva*) having self-existence (*svabhāva*)” (Ruegg 2000, 207-8, quoted by Oetke, 2003, 449). Part of the problem is that in terms of Indian epistemology and semantics a positive statement about an entity, even that it doesn’t exist, implies its existence, similar to the basis of Western locutions which we will find in Chapter Four such as ‘A stone, if it exists, has N atoms’ by Unger. Oetke (2003), by the way, disagrees with Ruegg’s interpretation, but explication of it will take us too far astray. A further tension identified by Oetke (1991) that is relevant to this particular verse MMK 24:18 (and also relevant to the previously mentioned tension) is the declaration that dependent arising is *sūnyatā*, while in MMK 1:1 there is a “Denial of cause-effect-relationships” (Oetke 1991, 315). As mentioned, there is a prevalent nihilist interpretation of that verse as a complete denial of causality, yet I argue that this tension is resolved in a more consistent way—and also in a way that is consistent with our interpretation of physics to be discussed later—if we are careful about how we characterize the causal relationships and how we characterize dependency, as demonstrated in our analysis of Madhyamaka causality arguments, independence and dependence in Western Metaphysics in Chapter Three, and causality in physics in Chapter Seven. See also Ruegg (2000) who provides an extensive analysis of the problem of positive theses.

positive property of phenomena. However, we should note that the lack of inherent nature is the lack of a certain kind of nature: inherent nature. It is therefore hard to say that anything has any nature, since ‘nature’ sometimes implies the ‘inherent nature’.

Intuitively, some may think that entities must have some nature or other, and therefore it is reasonable for advocates of Madhyamaka philosophy to consider whether there may be a conception of the nature of things that is non-inherent. A conception of nature based on relational properties is one candidate, yet our normal interpretation of relationality as a dyadic property associating independent entities cannot of course be entertained by a philosophy denying the existence of independent entities, as Madhyamaka does. In the philosophy of science literature concerned with structural realism this is called the problem of ‘relations without relata’. Formulating it precisely and solving it will engage us throughout this dissertation. Contrary to a common intuition that there must be some nature, one common answer that is frequently offered in ancient and contemporary Madhyamaka text and commentary is that phenomena have ‘no nature’. This is sometimes expressed as the idea that phenomena do not ‘truly’, ‘ultimately’, or ‘absolutely’ exist.<sup>26</sup> I reject these expressions as being misleading at best, and rather interpret the idea of ‘no nature’ in the following way, which I justify exegetically with classical Madhyamaka text and commentary below: as mentioned previously, phenomena with inherent nature have three interrelated components, namely they are causally independent, mereologically unitary and temporally persistent. Therefore, phenomena

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<sup>26</sup> Alternatively, the true nature of reality, and meaning of śūnyatā, is sometimes expressed as all phenomena being beyond conceptual elaboration. Some Madhyamikas then proceed to explain what that means, acknowledging that all concepts are provisional and may be instructive to achieve non-conceptual realization, which is the goal. We will not discuss this aspect of the philosophy, although I do think that these concepts, and specifically relationality as discussed here, can assist understanding.

without inherent nature are causally dependent, mereologically non-unitary and temporally impermanent. We discuss several Madhyamaka arguments to show that the three components of inherent nature are mutually entailing and are indeed consistent with the fundamental idea of inherent nature. The reader may recognize certain ingredients in these arguments as being similar to the discussions of ‘substance’ found throughout Western philosophy. The Aristotelian approach upon which much of the latter is based gives primary emphasis to objects, which then ‘have’ properties. The Madhyamaka approach puts emphasis on relational properties, while Aristotle and Spinoza (following Aristotle), for example, puts emphasis on substance. Spinoza defines substance as “that which is in itself and is conceived through itself” and this expression of the independence of substance is consistent with Madhyamaka definitions of *svabhāva*, which we have been translating as inherent nature.<sup>27</sup> Madhyamaka argues, with Aristotle and Spinoza, that substance is independent, unitary (or monadic) and permanent. Madhyamaka, however, denies that such things exist.

Here is the basic process of the mutual entailment between these three components of inherent nature: Concerning independence, a phenomenon with causally independent nature would have to be independent in virtue of properties that the phenomenon has itself, intrinsically, without regard to other phenomena. We shall see in Chapter Three how independence is discussed by Lewis and others in the contemporary metaphysical literature in terms of intrinsic properties of an isolated object in its own possible world. I argue (with Lowe and others) that this analysis gets into difficulties in trying to distinguish intrinsic from relational properties due the failure to properly ground their analysis in physical relevance, to be discussed and defined further in that chapter.

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<sup>27</sup> See Hopkins (1996, 36) for a list of possible meanings and alternative translations.

Causally independent properties would never provide empirical evidence of their existence, hence would be similar to an unknowable Kantian *thing-in-itself*, because evidence is obtained through interaction, and interaction requires relational material properties that are manifest as causal relationships. Therefore at the very least a truly independent phenomenon would be entirely unknowable, hence at least from parsimony its existence should be denied. Furthermore, according to Madhyamaka arguments that we explicate in the following chapter, such independent entities would fulfill no function. By various definitions of reality (e.g. Hacking or Dharmakīrti<sup>28</sup>) such a thing either does not physically exist or at least would be irrelevant. This understanding of independence is central to understanding the meaning of ‘no nature’: the entity has no nature of its own, independent of other entities or its parts, which is what ‘nature’ in this context implies. Hence, because the identity of an entity always seems to rely on its semantic, epistemic and ontological relationships to other entities or the parts of its own whole, it is difficult to justify the idea that there is a separate entity at all. In this sense, the entity does not exist, if existence is defined as being independent. To exist an entity must be interdependent with other entities, its parts and it must be impermanent. This is my understanding of the seemingly puzzling use of statements like ‘it neither exists nor doesn’t exist’ as found in the literature, based on the verse in MMK 15:10:

To say “it is” is to grasp for permanence.  
To say “it is not” is to adopt the view of nihilism.  
Therefore a wise person  
Does not say “exists” or “does not exist”. (Garfield 1995, 224)

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<sup>28</sup> Hacking (1983); and Dreyfus (1997) and Dunne (2004), respectively.

Since “it exists” entails permanence, in my interpretation this also entails independence, hence the statement says that nothing is either permanent (persistent) or independent (or singular, since all three of these are mutually entailing). Yet “it is not” is nihilist, hence we can’t say that things don’t exist in some way or another. So, what way do they “exist”. My interpretation is that this statement means that an entity does not exist independently yet exists interdependently, which is not that the thing exists on its own, but exists in some kind of mutual relationship mixture with other things.<sup>29</sup> Throughout the dissertation I develop an account of what this kind of interdependent existence entails, and if phenomena actually may be characterized in this manner.

Concerning the second component of inherent nature, a mereologically unitary phenomenon is singular, without proper parts,<sup>30</sup> hence is a metaphysical simple. A composite entity (also called partite) is not, of course, a metaphysical simple, but also could not be considered independent due at least to its internal relationship with its parts. Madhyamaka arguments such as *neither one nor many* also deny that there are atomic simples with inherent nature as the ultimate constituents of matter.<sup>31</sup> One possible

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<sup>29</sup> Garfield interprets this verse in the view of Nāgārjuna. Another relevant verse is 25:10, stating that “Nirvana is neither existent nor nonexistent” (Garfield 1995, 327), which Garfield also interprets in the author’s voice, while Mark Siderits, for example, interprets this as the view of a Pudgalavādin opponent, stating that “Indian commentators agree” (personal communication) with the latter interpretation. See Siderits SEP article on the Buddha. With verses 15-16 of Chapter 25, this is one of the countless cases where Nāgārjuna rejects all four lemmas in the tetralemma. Here he is simply following the precedent of the Buddha, who used the tetralemma form and typically rejected all four lemmas. (The language here has been adapted from comments from a member of the supervisory committee and included on advice from my supervisor, Tom Vinci.) I take Garfield’s view, which perhaps represents a more Tibetan interpretation, and see this as consistent with the text, yet this points out that there is a somewhat Tibetan bias to much of my interpretations, which may be contrary to some Indian Sanskrit scholars.

<sup>30</sup> An improper part of a whole is the whole itself.

<sup>31</sup> This statement is a simplification of what the argument denies, and is extensively discussed in Chapter Two. The core argument denies that things are ‘one’, i.e. single, hence also that they are many (multiple) since multiple is the sum of several singles. I interpret this as saying that there are no atomic simples, and therefore that all parts have relational parts, and it is somewhat redundant to say ‘no atomic simples with

conclusion of this argument is that even those ultimate constituents must have relational parts. We examine the problem of composition as explored in the literature of contemporary Western metaphysics, focusing on the eliminative arguments of Unger, van Inwagen and Merricks that reject partite objects from a viable ontology in favor of atoms alone.<sup>32</sup> Hence, this discussion revolves around the issue of reductionism, which is rejected by modern physics in many domains, and also (supposedly) by Madhyamaka. The latter was developed, at least in part, in explicit response to reductionist views of Abhidharma philosophy.<sup>33</sup> The reason reductionism is a problem for Madhyamaka is that reductionism posits some final, ultimate basis—such as atomic simples—which has inherent nature as a foundation from which everything may be securely derived. The fundamental goal of Madhyamaka arguments is to demonstrate that nothing has inherent nature, that there is no secure foundation from which all things derive.

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inherent nature’, since in this argument (as I interpret it) an atomic simple is something that has inherent nature due to its singular nature. The argument is found in many sources, including the first 61 verses of Śāntarakṣita’s MAL (see Bibliography and Section C of Chapter One for abbreviations of major texts) and Santideva’s BCA chapter 9, verses 78-96 (notationally 9:78-96).

<sup>32</sup> While we exclude persons from the scope of our discussion, those three philosophers actually include both (and only) atoms and people as unitary entities worthy of being elements of a viable ontology. Two notes are worthy of mention: first, the ‘atoms’ that they discuss are metaphysical atomic simples that are presumed to have intrinsic nature and which would be the foundation for a reductive physics theory of everything, and whether or not these actually exist, and whether or not they can form such a foundation is a matter of significant research and controversy. Second, Buddhist philosophies consider persons as composite entities made of various aggregates (skandhas), and Madhyamaka philosophy finds no inherent nature in any of those either.

<sup>33</sup> See Section C.3 of Chapter One. Interestingly, Greeks settled in Northwestern India, called Bactria, when they came with Alexander. After Alexander’s death, his generals tried to continue into India, and were defeated by Asoka, who then repented from his aggressive actions and became Buddhist, thus establishing the first major Buddhist kingdom. While Nāgārjuna’s works on Madhyamaka are generally considered to be responses to Nyaya non-Buddhist and Abhidharma Buddhist philosophies, it is possible that Aristotle’s ideas came with the Greeks, interacted with current Indian philosophies, including the precursor to Madhyamaka called prajnaparamita. One may conjecture, therefore, that Madhyamaka grew, in part, as explicit denial of Aristotelian substance. See McEllvey (2002). This connection is highly speculative, and it is unnecessary to postulate such engagement with Greek philosophy since there already was an established concept of substance in non-Buddhist and Buddhist non-Madhyamaka thought.

Rather, according to my analysis which accepts a particular positive thesis that I view is consistent with the hermeneutic meaning of the text if not the exegesis (which has been interpreted in many ways, some of which dispute my interpretation) by this view all things are interdependent. In my Chapter Seven, Section B.3 I introduce the term ‘inherent relationality’ to indicate that entities—although defined as without inherent nature, do have a nature, and that nature is that they are mutually interdependent, thus inherently relational. This is somewhat of an oxymoron to be explicated in detail in that section and what follows.

Now, it has been maintained by some scholars that the view that real things are inherently relational is simply not to be found in Nāgārjuna. Indeed that he explicitly denies that there could strictly speaking be such a thing as inherent relationality, for instance in the following:

Given the nonexistence of intrinsic nature (*svabhāva*), how will there be extrinsic nature (*parabhāva*)?

For extrinsic nature is said to be the intrinsic nature of another existent.

(MMK 15.3)

According to these scholars this position, and the argument for it, are shared by Madhyamaka and Abhidharma. The argument is simply that something can have a relational property only by virtue of the relata having their own natures. Jill can have the property of being taller than Jack only by virtue of there being some height that Jill has and some height that Jack has. What Madhyamaka and Abhidharma disagree about is just whether strictly speaking anything has intrinsic nature. Moreover, modern scholars who work on the texts of Indian Madhyamaka—MMK and the four extant commentaries, Āryadeva, Bhāviveka’s and Candrakīrti’s independent works, and Śāntideva—agree that there is no affirmation of what I call inherent relationality to be found there. Where such

an idea is to be found, though, is in some modern scholarship on Madhyamaka that is based on Tibetan sources. (The language from this paragraph has been adapted from a comments from a member of the supervisory committee and included on advice from my supervisor, Tom Vinci.)

While I will not dispute that many Western scholars focusing on the Indian texts and commentaries reject the notion that Madhyamaka makes the positive thesis that things have a nature in any sense, including an relational nature, some, including Ruegg (2000) and Oetke (1991, 2005) find support for the notion. Ruegg interprets the restriction as only denying any positive thesis concerning an entity with self-nature, or what I call inherent nature, and this is universally agreed by Madhyamaka scholars. However, it is also generally acknowledged that Nāgārjuna and other Madhyamikas conduct philosophical analysis and support philosophical views, such as that nothing arises from itself, other, etc. By my way of thinking, this leaves open the possibility that a positive thesis concerning entities without any self-nature may indeed be allowed or perhaps may be indicated by certain texts and commentaries. It is with this in mind that I interpret MMK 24:18-19 as promoting the classical Buddhist notion of interdependence (pratīyasamutpāda) as the very nature of things, as long as nature excludes any self-nature. While Ruegg in particular finds support in the Indian Madhyamaka texts and commentaries for the acceptance of positive theses which, however, still must not entail notions of self-nature, most of the support for the idea of a positive thesis comes from Tibetan interpretations of the Indian texts, and especially from Tsong-kha-pa, notably in the LRCM, and commentaries based on his, as described in detail by Ruegg.

Returning now to the analysis of atomic simples, we see that some commentaries and texts explicating *neither one nor many* seem to imply certain kinds of reductionist thinking, even though the argument denies the existence of atomic simples and should be entirely anti-reductionist. One of our purposes is to resolve that tension between implementation and intent by modifying the arguments through use of some contemporary philosophical perspectives, viz. the model-theoretic semantics, Physics Pluralism and structural realism. This tension is also demonstrated in the following treatment of the third component of inherent nature, persistence.

Impermanence is a foundational conclusion of much Buddhist analysis, both non-Madhyamaka and Madhyamaka. Momentariness—the idea that objects last for only a moment—has also become a widely stated concept,<sup>34</sup> yet, Madhyamikas argue against momentariness, thus offering arguments that further refine the concepts around impermanence, suggesting that no ‘ultimately’, ‘truly existent’ things (i.e. with inherent nature) arise, abide or cease in discrete moments of time. Ābhidharmikas argue that if something persisted for two moments it would be permanent, hence because nothing is permanent nothing could persist for even two moments. They support this argument by saying that if a phenomenon embodied no cause for it to cease during those two

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<sup>34</sup> The concepts of impermanence and momentariness form a major thesis of Buddhist thought which is the starting point of Madhyamaka arguments. See Rospatt (1995). Impermanence is a standard feature of (as far as I can tell) all schools of Buddhism. However, according to Rospatt early texts talk of a duration prior to change or destruction. Latter, momentariness is discussed as objects coming into existence for a moment and then ceasing their existence. A new object, connected through causality, appears in the next moment. The objects together make up a continua which has no existence of its own, yet one may mistakenly conceive of the continua as a single object persisting over time. The description of this as ‘impermanence’ is technically not correct, since there is no thing that is impermanent, it is rather that objects are momentary. However, I use the description ‘impermanence’ as a shorthand for this concept. Note that the concepts pertain to objects in time, not to time directly. I note also that much of Buddhist and in particular Madhyamaka thought pertain to the distinctions between discrete and continuous space and time, similar to Zeno’s puzzles concerning them. Quanta are discrete, but classical objects are continuous, and universal characterizations based on one domain or another may not apply in all domains.

moments, there would be no reason for a cause (of the ceasing of the phenomenon) to arise spontaneously in some successive moment. Entities therefore change spontaneously after one moment of existence. Madhyamikas further analyze existence during even ‘parts’ of moments, and parts of those parts, down to no time at all, leaving us with no persistence with inherent nature at all. Madhyamikas argue that any existence with inherent nature entails permanence, since inherent nature entails non-interactivity and without that no change can ever result. Hence, for Madhyamaka there is continuous change and radical impermanence.

One argument<sup>35</sup> for impermanence is based on obvious changes in properties of objects. However, many objects do not obviously change in all moments. Some non-Madhyamaka Buddhist arguments for impermanence of even objects which seem to be persistent—such as a vase sitting on a table—involve a logical analysis called *eventual destruction*. One argument is summarized here:

momentariness is proved by demonstrating that the *samskāras* (i.e. conditioned entities) cannot persist at all. This demonstration can be summarized thus: 394 The duration of the *samskāras* beyond their origination cannot be effected by a cause, because no such cause exists.<sup>395</sup> Nor could the *samskāras* endure on account of their own nature. For, given the immutability of selfsame entities, they would always have to be endowed with that nature and hence persist for ever. Finally their endurance could not result from the absence of a cause of destruction, because no such cause exists. Nor could the cause of origination effect their destruction, for one cause cannot produce two contradictory effects. Since it is thus impossible for the *samskāras* to persist beyond origination, they have to be momentary. (Rospatt, 1995, 180).

See also Mipham’s (2005) discussion of a vase produced and then destroyed by an external force like a hammer in a hundred ‘moments’:

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<sup>35</sup> “Arising and perishing so many times...in the course of one night and day, the person [constituted by] the five *skandhas* is impermanent” (Quoted in Rospatt 1995, 21, fn.25). Impermanence is considered one of the three marks of existence, along with suffering and non-self.

Let us take the example of a vase, which for a hundred instants after its production does not meet a cause of its destruction. IT is then destroyed by some external force. There must be one *instance-of-vase* in the first moment after its production, and there must be a second instance-of-vase in thesecond moment, and so on sequentially. If this were not so, if all the momentary instances of the vase occurring in successive points in time constituted one and the same vase-instance, it would follow the two vases—the one in the first moment immediately after its production and the one occurring in the actual moment of its destruction – would be the same vase. Therefore, the vase must be disintegrating at every moment; a single identical vase does not perdure for a hundred instances. ...Moreover, these so-called vase-moments are not different from the vase itself. You cannot count the vase-moments while the vase remains permanent. (270)

I find these arguments incoherent, entailing from logical ‘necessity’ of analytic arguments to ontological consequences of the way things are, while the vase just sits there innocently persisting. The only way out, as I see it, is to examine the process of ‘disintegrating at every moment’, the slow, perhaps imperceptible decay that (we are told) is ubiquitous in all physical things from the moment of their production, which is taken as the efficient cause of their destruction. While not expressly based on changes in microscopic or atomic components, there is in this approach an implied reductionism—the whole is changing (hence impermanent) because the parts are changing and impermanent. This type of argument invokes what we call *very strong mereological reductionism*,<sup>36</sup> which is that the whole has the same characteristic as the parts.

The above argument explicitly uses *mereological essentialism*, which says that “if y is ever part of x, y will be a part of x as long as x exists” (Chisholm 1976, 145), but mereological essentialism entails the same conclusion as implied by very strong mereological reductionism. By mereological essentialism, if a part has been taken out, or is changed, then the whole is not the same whole, but rather is a different object.

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<sup>36</sup> See Section F.2 in this chapter for a brief discussion of different kinds of reductionism. Very strong mereological reductionism says that the composite whole has the same characteristics of the constituents.

Mereological reductionism requires that a whole is defined by its parts, hence if the parts change then the object changes. These conclusions are generalized in Leibniz' Laws: a change in properties entails a change in entities, and different entities have different properties. There is frequent use of Leibniz' Laws in many Buddhist arguments. Since (we are told) there is always at least gradual and subtle change, which we can express in terms of change in fundamental atomic constituents that are always in motion and changing, at least in the chaos of the background vacuum quantum field, therefore by mereological essentialism there is a new partite object that is different from the one which existed before the change, hence the whole also is impermanent. Madhyamaka just makes this impermanence continuous: nothing is ever persistent even for a moment, which is that nothing even abides even for a moment with any inherent nature at all. We might phrase this as a continual flux, and we shall see such a flux in quantum mechanical domains, what Wheeler (1998) called *quantum foam*.

We use this situation as a further way to explicate at least one classical interpretation of the *two truths*: on a relative truth level of our normal and conventional understanding, everything is impermanent. However, on an ultimate level that involves more detailed analysis in the Madhyamaka style, we find that even impermanence of an entity as it is frequently understood has been invested with inherent nature: Impermanence is sometimes characterized as a change of an object that has maintained its identity and intrinsic properties for some duration and then experiences a substantial change to become another object with different intrinsic properties. Madhyamaka denies any inherent nature, even for a moment, hence ultimately even impermanence (if understood in this way) is denied. The ultimate truth, in this analysis, is that all things are

radically impermanent. By this term I designate the idea that nothing with inherent nature even arises, let alone arises and abides for a moment. Yet, by my analysis ‘entities’ (although without any inherent nature, hence how we understand that term becomes complex) with relational nature that is interdependent, composite and (radically) impermanent in a continuous rather than discrete fashion do ‘exist’, as long as ‘existence’ does not imply inherent nature.

However, in later chapters I argue that this characterization of the two truths is inconsistent with modern physics, and rather we must apply the pluralist interpretation of the two truths introduced previously. Hence, as interpreted by Physics Pluralism, we find that in some domains of physics some entities are persistent for substantial lengths of time. However, if we examine those same entities in other domains we find radical impermanence. Thus, the relative truth corresponds to truth in a domain and the ultimate truth corresponds to truth determined when we analyze all domains.

## ***B. Relationality***

Central to the idea that all phenomena lack any independent inherent nature is that phenomena demonstrate relationality or dependency. As mentioned early in the introductory chapter, we should be aware that use of a positive characterization of the nature of phenomena is quite controversial. One school of thought requires only negation of the opponent’s views by seeking the fallacies or biases in assumptions that are utilized in any positive statement.<sup>37</sup> However, I argue that if we are careful about what we say and mean we can maneuver a fine line of positive statements that will not be (too)

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<sup>37</sup> This is Prasangika, distinguished from Svatantrika; see Section C.3 in Chapter One and Dreyfus and McClintock (2003) and Section A.2 of the current chapter.

vulnerable to opposition. There definitely is frequent mention in the texts and commentaries about dependent arising ( ) as being a core concept in Madhyamaka. However, dependent arising is also identified as a provisional or conventional view, while the final and ultimate view is beyond all conceptual understanding. We should not fail to recognize that when we say ‘phenomena are relational’ this phrase hides something quite different from the normal meaning of ‘relational’. Dependency is, of course, a relational concept, but as interpreted by Madhyamaka this concept is not that of a relation between one independent thing or things and another independent thing or things, which is a common understanding. Rather, Madhyamaka dependency is interdependency, mutual dependency and relationality that is not defined in terms either of intrinsically characterizable and independently existing entities or of intrinsically characterizable and independently existing relations. Such independent entities, or their inherent nature, are called ‘substances’ or ‘essences’ in both the Western and Indian philosophical tradition, as translations of *svabhāva* in the latter, and such substances or essences are denied by Madhyamaka arguments.

One of the chief examples of relationality in this sense is causal dependency. As stated by Nāgārjuna near the end of his major text *The Fundamental Wisdom of the Middle Way* (*Sanskrit: Mūlamadhyamakakārikā*, henceforth MMK) in two of the most often quoted verses:

(MMK 24:18-19)<sup>38</sup>  
 Whatever is dependently co-arisen  
 That is explained to be emptiness.  
 That, being a dependent designation,

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<sup>38</sup> (24:18-19) denotes chapter 24 verses 18 and 19.

Is itself the middle way.

Something that is not dependently arisen,  
Such a thing does not exist.  
Therefore a nonempty thing  
Does not exist (Garfield 1995, 69).

These verses summarize many features of Nāgārjuna's Madhyamaka view, and have been interpreted in many different ways. Briefly,<sup>39</sup> they say that the central feature of Madhyamaka is dependent origination (*pratītyasamutpāda*), and that all entities are ontologically dependent or derivative of other entities or relations. Because entities do not exist independently, they can interact and function and that is the meaning of 'existence': to exist is to exist dependently. The contrasting view is that objects 'arise' from a pre-existing internal principle of motion or change. As a first approximation this contrasting view may be likened to Aristotle's notion of a potential form, e.g. the internal "blueprint" that guides the development of organisms from embryo to adult.

Another kind of relationality mentioned in these verses, "dependent designation", indicates what we call semantic *sūnyatā* or semantic relationality. This verse may simply refer to *sūnyatā* as being a dependent designation, or it may be more generally interpreted as a characteristic of meanings of any term or statement, such that the truth value of the latter vary with different domains of discourse.<sup>40</sup> I find the latter interpretation more consistent with the overall text and is consistent with certain commentaries, such as

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<sup>39</sup> See Garfield (1995:304-308) for more complete analysis.

<sup>40</sup> What I call semantic is similar to what Westerhoff (2009, 27-29) calls notional; Oetke (1989, 11, referenced in Westerhoff, 27, fn 39) calls logical; and others call it conceptual. What I call ontic, Westerhoff calls existential; Oetke calls causal, and Westerhoff says they correspond. However, there is a problem with relating existential=ontic, as pointed out by Taber (1998) in that what something is should be considered in terms of its properties independent of causal or other relations. However, such independence is brought into question in the Madhyamaka arguments, so what something is can be identified with what its relations are.

Garfield (1995) and Westerhoff (2003). Semantic relationality encompasses several varieties of dependence which relate to our use of words and concepts. I include in semantic relationality what Westerhoff (2003, 27) identifies as notional dependence, which he defines as a relationship between descriptions. He distinguishes that from existential dependence, which is a relationship between properties of physical entities, which I include in the category of ontological dependence. Examples of the notional dependence aspect of semantic relationality are dependences between the following pairs of designations: left-right, north-south, tall-short. These are similar to what Taber (1998) calls co-existing counterparts, and this type of dependence is one variety of semantic relationality. Another sort of semantic relationality is what Westerhoff (2003, 27) cites as a variety of conceptual dependence that is identified in some of the Tibetan commentarial literature. Conceptual dependence is mentioned as one of the three types of dependence in this literature, including also causal and mereological dependence. We added a ‘temporal’ dependence—the question of duration of an entity through time. Conceptual dependence is defined by Westerhoff as “the dependence of an object on a basis of designation, a designating mind,<sup>41</sup> and a term used to designate the object” (27), hence the above reference in MMK 24:18 qualifies as such a dependence. We will see examples of conceptual dependence in our examination of the necessary and essential identity of an object that is designated, for example, as ‘a rock’ or as ‘a quartz rock’: How we identify an entity has relevance to what we consider necessary for its identity (although different designations of course don’t change the entity). Semantic dependence of this conceptual variety also relates with epistemic relationality when we deal with scientific theories,

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<sup>41</sup> ‘A mind’ is cognition at the moment of awareness or consciousness of an object. See Dreyfus (1997) for a detailed discussion of Buddhist epistemology.

discussed briefly below and in more detail in Part III. An additional kind of semantic relationality is an application of contextualization, which (as previously mentioned) is briefly that a term used in one context may have an entirely different meaning when used in another context. Lack of clear specification of context in philosophical discourse frequently leads to confusion, as we shall see, and has apparently been a source of confusion, or at least of the many different interpretations, concerning the works of Madhyamaka, including the MMK of Nāgārjuna.<sup>42</sup>

Moreover, the verses also refer to the epistemological and ontological dimensions of the lack of inherent nature of what has been assumed by the opponent in the argument to be objective phenomena independent of subjective value-judgments such as those just mentioned. We therefore are introduced to epistemic and ontic relationality in addition to semantic relationality. For example, in the case of fire, while the ‘nature’ of fire is that it is hot, the heat is not taken to be an inherent property, but rather a relational property in both epistemic and ontic sorts. Relative to the heat inside the sun a campfire could be considered quite cold, thus exemplifying ontic relationality in terms of the properties of the fire, but a semantic relationality relating to our use of terms. It is an objective fact that the campfire is colder than the heat of the sun, which is an ontic relationality, and if we say “that fire is hot” we must acknowledge the semantic relationality in use of the word ‘hot’. Also, consistent with our experience and modern chemistry the campfire heat is always dissipating, while the campfire and its heat are interdependent with the wood, atmospheric oxygen, etc., demonstrating epistemic and ontic relationality. Ontic

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<sup>42</sup> I think that Nāgārjuna’s failure to more obviously identify the context of his terms is at the heart of Hayes’ (1994) identification of the fallacies in MMK, and clarification of context is at the heart of Taber’s (1998) interpretation.

relationality relates with causality in physical relations, hence that kind of relationality has also been called causal relationality. In sum, there is nothing inherent about the fire: it lacks inherent nature. No property inheres within the fire that is independent of either external or internal entities, parts, causes, conditions or processes.

As far as Madhyamaka is concerned, and as we elaborate throughout this dissertation, we interpret particular languages, like ‘fire-languages’ above, as also semantically relational because an assessment of the truth of a sentence of the language must allow for different contexts of comparison of its nature according to the different domains of discourse. These domains of discourse also relate with different scientific explanatory schemes (theories of physics) that we can utilize to understand what the fire is in precise logical and scientific terms, hence there also is an epistemic dimension of relationality to this phenomenon. Classically, this dimension is explicated in Buddhist texts in terms of the type of observer. For example, someone in the arctic would have a different view of fire than someone in the tropics, and we may find a telephone wire to be thin but an ant may find it thick.<sup>43</sup> We classify these types of relationalities as epistemic when the perspective is connected with physics theories and semantic when connected with rational philosophical discourse, and this distinction may not be fully understood until those sections of the dissertation are examined. However, this categorization is not meant to suggest that the relationality dimensions are independent. We will argue that in

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<sup>43</sup> One typical example is comparing our perceptions with those of beings (interpreted metaphorically, psychologically or literally) in other realms (as I have compared different environments or different animals), for example with a ‘hungry ghost’ being, a *preta*, who experiences suffering of insatiable desire while every object of desire causes further intense pain. Hence, in order to demonstrate the ontological dependence of an entity on our concepts and perceptions which are not necessarily universally valid, Candrakīrti in MAV 6:71 writes “Like one who suffers from an eye disease, a *preta* will perceive a river as a stream of pus” (MAV, 78). These realms may also be interpreted as human psychological states. Also, see *Flatland* by Edwin Abbott.

Madhyamaka reasoning—as we have begun to demonstrate in relation to the MMK verses discussed above and will continue to demonstrate based on text and commentary below—the meaningful, the knowable and the existent are all entwined, interrelated and mutually entailing.

These types of relationality do not deny that the normal, empirical objects of our world ‘exist’—Madhyamaka in my interpretation (informed by Tsong-kha-pa’s LRCM and other texts and commentaries) is not eliminative of entities, just eliminative of any inherent nature.<sup>44</sup> Thus, Madhyamaka *is eliminative* of entities with inherent nature, and I argue that this is the meaning of statements like ‘objects do not exist’, since ‘to exist’ typically, conventionally implies ‘true existence’, or ‘inherent nature’. Thus the existence of entities that are interdependent, non-unitary and impermanent is not denied. When considered in the context of a metaphysical investigation, a table should not be considered as a separate and independent entity, since it has parts that interconnect in order for it to be a table, and because its relation to the floor, chairs and its use are relevant to its nature.

The table, we might say, is a purely arbitrary slice of space-time chosen by us as the referent of a single name and not an entity demanding, on its own, recognition and a philosophical analysis to reveal its essence. That independent character is precisely what it lacks on this view. (Garfield 1996, 90).

Thus, in the Madhyamaka view the table as an independent entity must be seen as somewhat arbitrarily defined in accommodation to our relationship to the entity—what is called ‘conventional’ in the sense of habits, whims and conventions of use that are part of our understanding of what a table is, i.e. of the identity of that object as a table. Our

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<sup>44</sup> There are some interpretations of Madhyamaka, e.g. by Gorampa and his followers that are more eliminative of empirical objects than his contemporary Tsong-kha-pa in 14<sup>th</sup> Century Tibet and his followers. I mostly rely on the latter. See Thakchoe (2007).

conventions could easily have been different, and may indeed be different tomorrow. (Yet we must ask: if I sit on the table, does that make it a chair, or am I using the table to sit on? I think the latter, but it is vague.) And note that nothing hinges on the table being an artifact: How we determine where the rock ends and the mountain begins is in some sense arbitrary. (Yet does that make a rock a small mountain? This would be a convention of word usage without ontological consequence.) Madhyamaka argues that there is a distinction between conventional discourse and ‘ultimate’ metaphysical philosophical enquiry, and here we find the two truths:

MMK 24:8:  
The Buddha’s teaching of the Dharma  
Is based on two truths:  
A truth of worldly convention  
And an ultimate truth. (Garfield, 1995, 296)<sup>45</sup>.

Madhyamaka arguments suggest that no independent phenomena can be found in the analysis of ultimate nature, even though we normally discuss things as if there were ultimately independent nature. As mentioned, I argue as a thesis of this dissertation that metaphysical inquiry into the ultimate nature of physical phenomena requires physics, and also argue that physics should be interpreted within the epistemic framework of Physics Pluralism. Hence, Physics Pluralism is both relevant and essential to any metaphysical inquiry concerning physical phenomena. I argue for these by demonstrating the confusion that is entailed by ignoring physics thus interpreted, and also by demonstrating the clarity and coincidence with the actual results of physics that is obtained when that framework is used. The analysis demonstrates further that there is no one absolutely ultimate nature of phenomena: Natures are always relational in semantic,

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<sup>45</sup> See Newland (1992) for a detailed introduction to the concept of the two truths, and Thakchoe (2007) for more details. The *two truths* is a major concept in Madhyamaka, with nuances well beyond the scope of this dissertation.

epistemic and ontic ways, at least across different domains even if not śūnya within each domain. Note that it is not the case that conventional natures should be identified with the semantic dimension while ultimate natures should be identified as ontic. Rather, we can identify all three dimensions of semantic, epistemic and ontic relationality in each of conventional discourse and ultimate analysis. However, I do make the further claim, made plausible by various arguments and demonstrations, that we can interpret relative truth as the truth that is found within a particular domain, and there may be different domains with different truths. Ultimate truth is obtained from a cross-domain analysis.

Here is the fundamental pluralist perspective that is embodied in my interpretation of the two truths. There is a suggestion of that interpretation in the classical presentation and discussion, since relative truth is confined to the common sense, conventional, or some other limited perspective, while ultimate truth is obtained through extensive and intensive analysis. Hence, there is some consistence between at least some classical and my own interpretations. However, the major motivation for my interpretation of the two truths is due to analysis of contemporary physics and philosophy of physics, as supported by my examination of some contemporary arguments pertaining to some of the perennial metaphysical puzzles. The relevance and power of this pluralism is explored throughout the dissertation, hence it is the major focus of the dissertation.

### ***C. The Madhyamaka causality arguments: Causality without powers***

Analysis of causality is a large part of *Madhyamaka* analysis, and indeed causality has been called the central conception of Buddhism altogether (see, e.g., Kalupahana, 1975). As we suggested previously, the purpose of Madhyamaka arguments is to deny

*essentialism*, i.e., to deny that phenomena—including objects and their causal relationships—have essences or substances (*svabhāva*), which are interpreted as permanent, causally efficacious and composed of properties inherent to the substance whose nature is to be expressed by its essence. The point of the current section is to explicate what exactly is being denied relating to causality. However, that discussion must be integral to an understanding of the Madhyamaka view of objects that exhibit causal relationships, as discussed in later sections, hence complete understanding of Madhyamaka views on causality await further views explicated throughout the chapter.

I take the stance, based on analysis of text and commentary, that Madhyamaka denies production theories of causality, yet does not deny dependence theories. Production theories—as we see in *Chapter Seven: Physics of Causality* and which have been categorized and examined by Bunge (1959)—involve creation of something (an effect) that is *in a relevant sense* intrinsically different from its cause. By ‘intrinsic difference’ we indicate that there are properties had by either the cause or effect which are intrinsic to one but not the other. Nāgārjuna criticizes the notion of inherent nature that underlies identification of intrinsic differences. We see in *Chapter Seven: Physics of Dependence* that a contemporary dependence theory of causality—the conserved quantities theory—is consistent with his view.

I proposed the following as a way to understand the Madhyamaka view of causality: A causal relationship may be expressed as  $cRe$ , where  $c$  is the set (not the member of the set alone) of all causes,  $R$  the set of all causal relationships and  $e$  the set of all effects. One way of interpreting the Madhyamaka critique of causality is to conclude through its progressive denial of different kinds of cause-effect relationships (as in MMK

Chapter 1) that no coherent rational account of it is possible, hence there is no such thing. However, Kalupahana emphasizes the idea that Nāgārjuna is an empiricist, requiring evidence through observation rather than relying on rational analysis alone. Also, as suggested previously, what is frequently considered the culmination of the text in MMK 24: 18-19 identifies “dependent co-arising” with *śūnyatā*. I argue that a consistent interpretation of this tension (as Oetke 1991 calls it) may be resolved by cashing out the meaning of Madhyamaka causality arguments as follows: They promote the view that not only are there no entities which are independent of other entities, we cannot even define the causal relationship itself as separate from the entities. Hence, any causal process must be considered interdependent between many different ‘causes and conditions’. Causes, effects and the causal relations themselves, are all mutually interdependent.<sup>46</sup> In contemporary philosophy of science this view is similar to a kind of structural realism, that views the causal structure as being ‘real’ while the relata are not necessarily existent

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<sup>46</sup> This is largely Garfield’s (1995) interpretation. See also his (2002, essay 2) where he states: “To assert the emptiness of causation is to accept the utility of our causal discourse and explanatory practice, but to resist the temptation to see these as grounded in reference to causal powers or as demanding such grounding. Dependent origination simply is the explicability and coherence of the universe. Its emptiness is the fact that there is no more to it than that” (33). Oetke (1991) attributes to Padhye the view that it is a *correct* understanding of dependent arising ( ) that can be equated to *śūnyatā* in MMK 24, as opposed to the substantialist *misunderstanding* of causality that is being denied in MMK 1. Oetke, however, disagrees, emphasizing the denial of existence of empirical phenomena along with the denial of its non-existence that is found throughout MMK, as it is also found in the prajnaparamita sutras which are its precursors. (see, for example, the *Heart Sutra*, many versions of which are available online), Upon that basis, Oetke states “Therefore (the) things (of the phenomenal world) cannot exist in reality because they are subject to , since it is necessitated by the assumption of their existence. But the dictum that is what the Madhyamika calls *śūnyatā* can easily be taken as a slightly rhetorical means to convey just this thought. In this way the facts involved in [the tension between MMK 24:18 and MMK 1:1] can be elegantly accounted for and the appearance of an inconsistency vanishes.” (321) A good portion of this dissertation has the purpose to cash out the way in which existence and non-existence of empirical entities relates with dependent arising and relationality. One way is to consider existence and non-existence in different contexts, hence different domains, requiring analysis based on the contextualization aspect of semantic relationality; another is to say that things don’t exist independently yet do not not-exist dependently—or simply that things are relational, without their own independent identity, and may have a causal relation yet the relation itself has no independent identity. See also the Madhyamaka critique of momentariness in Section E of this chapter, including the footnote 83 on Dharmakāya. More will be said on this topic in further chapters.

at all (Worrall 1989), perhaps are implied by the relation (Ladyman, 1998) or may be at most derivative of the relations exhibited in causal structure (Chakravartty, 2003). See Ainsworth 2009 for a summary classification of structural realist positions and Chakravartty (2003) for extensive analysis. For an entity to be ‘real’ usually entails that it has some kind of inherent nature, yet Madhyamaka rejects any inherent nature even in the causal structure, which is sometimes expressed as saying that entities are not real. We will avoid such locutions, preferring to say more descriptively that Madhyamaka argues that entities lack any kind of inherent nature and are instead relational through-and-through. As we shall see below, in Madhyamaka philosophy, the causal process *cRe* must be understood as an integrated unit, although that unit also has no inherent nature and does have relationships with other relational units. A systems theory approach may be useful, but will take us too far astray. All entities and relations are related with all other entities and relations, hence *c* represents many causes and *e* represents many effects. Yet in discussion, in scientific theories, and in characterizations of properties of entities the entities and relations are confined to contexts in order to make sense of what is being discussed. As we see in the physics chapters, there are relationships between domains, yet many domains are demarcated by strict differences resulting in objective distinctions and boundaries to those domains. Hence, in general, categorization of a particular *cRe* causal unit *qua* unit should therefore be considered to be confined within a specified domain of philosophical discourse, physical (ontic) domain or (merely pragmatic) domain of applicability of a particular scientific theory, while other contexts—hence other categorizations—are possible within other domains. Each unit would be called a causal process, and causal processes are interconnected. In specified domains, we may be able to

justify a particular type of causal process, and there may be different types of causal processes demonstrated in different domains. Thus, there will be a relative truth understanding of causality specific to each domain, while an ultimate truth understanding comes from cross-domain analysis, and that will demonstrate a pluralist view of causality. This topic is discussed in more detail in *Chapter Seven: Physics of Dependence*.

There are several interrelated arguments concerning causal independence and dependence that we group together as *Madhyamaka causality arguments*. The main causality argument is the *refutation of arising from the four extremes*, and related arguments are the *refutation of production from existent or nonexistent*; *refutation of the four kinds of production*; and *the Great Independence argument*. We first introduce the main argument, and then briefly summarize the related arguments before analyzing the main argument in detail.

The *refutation of arising from the four extremes* is the main Madhyamaka causality argument. Recall that Madhyamaka is loosely translated as the Middle Way between extremes.<sup>47</sup> The argument presents four exhaustive possibilities for kinds of productive relationships that could possibly relate cause with effect. Briefly, the production theories of causality that are being denied by Madhyamaka reasoning involve the ‘creation’ of something which comes into being yet is independent from the ‘creator’, i.e. where either the result of a creation, the creation, the creator, or the creation process itself have inherent nature. Recall that ‘inherent nature’ of a phenomenon is a nature that is intrinsically independent of other phenomena, intrinsically independent of any parts

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<sup>47</sup> Yet note that some translate it as ‘not even a middle’, that removing the extremes leaves us with no secure position at all, because any position stated in a positive way entails, implies, connotes or suggests some kind of inherent nature, and this is rejected. Thanks to Karl Brunnhölzl, personal communication.

(hence cannot have parts) and is permanent. In this section we examine the first kind of independence that relates with causality: phenomena with inherent nature must be causally independent of any other phenomena, and Madhyamaka argues that such things cannot exist. Through *reductio* lines of reasoning the argument demonstrates contradictory consequences arising from all possibilities if it is assumed that there is inherent nature in the entities produced and/or if there is something inherent about the production process itself (this is Tsong-kha-pa's interpretation, and is spelled out in Garfield, 1995). Thus all production theories of causality relying on inherent nature are rejected, in favor of a dependency theory that includes no inherent nature either in the entities or in the relation. The four possibilities (the 'four extremes') are: independent production (from self); production from another entity; both independent production and production from another; and neither independent production nor production from another, i.e. causeless production. The argument is classically presented in the first and seventh chapter of Nāgārjuna's *MMK*; hence it is the first topic of the first major comprehensive philosophical Madhyamaka text.

Recall our previous explanation in *Section A.2* of this chapter of how proponents of Madhyamaka attempt to convince us that entities with inherent, hence independent, properties cannot interact and are therefore permanent. It is somewhat the ground of Madhyamaka critiques of inherent nature to understand that any kind of production of an entity or any kind of process to produce an entity cannot involve inherent nature: A produced entity cannot be independent, since it would be dependent on its production process; it cannot be unitary, since it must be assembled from parts; and it cannot be permanent since it was produced and hence both did not exist prior to the production

process, and also must eventually deteriorate or be destroyed. Madhyamaka arguments then go further to analyze the dependencies, the parts of parts, the production and destruction process and the entire notion of ‘entity’ and ‘relation’, denying more and more subtle forms of inherent nature that are suggested by those terms.

Yet, is inherent nature an outdated straw man in today’s sophisticated philosophical climate? According to Madhyamaka it does not seem to be. Madhyamaka is a Mahayana school of Buddhism, and a major foundation of Mahayana is Abhidharma and meditative practice. Abhidharma teaches, and meditative practice based on those teachings enables us to realize the depth and breadth of how we attribute inherent nature to our world and our selves. Even the duality of internal self and external world is such an attribution. Abhidharma identifies a substantial amount of this false attribution, and Madhyamaka just goes a little further, focusing on the attribution in external phenomena.<sup>48</sup> It does so with the idea that once we have realized that external phenomena do not have inherent nature, we can unite that understanding with the partial realization obtained concerning the lack of inherent nature in our selves to dissolve the duality altogether and understand the depth and breadth of śūnyatā in all things. The signs of relationality are all around us, yet we usually ignore them. One of the things we usually ignore is the deep meanings of the ubiquity of change. Since common sense tells us that we see change all around us, we can conclude that there are no inherent essences in our world. However, without the concept of inherent nature in our toolbox for understanding the world we must re-interpret what is happening—new independent

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<sup>48</sup> This characterization is perhaps dependent on a particular Tibetan doxographic organization of Indian Buddhist schools of thought, and other characterizations may be found. Certainly, Abhidharma pertains to ‘external’ (physical, non-psychological) phenomena as well as psychological states. However, Tibetan doxography attributes to Abhidharma only partial divestiture of the inherent nature of physical phenomena, still holding on to the inherent nature of partless particles.

things cannot be produced; old independent things cannot change or be known, hence we must be at least highly skeptical that there are any such independent things. *MMK* Chapter 1 is the first and foundational segment of this argument, and variations of it are found throughout *MMK*, Chandrakirti's *Madhyamakavātarā (MAV)*, Tsong-kha-pa's *Ocean* and many other texts and commentaries, ancient and contemporary. While they are classified as different arguments, they are actually further explications of the main view, and brief presentations of some will be helpful as background before analyzing the original *MMK* version, *the four extremes*.

The first related argument that we briefly examine concerning causality is *refutation of production from existent or nonexistent*, also called the *argument from dependent arising*.<sup>49</sup> Inherently existing phenomena, being persistent and unchanging, cannot arise or cease. "No origin can be ascribed to a truly existent product for the simple reason that it is already possessed of existence." (Kangyur 2001:336). This argument is found in *MMK* 20 with links to *MMK* 1, 7 and 19.

Focusing on a given result, such as a sprout 'arisen' from a seed, one investigates whether the result was present at the time of its cause, or whether it was absent, both present and absent, or neither present nor absent. When one finds no permutation from among these four in which arising is observable, one concludes that the result does not truly arise from the cause, for true [inherent] arising would necessarily involve one of these four. (Dewar 2008, 599; my insert).

My insertion of the term 'inherent' is in response to Dewar's use of the term 'true', also used frequently with 'true existence', which is a reference to *svabhāva*, inherent nature. The second related argument is *refutation of the four kinds of production*, also called *the refutation of the four permutations*. None of the four permutations of single and plural causes and results can be coherent: "Since neither the cause nor the

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<sup>49</sup> Westerhoff (2009, 31 and 113-123)

result is an indivisible discrete entity, they are devoid of both singularity and plurality” (Kangyur 2001, 336). Thus none of the following cause-effect relationships are coherent by this argument if they involve any kind of inherent nature: the single cause and single result; single cause and multiple results; multiple causes and single result; and multiple causes and multiple results. Each phenomenon is neither inherently single nor inherently plural. This is a variation of the *neither one nor many* argument that we discuss in the next section.

The third related argument is *the Great Interdependence argument* (Kangyur 2001, 337), also called *the king of reasonings* (Dewey 2008, 600) since it refutes both existence and non-existence. This argument is similar to the *sevenfold reasoning* we discuss in the next section in the way it considers various dependence relations, but here the argument form is applied to the four kinds of production rather than to the parts-whole relation. The conclusion is the same: None of the relations are coherent if we interpret the phenomena as having inherent nature. The argument concerns independence and dependent arising, which we interpret to indicate causal independence or causal dependence, or simply the presence or absence of causality. In sum:

...the reasoning of interdependence is capable of refuting both extremes of [inherent] existence and nonexistence. When one investigates to see if there is any phenomenon that bears its own nature, identity, or character without relying on another phenomenon to arise [causal-ontic relationality] or be designated [semantic relationality], one finds no phenomena that are not dependently arisen or dependently designated. Since true [inherent] existence<sup>50</sup> implies independent existence, one concludes that no phenomena truly [inherently] exist. Furthermore, to dispel clinging to nonexistence, one reflects on how the phenomena that are determined to lack an inherent nature are not utterly nonexistent, for they appear

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<sup>50</sup> ‘True existence’ is a technical philosophical translation of *svabhāva*, or inherent nature. While merely ‘existence’ is not denied (at least in this interpretation of Madhyamaka), and is understood as ‘relational existence’, ‘true existence’, or inherent nature, is denied.

in the world and arise in dependence upon other phenomena in a way that is renowned in the world. (Dewar 2008, 600; my inserts).

This selection highlights the view that even while inherent nature is denied, thus ‘things’ do not exist, i.e. as independent entities, phenomena do exist in a state of mutual interdependence, which we identify as causal dependence.

There is also semantic interdependence, such as with dualistic value judgments like good-bad and right-wrong, which are conceptually or semantically relational, and comparison categories like hot-cold or small-large which are ontologically relational, demonstrating that there is nothing inherent in one category or the other and each rather is relational and dependent on pragmatics, usage, personal perception, judgment, or relationships between entities in specified contexts.

Now we proceed with a more detailed examination of the main Madhyamaka causality argument, *refutation of arising from the four extremes* as presented in the first verse of MMK and explicated in the rest of its Chapter 1 and elaborated upon throughout that text:

(MMK 1:1)  
Neither from itself nor from another,  
Nor from both,  
Nor without a cause,  
Does anything whatever, anywhere arise. (Garfield 1995, 105).

Each of the four positions is a response to views held by Abhidharma.<sup>51</sup> Indeed, these discussions will strike a familiar note of similarity to philosophical discussions in the West that have been ongoing for millennia. Our summary here will be necessarily brief.

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<sup>51</sup> See Taber (1998) and Garfield (1995, 103-123) for two different and illuminating interpretive exegetic and explicative glosses on this chapter, which has been analyzed by many contemporary philosophers with various and sometimes contradictory interpretations. Also see Brunnholzl (2009, 264-5) for attribution of the four different views to different extant Indian philosophies, especially noting the forth: “The Lokāyatas assert that the entire world and its inhabitants arise without a cause, that is, just by nature.” (This is a

The first part “Neither from itself...” responds to those who believe that

...all causation is really self-causation. A proponent of this view would argue that for a cause to be genuinely the cause of an effect, that effect must exist potentially in that cause. If it does not, then the cause might exist without the effect, in which case the cause would fail to necessitate the effect, in which case it would not be a genuine cause. (Garfield 1995, 105).

With echoes of a substance perspective like Aristotle and Spinoza,<sup>52</sup> the prior potential causes the later actual effect, and in some sense these—like seed and sprout—are

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translation of Lodro Thayé’s *Commentary on The Treatise on the Distinction Between Consciousness and Wisdom* by Rangjung Dorje, the Third Karmapa.) The Lokāyatas, also known as Cārvākas, interestingly, were materialists who developed their philosophy about the same time as Buddhists, but that philosophy is known only in fragments before Jayarāsi’s work in the 8<sup>th</sup> Century A.D, intriguingly named *The Lion of the Dissolution of [all] Categories (Tattvōpaplava-sirṃha)*. That work uses a similar consequentialist/reductio type of reasoning as Nāgārjuna (*prasaṅga*) to negate other positive views, and describes a more empiricist view, eschewing metaphysical inquiry and inference as a basis for knowledge (*pramāṇa*)—both of which Nāgārjuna and successive Madhyamika utilize—and relying instead only on the evidences of our senses as the only valid foundation. Reasoning is left only to demonstrate the illogical consequences of other reasoning. The ‘causeless’ nature referenced in the fourth of Nāgārjuna’s tetralemma seems, therefore, less ‘no cause’ and more naturalistic and scientific than characterized by its opponents, one of which are the Buddhists. See Balcerowicz (2011).

<sup>52</sup> Taber (1998) writes

“I take as my parallel the first part of Spinoza’s *Ethics*. At the beginning of Part One Spinoza defines substance as “that which is in itself and is conceived through itself.” That is, a substance is that which does not depend causally on anything else; for Spinoza also says with Axiom Four that “the knowledge of an effect depends on, and involves, the knowledge of the cause.” Anything that is caused by another, in other words, is conceived through that other. To say that substance is conceived through itself, then, is to say that it is not caused by anything else.” Taber references *The Ethics and Selected Letters*, trans. Samuel Shirley (Indianapolis: Hackett, 1982), Part I, Def. 3. Further, “From the definition of substance and the implication that a substance cannot be caused by anything else, which Spinoza takes to mean that it is self-caused (*causa sui*), it follows that “it is of the nature of substance to exist.” [Part I, Prop. 7.] Additionally, “Spinoza’s conception of substance, which was shared by the other rationalist philosophers, clearly goes back, through Medieval philosophy, to the notion of substance in Aristotle’s *Metaphysics*. In that work Aristotle sought to determine the primary sense in which things can be said to be. He decided that substance is the primary mode of being and that all other modes of being are somehow derivative of substance. A prominent characteristic of substance for Aristotle is that it is *per se*; it is definable in terms that are unique to itself and it is not able to be produced by something else. [*Metaphysics* Z.4, 7–8] On the one hand, this means that an individual substance can arise only from a substance of the same type: man begets a man, not a horse. Thus it would seem that Aristotle did not consider substance to be fully eternal. On the other hand, insofar as he considered substance to be ultimately the substantial form that combines with matter to make an individual concrete substance, and that substantial forms are immaterial, intelligible, and not subject to change – indeed, that they are eternal objects of contemplation in the mind of God – he believed substance to be eternal. While it would certainly be farfetched to suggest that Nāgārjuna conceives of *svabhāva* as an Aristotelian substantial form (however, see footnote 29), it seems not implausible to suggest that he thinks of essence as that which is conceived through itself without reference to anything else. That is what makes an essence an essence; that is how an essence determines a

different forms of the same thing. Hence, the sprout can be said to be self-caused; hence, nothing new actually occurs. Yet it requires external conditions of certain kinds for the potential to actualize, and this requirement entails that there is nothing independent, unitary and persistent in the potential itself. Butter must be churned from milk, and a billiard ball doesn't simply start rolling of its own accord—it must be struck by another.

The second part “...nor from another...” is the more common contemporary and science-based understanding of causality, as opposed to the more ancient and early-modern discussion of self-causation. It is this type of cause that embodies the production theory of causality which we argue is the main target of Nāgārjuna's argument, and in light of his promotion of dependent arising is allowing for, if not promoting, a nuanced dependency theory. However, before we analyze this part we should step back and look at the fundamental Buddhist idea of progression of entities through time, since we will be looking at a progression from what might be called a causal entity to an effect entity. It is foundational in much Buddhist thought—to be discussed further in Section E of this chapter—that entities are impermanent, and exist at most only for short durations (moments, as argued by many Abhidharma proponents) or are continuously impermanent (as promoted by Madhyamaka), not persisting (with inherent nature) not even for a moment. As previously mentioned, we could interpret this as an application of Leibniz' Laws:<sup>53</sup> properties of entities change at least frequently if not continuously, and (since in

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thing's uniqueness. But then an essence cannot be produced by something else; for it would then bear the marks of that production. It would reflect its origin in some way, thereby ceasing to be what makes a thing unique. Essence or own-being, therefore, must be *per se*. The notion of a caused essence is a contradiction in terms (*karika* 2).” (224-225)

<sup>53</sup> The two laws are, briefly, that different properties entail different entities and different entities entail different properties. Some think one or the other is *the* law, but they are both relevant so we include both.

Buddhist views) an entity is nothing other than its bundle of properties,<sup>54</sup> the entity vanishes, to be succeeded by a new entity. Thus, any change in properties entails a change in identity. There is a further distinction to be concerned with: Do changing relational properties entail change in identity, or only changing intrinsic properties? And how do we determine the difference between those two types of properties? We discuss this latter question in detail in *Chapter Three: Metaphysics of Dependence*, and below we indicate where that problem arises in Nāgārjuna’s argument. He argues that there are no intrinsic properties at all, and therefore change of any property—each of which is relational—entails change of identity.<sup>55</sup>

Hence, we began with an arising and a ceasing of a phenomenon, and examine the causal process between them: An entity or other kind of phenomenon arises, and then it ceases. Why? How? As we saw above, Nāgārjuna denies that an effect could be in the cause itself. Here we consider the possibility that the effect is in something other than the cause. This is the second horn of Nāgārjuna’s tetralemma. But the Madhyamaka argument concerning causation from another is that for two entities to interact in a causal

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<sup>54</sup> “...these proofs [of momentariness] rest on two premisses, namely 1) on the premise that entities cannot change without losing their identity so that any change implies the destruction of the old and the origination of a new entity, and 2) on the premise that things change at every moment. Then it is shown that the first premise is the logical consequence of the antirealist tendency in Buddhism which denies a persisting substratum undergoing change so that the entity is nothing but the sum of its properties. Thereafter, it is demonstrated that the second premise follows naturally from the Buddhist stress on impermanence and in particular from reflections on the process of ageing” (Rospatt 1995, 11).

<sup>55</sup> This understanding is typically ascribed to a strict interpretation of Leibniz’ Laws, since different properties entails a different entity, hence an entity with a property in one time that has a different property in the next time (which is typically considered a change of properties of the same entity in Western metaphysics) is considered a different entity. Different schools of Buddhist thought argued that the entity lasted a duration of many ‘moments’, or one moment, thus the impermanence of all phenomena became the momentariness of all phenomena—that there was inherent nature for that discrete moment. Nāgārjuna began his critique of Buddhist and non-Buddhist thinking by examining the arising and ceasing of phenomena in this context, and I infer from his arguments opposition to all kinds of discreteness in time, space and matter, promoting instead continuity—at least in some contexts. We discuss momentariness and impermanence more extensively in the Section E of this chapter.

fashion there is a requirement that there be some interdependence and common factor—something shared by them—hence the interpretation of ‘the other’ as being ‘other’ is seen as conventional, arbitrary and context-sensitive, hence relational or *sūnya*. Garfield (1995, 109-110, fn 23) points out that Wood interprets Nāgārjuna as saying that nothing arises, but Garfield argues against it, by saying that “He simply says that they do not arise by means of an inherently existent causal process”, and points out that in other chapters Nāgārjuna shows how things do arise, dependently. In support of Garfield’s position, he provides the following quote, which I interpret as refuting the existence of inherently existent ‘others’, i.e. others (or anything) with inherent nature:

Dependent co-arising refers to a causal relationship wherein no essence is present at any time in either cause or result. Thus the sentence ‘Nothing arises from itself; nothing arises from another,’ is not intended to refute arising. It is a negation of others that might be explained as ‘from themselves’ or ‘from others’” (Nagao 1989, 7, quoted in Garfield 1995, 110).

Also, “An effect that is non-existent in the sense of being absolutely different from the condition will not be related in any way to a condition” (Kalupahana 1986, 110). Note that causes were previously denied and now Nāgārjuna is examining conditions. For our current purposes we may consider them similar.<sup>56</sup>

According to Tibetan exegesis of Tsong-kha-pa as further interpreted by such modern commentators as Garfield, yet which I think is justified in the text and logically, the central points to be gleaned from this argument are that identity of an entity is based on inherent nature, i.e. what is intrinsic to the entity independent of other entities. I justify

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<sup>56</sup> It is a common interpretation that there is an important distinction between causes and conditions given in the MMK, but consideration of it will take us too far astray, and I have not found it justified in the text *per se*, and may simply reflect Tibetan exegesis. See Garfield (1995, 110f) and Kalupahana (1986, 108f). Some say that causes are flatly denied but conditions are not, while others say both are denied. For a more nihilist interpretation see Wood (1994). My interpretation is that both are denied if any are considered as embodying inherent nature, while both are acceptable if they are thoroughly relational.

this by invoking MMK 24:18-19, quoted above, that I interpret as saying that things do happen, dependently, hence what is denied throughout the text is that things happen due to inherent nature. With no intrinsic properties, there is no inherent nature and no identity. With no identity of an entity, there is no identity of an *other* entity. Hence, things happen, and for causes, but causes and effect must be interpreted without any inherent nature in either, and also not in the process. How to cash this out will be a central theme throughout the dissertation. In terms of cause and effect, we have the additional situation of temporal sequence: When does the cause cease and the effect begin? Is there a moment when one stops and the other begins? If so, then at that moment they are the same. If not, then they never coincide and the causal influence cannot be transferred to the effect. Either way, there is no coherence to this sequence.<sup>57</sup>

As an extrapolation of Nāgārjuna's view we look at Hume's billiard table (Enquiry 4.1). According to the assumption that a cause must be in physical contact with an effect—which is called 'no action at a distance' and is a general and accepted principle of physics—the billiard balls must be in contact for the one to 'cause' movement of the other. When in contact, how would we distinguish one ball from the other? At that moment, it is a single entity formed by contact of two previously separate entities. The only way to distinguish them would be to invoke the way they were prior to this time, or the way they may be afterwards, in order to call them separate, unitary and independent entities. However, that would be a characterization of what they *were* or will be, not what they *are* in this moment of contact. In that moment the entity is one

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<sup>57</sup> As we see in *Chapter Seven: Physics of Independence* Russell (1913) will severely criticize this view of causality of temporal sequence that had been enshrined in Hume's insistence. Russell replaced it with a functional relationship which makes more sense in light of modern mathematical physics.

composite and interdependent entity.<sup>58</sup> We will need some way of determining what is intrinsic to the entity in distinction from what is intrinsic to a different entity. This sounds like it may be a simple problem, but is not. The entire problem of even defining intrinsicity is quite complex, and the further issue of determining what properties (if any) are intrinsic involves further complexities: They are issues running through several topics in metaphysics (as discussed throughout *Part II* with initial conceptual analysis provided in *Chapter Three*) and physics (as discussed throughout *Part III*).

Now we make a change that we discuss throughout the dissertation: change of reference frame. It is also a general principle of all physics that the inherent and intrinsic nature of phenomena cannot change if there is what is called a *Galilean transformation* of the frame of reference.<sup>59</sup> Our usual frame of reference for the billiard game is that of the floor and table. The white ball moves towards the stationary red ball, and then the white ball strikes the red ball, and (let us say) the white ball becomes stationary and the red ball moves. But these characterizations of movement are from our usual frame of reference only. Now consider the frame of reference of a fly which is flying along with the white ball. To that fly, the white ball is horizontally stationary in her frame, though spinning, and the table is horizontally moving as the red ball approaches. It is like being in a train and the station comes into view. Then, the red ball—which is moving in relation to the fly’s frame of reference—strikes the perfectly innocent white ball and sends it moving off somewhere else. From the fly’s frame of reference, the red ball was the cause and the

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<sup>58</sup> See Garfield (1995, p90 and fn.6) for similar analysis.

<sup>59</sup> For simplicity, we only use inertial frames, i.e. with no acceleration, and ignore special relativity that would require a Lorentzian transformation. The result would not change if we had accommodated it.

white ball the effect!<sup>60</sup> We see that it is even arbitrary to identify which ball is moving, thus demonstrating an observer perspective dependence. I call this an epistemic relationality in the context of this particular phenomena.<sup>61</sup> Thus, the standard understanding of causality as a cause being something that is different from the effect has significant difficulties, since we cannot always know which is the cause and which is the effect. Rather, according to Nāgārjuna's argument, we have interdependence:

What we are typically confronted with in nature is a vast network of interdependent and continuous processes, and carving out particular phenomena for explanation or for use in explanations depends more on our explanatory interests and language than on joints nature presents to us. (Garfield 1995, 113).

The latter reference to nature's joints is to Sellars' comment that science carves nature at its joints, i.e. by showing us the natural kinds that nature offers, a topic that is quite controversial with a huge literature which we will not approach at this time in any detail. However, we will be forced to address certain issues concerning the topic since so much of the literature of intrinsicity deals with it, and there is some commentary on Madhyamaka which is directly relevant to the topic of natural kinds relating to causality and the distinction between an entity and an 'other' entity: How do we distinguish one entity from another? Conceivably this could be done by listing the inherent or intrinsic properties of each, if there were any, and classifying them as members of different natural kinds, if there were any, and then including any relational differences to round out the different identities. However, what if there are no intrinsic properties, hence no natural

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<sup>60</sup> This analysis is flawed, yet provides a simple look at this situation which is pedagogically relevant, and correcting it will entail unnecessary complications. If we move to extragalactic space and have two rocks and a fly in a space suit in the same situation as the balls, the analysis will be straightforward.

<sup>61</sup> I identify this as epistemic due to its relationship to choice of a frame of reference in classical physics compared with further frames of reference that arise when we examine the phenomena in the context of Einstein's theories of relativity.

kinds? Garfield interprets Nāgārjuna as denying the existence of natural kinds that can be considered to be independent classes of entities which partake of objectively necessary causal processes. I will question the presumption of universally applicable intrinsic properties and their universally applicable natural kinds, i.e. which pertain within all domains, and instead demonstrate that a pluralist perspective is more plausible. Hence, I will call the resulting classes *domain-specific natural kinds* since within some ontic domains there are natural kinds with intrinsic properties, but those same properties are found to be relational in other domains, thus demonstrating a cross-domain ontic relationality.

Garfield has associated Nāgārjuna's view with that of Hume on this account. Natural kinds are associated with natural necessity. A denial of necessity has been typically associated with the Humean regularity theory of causality.<sup>62</sup> Hence, Nāgārjuna's rejection of a production theory and promotion of a dependence theory is interpreted by Garfield and others in a Humean fashion as a rejection of what Hume called occult powers of necessity. The latter seems like a reasonable way to interpret causality with inherent nature.

The key point in this analysis is that we may not simply say that there are no entities with inherent nature, but also must acknowledge that according to Madhyamaka the causal process itself lacks inherent nature. This is very important. In the usual sense,

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<sup>62</sup> The 'New Hume' view is a recent addition to the interpretations given Hume in the literature, and is the idea that Hume also included laws of nature in his thinking, and that regularities have causes in the way things are, rather than being simply examples of our habitual tendencies to connect the dots. I confirmed this New Hume view in my own reading, especially of the *Enquiry*, which is the later work and which, according to Hume, should be used instead of the *Treatise*. The latter work demonstrates the New Hume view but only ambiguously. See especially his *Dialogues on Natural Religion* (1963:164-5, towards the end of Part IX:191 of the Kemp Smith edition). See Read and Richman (2007) for recent essays on the New Hume interpretation.

to have no inherent nature is to not be real in itself, or as the Tibetan's say *from its own side*. In my interpretation, this is not that it does not exist, but that it exists relationally, dependently. We have already seen in the Madhyamaka argument the idea that there are no inherent natures to entities. One usual (non-Madhyamaka) way of considering causality—as one thing with inherent nature interacting relationally with another thing with inherent nature—is therefore being questioned.<sup>63</sup> By that common perspective Madhyamaka argues that we must therefore say that the two entities are interdependent, not independent: Entity one is dependent on entity two and entity two is dependent on entity one when we examine the interaction between them. Hence, they cannot be independent and their properties cannot be inherent. Our usual contemporary Western view of dependence is one entity with inherent nature dependent on another entity with inherent nature. But if there are no inherent natures, this view will not stand.

Now, we further question the dependence relationship itself. A further contemporary Western understanding of a relationship is that there at least might be a necessity to it, that there is something clearly distinct, inherent and intrinsic to the causal relationship itself, like a natural law inherent in the universe. Yet, we see here that Nāgārjuna is rejecting the idea that the relationship has any inherent nature either. This is the issue in Hume of 'occult powers'. Consider the following verse:

MMK 1:4  
Power to act does not have conditions.  
There is no power to act without conditions.  
There are no conditions without power to act.

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<sup>63</sup> While this chapter of mine mostly merely presents the Madhyamaka arguments, and the rest of the dissertation provides some criticism, it may be worthwhile to note that in light of modern physics we would break down the interaction into inherent properties, e.g. mass, and relational properties, e.g. velocity, which together form, e.g. the momentum of an entity such as a billiard ball. The relational properties change, interact, and are interdependent, while the masses are (in this domain) inherent. The Madhyamaka argument is not, therefore, entirely consistent with some domains of contemporary physics. We will, however, see how even mass should be considered relational in domains of quantum field theories.

Nor do any have the power to act. (Garfield 1995, 113).

In comment Garfield takes a particularly Humean stance (also exhibited in his 2002) and writes:

This is the beginning of Nāgārjuna's attack on the causal power/cement-of-the-universe view of causation and his contrastive development of his regularity view of conditioned dependent arising. Causal powers, according to those who posit them, are meant to explain the causal nexus—they are meant to explain how it is that causes bring about their effects, which is itself supposed to be otherwise inexplicable. But, Nāgārjuna argues, if there were a causal power, it itself, as a phenomenon, would either have to have conditions or not. If the former, there is a vicious explanatory regress, for then one has to explain how the powers to act are themselves brought about by the conditions, and this is the very link presupposed by the friend of powers to be inexplicable... If, on the other hand, one suggests that the powers have no condition, one is stuck positing uncaused and inexplicable occult entities as the explanans of causation. (Garfield 1995, 113).

Yet see also Kalupahana's translation and commentary:

MMK1:4

Activity [*kriyā*] is not constituted of conditions nor is it not non-constituted of conditions. Conditions are neither constituted nor non-constituted of activity. (Kalupahana 1986, 108).

Kalupahana points out that *kriyā* may have two meanings. First, it is...

“...an inherent activity, a power or potentiality (*śakti*) in something to produce an effect...Activity would then be an embodiment of a condition...or a condition would be an embodiment of activity...In either case, the activity or the condition is said to produce the effect...This, once again, is the substantialist interpretation of causation...[in contrast] activity is not an embodiment of a condition...or that a condition is not an embodiment of activity...Nāgārjuna says no to both extremes. (Kalupahana 1986, 108-9).

The second meaning of *kriyā* is a pragmatic understanding in which activity and conditions are defined in terms of the effect. In Kalupahana's view, Nāgārjuna next examines this second meaning to divest it of any inherent nature, and it is that continuing process that Garfield interprets as dismantling causality of occult powers. Garfield also

addresses the ‘terminus of causality’ problem in his mention of a possible “vicious explanatory regress”.

One way of interpreting this verse, and the rest of this chapter, is to conclude that there are no conditions, and/or that nothing arises. However, I find that contradictory both to 24:18-19 where we find a reference to dependent arising, and also to the logic of things happening. Therefore, without discarding the text entirely as incoherent, we must find a way of interpreting it with meaning. The meaning that Tsong-kha-pa finds (below) and that I adopt is that it points out the lack of inherent nature in arising and causality altogether, that things arise interdependently.

The third part of MMK 1:1 “...nor from both...” could be interpreted as a mere conjunction of self-causation and causation from other, in which case its denial is trivial given the denial of each component. Rather, let us read a little more into it in order to make it more consistent with current knowledge, and consider it a compromise that acknowledges the complexities of both the potential and the necessity for particularly hospitable conditions to exist in order for the potential to actualize. Nāgārjuna analyzes individual conditions of a causal process and cannot find the effect in any one of them, but the effect does arise from the collocation or synthesis of those conditions with the interactive potential that lacks inherent nature. No individual entities or conditions involved in the causal process have inherent nature (or they couldn’t interact), hence there is no principled way to distinguish or characterize as separate the different entities or conditions. So the effect cannot be considered separate from either the cause or the conditions. Concerning the effect not arising from an ‘other’, Garfield writes: “Given that things have no intrinsic nature, they are not essentially different. Given that lack of

difference, they are interdependent. But given that interdependence, there cannot be the otherness needed to build otherness-essence [dependence upon another for existence] out of dependence” (Garfield 1995, 112). If we extrapolate by combining a thoroughly relational view of no inherent nature anywhere in the causal process of producing an effect from a cause (other), effect (itself) or relation either, then a nuanced interdependence, or mutual dependence, is implied that will be worked out in the rest of this dissertation.

The final “Nor without a cause...” denies that there is no causality, while it does deny the kind of causality relating with entities that have inherent nature.<sup>64</sup> Tsong-kha-pa summarizes the argument:

So the very arising of such effects as sprouts in dependence on such causes as seeds shows that there is no arising in any of the four extreme ways. This is because the refutation of causeless arising is easy, and, if they had the same essence, one giving rise to the other would be contradictory as has been previously shown. If they had different essences, they would be unrelated, and their arising would be contradictory. Thus there could not be arising from both either. (*Ocean*, 72)

Yet note also that Tsong-kha-pa later points out that Nāgārjuna is not denying dependent origination, but is rather denying dependent origination which has any inherent existence. In commentary to portion of the *Sūtra-samuccarya* that says

Since all phenomena are dependently arisen, there is no entity. O, Lord! Whatever pertains to samsara or to nirvana is a dependently arisen object, meaning nonexistent. O, Lord! The meaning of “nonexistent” is understood by the wise as *dependently arisen*. But the wise do not conceptualize the meaning of “nonexistence” as *dependently arisen*. Quoted in (*Ocean*, 199).

Tsong-kha-pa states:.

One should understand this as quoted from the *Ratnasancaya-Sutra*. The meaning of the last line of this passage is that the *fact* that the meaning of “dependently

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<sup>64</sup> Although see previous footnote 58..

arisen” is *essentially empty* is also conventionally the case; and so the meaning is that even *that* is not conceptualized as truly existent. Thus nonexistence is not *complete* non existence, but non existence of *inherent existence*. Therefore, the entire system of cause and effect is coherent. (Ocean, 199).

Recall, “truly existent” means existence with inherent nature. But things exist *dependently*, or what I am calling *relationally*. This is the interpretation that I adopt here: causality between independent entities is impossible, but causality among entities that have no inherent natures is not denied.

In this section we saw how the causal process is understood in Madhyamaka philosophy. In terms of the symbolism at the beginning of the section, the causal process may be indicated by  $cRe$ . In normal Western understanding (although see also *Chapter Seven: Physics of Dependence*) the cause  $c$  is an event which is independent of the effect  $e$ , and the relation  $R$  embodies the production of the effect from the cause. Humean causality embodies the regular conjunction of cause with effect without inference of production. Madhyamaka goes further to point out that not only do the entities involved in the causal events lack inherent nature of their own, and also lack independence from each other, they also lack independence from other events and processes. Thus  $c$  and  $e$  should be understood as interconnected sets  $\{c_i\}$  and  $\{e_i\}$  of interrelated causes and effects in interconnected sequences of  $\{c_i R_{ij} e_j\}$ .<sup>65</sup> In regards to our conventions of common discourse, we say that a cause is one thing (with inherent nature) and an effect is another thing (also with its own inherent nature). However, ultimately we see that causes and effects are interrelated, each without inherent nature. In this way we see the pluralism

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<sup>65</sup> These are, in the language of systems theory, massively interconnected, and again, while I think that we can express this concept in the language of systems theory, it would take us too far afield to do so here in any precise mathematical form.

of a classical interpretation of the two truths of Madhyamaka demonstrated in terms of causality. We await further chapters to investigate the nature of causality in domain specific (relative) and cross-domain (ultimate) analysis, corresponding to my interpretation.

#### ***D. Mereological analysis: relations without relata?***

All phenomena, including the normal entities of our commonsense understanding, are said by Madhyamaka to lack inherent nature. Our second or mereological component of *sūnyatā* and relationality is that all phenomena lack unitarity, which we interpret as entailing that they are composite. Yet, it is composite only in a comprehensive relationality sense: If ‘composite’ is considered to be a composition formed from independent parts with inherent nature, or if the composite whole is considered to be independent with inherent nature, *sevenfold reasoning* demonstrates that no coherent logical relationship between those parts and whole will pertain. *Sevenfold reasoning* demonstrates these conclusions by examining an explicitly composite object through analyzing some apparently reasonable characterizations of the relationship between it and its still composite proper parts in order to show that none of those characterizations are coherent as long as we interpret the whole and/or parts as having inherent nature. For a coherent mereological relationship to exist between things, the things must be separately independent, so that one thing can be clearly identified and have a clear relationship with another thing that is clearly identified. According to this argument, since no coherent mereological relationships pertain therefore there are no independent things,<sup>66</sup>

What if the parts have no further parts—what if there are atomic simples that form the fundamental building blocks of composite wholes? In this case, by Madhyamaka arguments the atomic simples would be independent, unitary and permanent—but how, then, could they combine to form a composite whole? *Neither-one-nor-many* argues that

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<sup>66</sup> Note also that these arguments use classical extensional mereology which is not well fit to deal with structural relations of a sort that exist in any real physical structure other than an unrelated mereological fusion or ‘heap’.

there are no atomic simples, since in order to combine, the ‘ultimate’ building block must have parts that combine with neighboring parts of other building blocks. Since neither a composite nor its either composite or ‘ultimate’ parts have inherent nature (hence there are perhaps no ‘ultimate’ parts), nothing has inherent nature.

#### ***D.1. The Sevenfold reasoning***

*The sevenfold reasoning* is a set of seven related mereological arguments examining a composite object and its still composite parts. The purpose of the reasoning is to dispute the position of Abhidharma reductionists,<sup>67</sup> whom Tsong-kha-pa calls the *essentialists*, because they posit inherent nature or essence in some posited ultimate proper parts, even though they eliminate the whole from their ontology. The purpose is to show that no coherent part-whole relationship exists. The argument has similarities to some arguments concerning classical Western puzzles of composition, and we present contemporary versions of them in *Chapter Four: Metaphysics of Composition*.<sup>68</sup>

Nāgārjuna summarized a fivefold reasoning:

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<sup>67</sup> Especially discussed in Siderits (2003).

<sup>68</sup> These puzzles are ancient in East and West. An early example of the argument from the Indian Buddhist tradition is recorded in *The Questions of King Milinda*. *The Questions* is a record of discussions that are actually Socratic/Buddhist investigations into the true nature of reality between a Buddhist scholar Nagasena (perhaps apocryphal) with King Milinda (the historical Indo-Greek King Menander, ruler of what is now in Pakistan, at around 150 BC). The relevant discussion examines the mereological relationships between a composite whole and its proper parts. See Müller (1890) for the entire record, and Kapstein (1988) for a contemporary formal mereological analysis of a version of the argument by Vasubandhu. From the former (43-44): “(N) How then did you come, on foot, or in a chariot? (M) We did not come, Sir, on foot. We came in a carriage. (N) Then if you came, Sire, in a carriage, explain to me what that is. Is it the pole that is the chariot? (M) we did not say that. (N) Is it the axle that is the chariot? (M) Certainly not. (N) Is it the wheels, or the framework, or the ropes, or the yoke, or the spokes of the wheels, or the goad, that are the chariot? And to all these he still answered no. (N) Then is it all these parts of it that are the chariot? (M) No, Sir. (N) But is there anything outside them that is the chariot? And still he answered no. (N) Then thus, ask as we may, we can discover no chariot. Chariot is a mere empty sound... (M) It is on account of its having all these things—the pole, and the axle, the wheels, and the framework, the ropes, the yoke, the spokes, and the goad—that it comes under the generally understood term, the designation in common use of ‘chariot.’”

The self does not inherently exist because of (1) not being the aggregates, (2) not being other than the aggregates, (3) not being the base of the aggregates, (4) not depending on the aggregates, and (5) not possessing the aggregates. An example is a chariot. (translated in Hopkins 1983/1996, 178, from Nāgārjuna's Fundamental Wisdom of the Middle Way, *MMK*)<sup>69</sup>.

Note that 'inherent existence' is a translation of *svabhāva*, and it is this which is being denied, while the 'conventional' understanding of a chariot is not denied. Candrakīrti added two further reasons, and his seven alternatives are summarized in the following verse from Chapter 6 of *MAV*.<sup>70</sup> Here, he is using the example of a chariot and analysis that goes back at least to the *Milindapanha*, as noted in the footnote above, and which was adopted by Madhyamikas:

(MAV 6:151)  
We cannot claim a chariot is other than its parts,  
Nor that it is their owner, nor identical with them.  
It is not in its parts; its parts are not contained in it.  
It's not the mere collection of the parts nor yet their shape.  
(Padmakara 2004, 89).

An alternate translation from Tsong-kha-pa's LRCM is helpful:

(MAV 6:151)  
A chariot is neither asserted to be other than its parts, nor to be non-other. It does not possess them. It does not depend on the parts and the parts do not depend on it. It is neither the mere collection of the parts, nor is it their shape. It is like this.  
(LRCM 2002, 279).

After rephrasing and reordering,<sup>71</sup> the seven conclusions of the seven arguments are that the chariot cannot be considered as:

1. independent from the parts
2. identical to the parts

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<sup>69</sup> Note that 'the aggregates' refer not only to the parts of any composite object, but specifically to the *skandhas*, or parts of conventional consciousness of ego, which is beyond the scope of this dissertation.

<sup>70</sup> See also Huntington (1989) and Conze (1959).

<sup>71</sup> Jinpa's (2002, 83) articulation is helpful in this regard.

3. the possessor or ‘appropriator’ of the parts
4. dependent on the parts like an object inside a container
5. the basis of the parts
6. the collection of the parts
7. a special configuration of the parts.
- 8.

The first five arguments are discussed in the MAV 6:121-150 in the context of the personal self, after which Candrakīrti returns to the chariot. Since discussion of a personal self would bring us outside the scope of our current inquiry we will rely on Tsong-kha-pa’s commentary in LRCM, Chapter 22 which provides analysis of the chariot throughout. It should be remembered that the existence of the chariot is not in dispute; it is only the inherent nature (*svabhāva*) of the chariot that is disputed:

MAV 167

Parts and part possessors, qualities and qualified, desire and those desiring,  
 Defined and definition, fire and fuel—subjected, like a chariot,  
 To sevenfold analysis are shown to be devoid of real existence [*svabhāva*].  
 Yet, by worldly, everyday convention, they exist indeed. (MAV, 91).

And in further commentary by Tsong-kha-pa:

But when reason fails to find it in those seven ways, does this refute the chariot? How could it? Reasoning that analyzes whether things intrinsically exist does not establish the assertion of the chariot; rather, leaving reasoned analysis aside, it is established by a mere, unimpaired, ordinary, conventional—i.e., worldly—consciousness. Therefore, the way a chariot is posited is that it is established as existing imputedly; it is imputed in dependence upon its parts. (LRCM, 283-4).

By imputed existence, Tsong-kha-pa is, I argue, referring to our cognitive habit or convention of assigning or attributing inherent nature where there ultimately is none. This is not to say that the chariot is dependent on its parts—that is explicitly denied in the argument if we consider parts and chariot as separate, independent, inherently existent things. Here we have another example of co-existing counterparts (Taber, 1998): The assumption that there is a composite whole object involves an underlying assumption that there are parts, and assuming parts involves an underlying assumption that there is a

composite whole to which they somehow ‘belong’. Parts-whole pair up like left-right. And the assumption of their mutual existence generally involves an underlying assumption of their independence, some intrinsic qualities to each, and when it does involve such an assumption Madhyamaka argues that therein lies a fallacy. We fallaciously attribute independence to the chariot, something that has ‘chariot-ness’ over and above the assembly of its parts. But even if we acknowledge dependence on parts, we still may be investing inherent nature into the parts, and that would also be fallacious since nothing independent can be combined, and nothing that is combined from parts can be independent. What is rejected by the *sevenfold reasoning* is that we can coherently reason to have an independent (hence with inherent nature) set of things that can then form relationships to build a composite whole, or that we can have an independent object that can be considered as the mereological sum of independent parts.<sup>72</sup> The conclusion is that we impute the whole on the illusory basis of dependency on independent parts. In sum:

If the chariot had an essential or intrinsic nature, it undoubtedly would be established by reasoned knowledge that analyzes whether it exists intrinsically in any of the seven ways. However, since it is not established by such knowledge in any of the seven ways, it does not intrinsically exist. (LRCM, 279).

Briefly, the seven ways are explained as follows:<sup>73</sup>

1. The chariot cannot be independent—”intrinsically separate”—of/from its parts (“the axle, the wheels, the nails, etc”)...” because if it were it would be seen

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<sup>72</sup> These arguments are not unfamiliar to Western philosophers. They arise in analysis of the Ship of Theseus, for example, and are used in modern treatments of mereology, see Simons (1987). I reserve detailed associations and comparisons with Western approaches for the Chapter Four, but here will add that the Western varieties of these arguments entail significant difficulty in generating a comprehensive and consistent mereological theory.

<sup>73</sup> Quoted selections are from Chapter 22 of Tsong-kha-pa’s LRCM commentary on Candrakīrti’s argument.

separately, apart from them, like pot and cloth, yet it is not” (279). If all the parts were removed, and laid out on the ground, we would be hard pressed to justify saying “there is a chariot”, as opposed to “there are the parts of a chariot”. Or going further, if the parts were then burned, certainly no chariot would remain. Yet the chariot, as known prior to disassembling and burning the parts, was not burned. But burning the parts means that there is no more chariot. Hence, there cannot be an independent chariot.

2. The chariot cannot be identical to—cannot be “non-other” than—the parts, because if it were then “...just as the parts are plural, so the chariot also would be many; just as the chariot is singular, so the parts would be single...” (279). But taking a small part away, say a chip of the seat, and burning it does not destroy any instance of a chariot. This is similar to the Sorites puzzle of classical Western metaphysics. That the chariot is identical to its parts is an example of the *principle of composition as identity*, to be discussed in Chapter Four.
3. The chariot cannot be the possessor of its parts because then there would have to be essential independence and separateness of the chariot and its parts, just like a person owns a bowl. But this relationship was denied above in reason number 1.
4. The chariot cannot be dependent on its parts because, again, they would have to be considered to be essentially separate and independent to be able to form such a relationship. The parts and chariot are not “intrinsically separate”, from reason 1 above. Also, “Here we do not refute mere mutual existence; we refute a basis and dependent that exist by way of intrinsic character” (279), hence it is the parts *as a basis for the inherently existent chariot*, and the chariot *as dependent on*

*inherently existent parts* that is denied. If the parts have inherent nature, then they must be independent, hence (from the causality arguments of the previous section) cannot interact to become parts of a whole, and from reason 1 above are not independent; if the whole has inherent nature then it must be independent and unitary, hence cannot have parts. There is, of course, a purely semantic relationship such that ‘parts’ cannot exist independently because they must be parts of something. However, this reasoning relates with more than just that semantic counterpart relationship, but also with further attempts to deny an ontological mereological relationship between independent entities.

5. The parts cannot be dependent on the chariot, again because the dependence relation assumes that there must be independent things dependent on another independent thing. Tsong-kha-pa analyzes these two (#4 & #5) dependence relations together as arguing against “positing a chariot and its parts as basis and dependent” (279).

It is certainly conventionally acceptable to say that a chariot is dependent on its parts, or that the parts *qua* parts of the chariot are dependent on there being a chariot of which they are parts. Proponents of Madhyamaka argue that hidden in this usage is an assumption that there is something like a separate and independent singular thing that we call *chariot*, and it is this assumption that is denied. As mentioned above, if there is a dependence relation, then there must be something in common; according to this view two totally independent entities cannot interact, and I argue in support of this view below.

6. The chariot cannot be merely the collection of its parts, because “then a chariot would exist even while its parts lie in pieces” (280) and “the scattered fragments

likewise would comprise the chariot” (MAV 6:151b). One could now respond that it is not a mere collection of the parts which is relevant, but a particular arrangement and functioning of the parts *as a chariot* that gives the chariot its special inherent *chariotness*. A response follows:

7. The chariot cannot be just a special configuration of the parts, because “Without the whole, the parts do not exist [as parts of the whole]” (280) and “...if there is no owner of the parts, there are no ‘parts’.” Here is the semantic relationship of co-existing counterparts referred to above, that in calling something a composite whole we require parts and in calling things parts we require a whole. But the analysis goes beyond the semantic (MAV 6:151c).

By special configuration, Candrakīrti is referring to its shape, and examines this aspect of the collection over four verses in MAV 6:152-155 examining the shape and “mere collection” of parts mentioned in verse 151cd. Tsong-kha-pa sees these two reasonings (#6 and #7) as explicit responses to Ābhidharmikas who eliminate composites from their ontology while ascribing inherent nature to ultimate proper parts. He argues that if the whole is eliminated then so are the parts because parts cannot exist apart from a whole of which they are parts. He is invoking a semantic relationality of co-existing counterparts and concluding from it existential implications. (Throughout *Part II: Western Metaphysics* we critically analyze and deny that such an entailment is valid.) Candrakīrti analytically disassembles the chariot, laying the parts out on the ground, comparing the chariot as a shape or as disassembled parts. The scattered fragments are not the chariot, so the mere collection cannot be the chariot. Again in Verse 152 we have the ‘owner’ of the parts, which is denied, then therefore the ‘parts’ are denied, as a co-existing

counterpart pair. The parts are many, hence the chariot cannot be the parts since the chariot would have to be many. (We see this argument again in *neither-one-nor-many* below, and also in analysis of composition puzzles of Western metaphysics in Chapter Four.)

Note again, that *the sevenfold reasoning*, and even the example of a chariot, is not unique to Madhyamaka, and has been used in various Buddhist analysis. However, it is also directly relevant to Madhyamaka, and it is in that context that I examined it.

There are two issues that we may identify that have not been resolved. First, what happens if we consider the ‘configuration’ as a particular arrangement of parts and then replace one of its wheels for a newly constructed wheel, while maintaining the overall shape and configuration, such as in variations of classic Western puzzles of composition like the Ship of Theseus? Can that shape and configuration be considered the chariot despite this exchange of parts? If we insist on maintenance of function through these changes, then we certainly should be able to answer in the affirmative, at least conventionally. After all, the chariot is not denied, only its intrinsic, inherent character, and that of its parts, over and above their relationality. Therefore, we must ask if there is intrinsic, inherent character that is permanent, singular and persistent. Does the chariot persist while parts change? This is bound up with how we define the chariot that may or may not persist: Is the chariot its parts, the configuration (shape and function) of the parts together, or is there a ‘structure’ that embodies causal relationships which are over and above the individual parts, whether replaced or not? We cannot answer this yet. We also need to look at the parts of the parts, down to atomic entities—if they exist—and it is on the *neither-one-nor-many* argument that we must rely in order to show that the parts of a

chariot, e.g. a wheel, and its parts, etc. down to any proposed atomic simples also lack inherent nature, concluding that there are no atomic simples.

Since Ābhidharmikas have eliminated the inherent nature of the composite object, building up the composite object from separate parts is incoherent: "...since you assert that what has parts does not exist, parts also would not exist" (280), as mutually dependent co-existing semantic counterparts. If there is no [inherent] whole, then there are no [inherent] parts. The semantic analysis is not an ontologically interesting argument, but the overall relationship of parts to whole that is being analyzed is. To reiterate, for proponents of Madhyamaka, this sevenfold argument entails that the ascription of inherent nature to parts and/or the whole is incoherent. If we consider the chariot dependent on its parts we are assuming that there is a chariot that is separate and independent of its parts, simply by saying 'there is a chariot'. Yet, at the same time we have acknowledged dependency. Hence the entire idea of dependence among independent things is denied. Dependence means mutual interdependence.

Candrakīrti's argument as interpreted by Tsong-kha-pa insists that the issue is about the independence of a whole in relation to its parts, and the independence of the parts, as the relevant component of inherent or intrinsic character. If there is any kind of independence then we cannot have a coherent analysis of what it is to be composite. This is, of course, not the only interpretation, and many interpretations (such as Kalupahana) reject emphasis on Candrakīrti's text. Some nihilist interpretations stress the rejection of all existence, while ignoring the rejection of all non-existence. The key, I argue, is to understand what rejection of both existence and non-existence might mean, and that means acknowledging mutual interdependence and sometimes interpreting co-existing

counterparts in a pluralist fashion as indicating comparison between different domains (and in *neither-one-nor-many* especially we will have to delve into different domains).

In sum, given a dependence relation  $R_d$  of either of the seven kinds between the chariot  $C$  and its parts separately or as a set  $\{p_i\}=P$ , I argue (based on Tsong-kha-pa) that the sevenfold argument concludes that one cannot deconstruct  $CR_dP$  into independent components and still maintain a coherent logical understanding. Neither  $C$ , each  $p_i$  nor the set  $P$ , nor even  $R_d$  have independent, inherent existence—thus relations cannot be separate and independent from the relata just as the two relata elements are not separate and independent from each other.

#### ***D.2. Neither one nor many***

*Neither one nor many* analyzes an object down to the material atomic simples that are assumed by some Abhidharma proponents (and some Western atomists) to be the basic building blocks of all matter. The argument then applies further analysis to the atomic simples by reasoning that since (according to Abhidharma) such atomic simples are the fundamental constituents of a whole partite object the atomic simples must combine with each other. But such combination entails attachment of directional parts (e.g. left side, right side) of each atomic simple with corresponding directional parts of neighboring atomic simples. If this is the case, then the atomic simple must have parts, which means that it is not an atomic simple. By this contradiction is argued that there are no atomic simples, hence no fundamental constituents with inherent nature.

This argument uses an indirect proof or *reductio* form to establish that no entity could be just ‘one’: a single, independent and persistent entity with inherent nature. After that argument is made, since there is not one, there could not be many. This argument is offered in several classical texts and is essentially unchanged from non-Madhyamaka

versions by Madhyamaka scholars, except for their interpretation. We view the argument as an attempt to apply general Madhyamaka principles to the best atomic theory of the day. Since that atomic theory is known today to be false, its use in this argument, therefore, means that the argument must be reexamined and articulated within the context of modern atomic theory. Once we do that, we will find that a pluralistic interpretation of the general principles provides reasonably correct conclusions according to current knowledge and practice. The approach to the argument seems to be quite valid, that is if we try to apply the Abhidharma argument of analytically or physically breaking an entity apart (even using modern physics) in order to find the entity's ultimate nature the *neither-one-nor-many* argument results in absurdity. This fundamentalist assumption is, however, highly controversial and complex, as we shall see in later chapters,

Śāntarakṣita's exposition is the classical Madhyamaka presentation of this argument, found in his *Madhyamakalankara (MAL)* throughout verses 1-61 of its 97 verses.<sup>74</sup> The general principle of the argument is given in the first verse:

[MAL:1]

Those entities, as asserted by our own [Buddhist schools] and other [non-Buddhist] schools, have no inherent nature at all because in reality they have neither a singular nor a manifold nature – like a reflected image. (Blumenthal, 2004, 61; his inserts).

In the next 59 verses Śāntarakṣita examines various phenomena—including inanimate material objects—to see if they have singular inherent natures, and in the 61<sup>st</sup> verse he extrapolates to the lack of manifold nature since manifold nature is considered the

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<sup>74</sup> Padmakara (2005). Also translated as *Ornament of the Middle Way* by Blumenthal (2004). See Blumenthal (2009) for a summary and bibliography, which is also duplicated in my bibliography, his (2004) for a detailed treatment, and his introduction in (2004:19-50) for a summary examination of the text, its context, source materials, and general perspectives. Tilleman's articles (1982, 1983, 1984) provide detailed analysis. See also Mipham's introduction in Padmakara (2005, 83-145) and the translator's introduction pp.1-47 for some general background context.

mereological sum of unitary natures, i.e. since there is no ‘one’ then there cannot be the sum of many ‘ones’:

MAL:61-62  
No matter what we may investigate,  
A single entity cannot be found.  
And since there is no ‘one,’  
Indeed there is no “many” either..

A thing cannot exist unless it be in singular or plural—  
Aside from this, no other mode of being can it have.  
For singular and plural  
Are mutually excluding contraries. (MAL, 61).

Note that the 62<sup>nd</sup> verse does not address the option for something to be singular in one context—in one domain—and plural in another. Rather, it assumes a single and universal domain, as is typically assumed when we try to argue for the nature of ‘ultimate’ reality. (I rather argue throughout this dissertation for a pluralist approach.) Several options were suggested as to how these proposed simples could combine into a composite whole, e.g. either touching or with space between them, but all seem to assume that the atomic simple has physical extent and parts, and is therefore not simple.<sup>75</sup> Therefore, the

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<sup>75</sup> There is a background of Abhidharma theory from the Vaibhāṣika and Sautrāntika schools that is being analyzed here. Proponents of those schools considered composite objects to not have inherent nature, yet the atomic simples do. ‘Atoms’ in this case are the four elements of earth, water, fire and air. Hence, all material substances were composed of combinations of such ‘earth atoms’, ‘water atoms’, etc. Different philosophers proposed different ways in which these atoms combined to form the furniture of our macroscopic world. Each atom were proposed to have directions (typically the 10 or 6 directions of 8 or 4 compass points plus up and down), and could therefore combine with neighboring atoms in each direction. Some described a space between the atoms and some described them as touching. For example (although not generally considered Madhyamaka) from Vasubandhu’s *Twenty Verses (Vimsatikā-Kārikā)* in Anacker (2003), verses 11-14: “A sense-object is neither a single thing, nor several things, from the atomic point of view, nor can it be an aggregate (of atoms). So atoms can’t be demonstrated. How is it that it can’t be demonstrated? Because through the simultaneous conjunction of six elements [directions], the atom has six parts. If there were a common locus for the six, the agglomeration would only be one atom. When there is no conjunction of atoms, how can there be one for their aggregations? Their conjunction is not demonstrated, for they also have no parts. (To assume) the singleness of that which has divisions as to directional dimensions is illogical. If the agglomeration isn’t something other, then they can’t refer to it.” (167-169)

assumption of an atomic simple with physical extent leaves the door open for

Mādhyamikas to point out the contradiction:

[MAL:11-12]

What is the nature of the central [partless] particle which faces singly towards [another] particle yet abides [with other partless particles in various directions] either [around and] joining with it, or around it [with space between them, or] around it without space between? If it is asserted that [the central particle] also faces entirely toward another such [unitary, partless] particle, then if that were so, wouldn't it be the case that [gross objects such as] land and water and the like would not be [spatially] expansive? (Blumenthal 2004, 236; his inserts).

It is an Abhidharma argument that macroscopic objects are made of atoms which are unitary and independent, yet which combine into the larger object which has no inherent nature.

[MAL:13-14]

If you accept [partless particles with sides] which face other such particles [in different directions], then if that is the case how could [even] the most minute particles be singular and partless? Particles have thus been established to have no inherent nature. Therefore it is evident that eyes and [other gross] substantial [entities], etc., which are asserted [to be real] by many of our own [Buddhist] schools and other [non-Buddhist] schools, are directly known to have no inherent nature. (Blumenthal 2004, 236).

The assumption to be disproven is that there ultimately are atomic simples which together constitute a whole, but in order to combine into wholes—which according to assumption they do—they must do so by connecting one directional part of the atomic simple with a neighboring atom. Hence, we have two separable and clearly contradictory assumptions in the Abhidharma argument:

Atomic simples: A whole entity is composed of atomic simples with inherent nature which are unitary entities without proper parts.

Combination: Atomic simples also have parts, since they combine to make wholes.

But if all gross and subtle entities have parts, and they in turn have parts, how does it all end? Śāntideva<sup>76</sup> brings the analysis as far as possible in *BCA*:<sup>77</sup>

[*BCA* 9:86-87]

These parts themselves will break down into atoms, and atoms will divide according to directions. These fragments, too, will also fall to nothing. Thus atoms are like empty space--they have no real existence [*svabhāva*]. All form, therefore, is like a dream, and who will be attached to it, who thus investigates? The body, in this way, has no existence. (Padmakara 2003, 149).

In this verse, and in the last sentence of *MAL*:14 quoted previously, there is a suggestion of a strong reductionist premise: if the minutest particles have no inherent nature, then the whole composite entity they constitute also has no inherent nature, and inherent nature is the ‘existence’ being denied in *BCA* 9:87. However, another way of interpreting this verse that better fits the general context of the Madhyamaka denial of inherent nature is the following: The verses indicate that the absurdity of the conclusion—that everything is empty space and no matter exists<sup>78</sup>—serves to deny the premise that there are atoms which can be divided without end. Indeed, Vaibāshika Ābhidharmikas rejected this premise, positing atomic simples with inherent nature. Yet by Madhyamaka arguments the end of the dividing cannot be atoms with inherent nature either, since those could not interact in order to combine.

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<sup>76</sup> Also see Vasubandhu *Twenty Verses (Vimśatikā-Kārikā)* in Anacker (2003) and Kapstein 1988)

<sup>77</sup> Translated in Crosby and Skilton (1996), and with extended commentary in Pelden (2007)

<sup>78</sup> Some interpreters actually state that this verse supports the notion that all matter is empty space, and no matter exists. There is also a modern version of this view as an interpretation of the ‘equivalence’ between mass and energy or as interpretation of quantum wave-particle duality. I reject all of these interpretations. It is not inconsistent to say all of the following: matter exists, matter is solid, matter and energy are interchangeable, energy is solid, matter is quantum fields which exhibit either wave or particle properties depending on the experimental context, matter is not space, space is influenced by matter and energy fields and permeated by energy fields, and energy fields can be quantized as particle fields and matter and energy fields are influenced by space. However, it is not true that matter can be subdivided into space, and space is empty, and therefore matter does not exist. Yet it is true that neither space nor matter have inherent natures independent of each other and independent of context. More on these issues in *Part III: Physics*.

We can develop several possible hypotheses from this analysis: (1) Even the most fundamental building blocks of matter—the ultimately elementary particles—are posited to be without inherent nature, hence must be relational by their nature. That could be cashed out by some of their ‘parts’, or some of their properties, being relational by their very nature. An interpretation of an electromagnetic field as being a ‘part’ of a charged particle might qualify. (2) There are no ultimate fundamental particles, and we must keep going deeper and deeper looking for them, yet still find more separable parts. Perhaps this will end at the Planck scale,<sup>79</sup> but that is highly speculative. (3) The entire analysis of parts and particles is incoherent in light of quantum field theories. Parts and particles are remnants of local realism and classical thinking.<sup>80</sup> In *Part III: Physics* we investigate each of these alternatives.<sup>81</sup>

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<sup>79</sup> *Planck scale* refers to the very small size and very high energy in which it is presumed (or hoped) that quantum field theory and the general theory of relativity unite, to be described by a quantum gravity theory (perhaps a version of string or loop theory) just as the electric and magnetic fields unite in electromagnetic theory. Much more on this in *Part II: Physics*.

<sup>80</sup> See *Chapter One: Introduction*, Sections C.6 and C.7

<sup>81</sup> From a personal communication with Jay Garfield, 2011:

“Here is one way to contextualize what I am going to say: Remember that Śāntideva is a Prasaṅgika Mādhyamika. He therefore accepts the view that emptiness is empty. As Candrakīrti puts the point, emptiness is not itself the nature of things, it is the absence of any nature in things. Keep this in mind. For Śāntideva is not arguing that the parts of a thing have a particular nature (emptiness), and therefore that the wholes they constitute have that nature. THAT would be reductionist. Instead, he is arguing AGAINST reductionism that because there ARE NO ULTIMATE PARTS, and since no parts have ANY nature, that you CAN'T get the nature of a thing by finding the nature of its parts and building up. He is an ANTI-REDUCTIONIST, which is not surprising, since Madhyamaka is often (correctly, in my view) seen as a critique of the reductionist project of Abhidharma.

“SO, here's the argument: The opponent here believes that a body can be reduced to its parts (foot, toes, etc.) and that the nature of the body is determined by the nature of those parts. The opponent here is an Abhidharma atomist, who thinks that eventually this bottoms out in atoms.

“Śāntideva argues that:

86: Since any thing can be divided into parts,  
 If the parts can be divided into atoms,  
 Since the atoms can be analyzed according to directions,  
 And since the directions have no parts,  
 They are simply space, NOTHING IS MADE OF ATOMS.

At this point we must recall the various definitions in our Section C.6 in *Chapter One: Introduction*. One form of reductionism (very strong) is that the nature of the parts is identical to the nature of the whole, and one (strong) is that the nature of the parts determines the nature of the whole. If there are no parts found from a reductionist analysis, then there can be no basis for these types of reductionism, and that is the basis for Garfield's anti-reductionist interpretation, which is the common interpretation based on the idea that Madhyamaka arguments generally are designed to be anti-reductionist to oppose Abhidharma reductionism, and which is our second hypothesis. However, if we interpret Madhyamaka as not denying that there are parts, but rather that there are no parts with inherent nature, while there are (by commonsense) parts, just as there are wholes (though also not with any inherent nature), we get our other two hypotheses, above.

It is my stance that while the Madhyamaka argument is explicitly intended to be anti-reductionist in response to Indian reductionist views, there are echoes of what seems

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“rGyal tshab rje's commentary is simple but useful here. Here's a quick translation:

Since things can be divided into parts, they do not exist intrinsically: Suppose that things could be divided into parts and atoms. They still would not exist intrinsically. This is because since according to this analysis even atoms can be divided by direction. Since they would have to depend upon their parts, they must be dependent designations and therefore not intrinsically existent. Even the parts of the directions lack intrinsic existence. They are not genuine parts, just like the example presented of space. Therefore, even atoms lack any intrinsic existence, even if they existed, those things made up of them would not. But you can't even maintain that atoms exist, and this undermines the argument.

“The point is straightforward. The reductionist needs BOTH atoms and their NATURE in order to reduce wholes to atoms with a particular nature and then to argue that the wholes inherit that nature. Śāntideva maintains both that the decomposition into atoms is impossible because atoms don't really exist, and that even if they did, they would lack any intrinsic nature that could be the basis of the reductionist analysis. And that lack, Robert, cannot itself be an intrinsic nature as required by the reductionist programme.”

Note that by ‘atom’ in, e.g. “nothing is made of atoms”, Garfield is referring to atomic simples, is not specifically referring to the atoms of chemistry, but rather (as I interpret it) the elementary particles of quantum field theory, which must, by this analysis, lack inherent nature. How that is cashed out will be discussed in *Chapter Eight: Physics of Composition*.

to be a subtle form of reductionism throughout numerous texts and commentaries, written and oral, ancient and modern, including the previous BCA 9:86-87 selection and MAL:

13-14 quoted above. For another example, in Tsong-kha-pa's analysis of this argument:

Therefore, (Candrakīrti) states in the *Four Hundred Commentary* that reasonings such as “there is no objective (realm), because neither gross nor subtle (forms) of matter exist, because the negation of indivisible atoms also negates gross (substances) which are their aggregates,” can negate the indivisibility of objective (things), but cannot negate the very existence of objective (things), since (such a conclusion) is faulted both by scriptural authority and by common sense. (Thurman 1984, 313; inserts his).

The key clause is “ ‘...because the negation of indivisible atoms also negates gross (substances) which are their aggregates’ ”. This could be superficially interpreted as methodological or epistemological reductionism: understanding of the whole comes from understanding the parts. Yet the following clauses recall that the ‘gross’ objective things are not negated, since by ‘common sense’ we know that they exist. Therefore, in light of the anti-reductionist intent of Madhyamaka, we must interpret the clause as saying that it is the inherent natures of both the subtle and the gross that are being denied.

While the intent of anti-reductionism is confirmed by many commentators, as pointed out we frequently find this kind of reductionist reasoning from the negation of inherent nature in ‘subtle forms’ (the most basic constituents of matter) implying the negation of inherent nature in the composite wholes. It may seem that I am beating a dead straw horse, to mix metaphors. However, there actually are numerous statements like this in the text and commentarial literature which is highly suggestive of reductionism, and it is therefore difficult—although not impossible—at times to maintain the firm and consistent anti-reductionist interpretation without seeming to stretch the point beyond anything obvious. True, it is a subtle form of reductionism: rather than saying that the

nature of the parts determines the nature of the whole, it is that the lack of nature of the parts means that there is no nature to the whole, where ‘nature’ is interpreted as inherent nature. Thus, it is a reductionism that stresses the relational (causal) ‘glue’ that binds the interdependent relata and the interdependence of that causal glue with the relata, rather than focusing primarily on independent objects of Aristotelian ontology (although even the causal glue cannot be independent). Therefore, it is difficult to pin a standard Western type of reductionism on this argument. Madhyamaka is committed to an anti-reductionist view, arguing that there is no basis for reductionism without independent relata. The main point, therefore, is that any material entity is interdependent and relational, without metaphysical bases to ground reductionism.<sup>82</sup>

One way of understanding the *neither-one-nor-many* arguments is from Tillemans (1982, 111), who writes: “...the Tibetan Prāsangika<sup>83</sup> line of attack is to use classical Mādhyamika arguments, such as the seven-fold reasoning, to find that *all* objects, however subtle they may be, are unfindable under analysis.”<sup>84</sup> Logically,<sup>85</sup> we might suggest that the most subtle entities which can be identified as the building blocks of

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<sup>82</sup> Perhaps one of the difficulties is because Madhyamikas—and non-modern physicists—could not, or cannot, conceptualize inherent nature (a ‘one’) arising from the combination of parts that have no inherent nature (the ‘many’), or a ‘many’ arising from parts that are ‘each’ not one. As we see in our physics discussion, those kinds of situations do occur in nature.

<sup>83</sup> Again, this is literally those who use consequentialist reasoning, and this sub-school of Tibetan Madhyamaka is generally considered to be the final correct view while others are either provisional or may be adopted for pedagogical or soteriological purposes. There are, of course, controversies concerning this. See Dreyfus and McClintock (2003). See Section C.3 in Chapter One.

<sup>84</sup> Note that the context of this excerpt is that Tillemans is providing a detailed comparison of the way Svātantrika-Mādhyamikas view the *neither one nor many* argument (and Tillemans says they are the ones who primarily use this argument) with the way Prāsaṅgika-Mādhyamikas view the argument. The former, it is argued by various Tibetan analysts (note that there was no clear-cut distinction between them in India, but that distinction is more a product of Tibetan doxography), did not deny conventional existence of the inherent nature of commonplace objects, while they did deny ultimate existence, and the latter denied both.

<sup>85</sup> This is at least from a line of classical analytic metaphysics perspectives that we will examine in the next chapters, which is consistent with Abhidharma and Madhyamaka, and which ignores modern physics. Abhidharma argues that such subtle entities exist, while Madhyamaka argues to the contrary.

matter (called atoms or atomic simples) should be unitary entities with inherent nature and only one intrinsic quality or property and have no proper parts. If we attempt to attribute to the ultimate atomic simple many different intrinsic properties, then we would have to figure out how would those properties could be ‘bundled’ together, since intrinsic properties are independent. While we might be able to answer this question somehow, nothing significant hangs on it, the point being that atomic simples must be singular and have at least one intrinsic property or properties. They would be called ultimate because they would be found at the foundational finish of mereologically reductive analysis; they would have ultimate existence because *since* they cannot be broken down into further parts, they must have no parts to combine with other parts, i.e., they would be independent, unitary and persistent. They would have ultimate reality due to the assumption of ontological reductionism. According to Madhyamaka (and perhaps our classical physics-based intuitions) such non-interactive things could never be experienced, be found through empirical investigation, or have causal efficacy, since these require interaction. Hence, we can eliminate them from our ontology. But note that it is a certain kind reductionism and a certain kind of atomic simple which are denied together. The presumption of atomic simples that are not simple—which are necessary to fulfill the ‘Lego-style’ composition principle—was mentioned above. The reductionism used is a simple classical extensional mereology of adding parts to make wholes:

When it is established that there is nothing that is truly single in nature, it follows according to this reasoning that there is also no truly manifold nature in phenomena, since ‘many-ness’ is dependent on the aggregation of those, which would be truly single, but no such truly single nature exists. Since singleness and ‘many-ness’ are mutually exclusive and exhaustive of all possible alternatives, the establishment of the lack of any singular or manifold nature in phenomena also establishes that they have no nature at all, and thus are properly described as empty of any inherent nature (Blumenthal 2004, 60).

Here Blumenthal defines ‘nature’ in “truly single nature” or “truly manifold nature” to be the same as an inherent nature, but non-inherent nature is still possible. Non-inherent nature cannot characterize entities that are unitary and independent. The entities with non-inherent nature must be interdependent, but this again suggests primacy of relations or some kind of relations-with-relata that are together inseparably interdependent, as we suggested previously. These types of things cannot be described by classical extensional mereology, and require a different sort of composition process that must be informed by modern philosophical analysis and physics.

To summarize and provide a preliminary analysis of the main points of this section, two main arguments have been examined. First, *sevenfold reasoning* analyzes the composition of a composite object in seven ways that might be suggested as positive relationships between parts and whole. Each one, however, results in contradictions. This analysis is somewhat problematic in light of modern chemistry because it applies classical extensional mereological methods without consideration of modern chemical bonding, which is understandable considering the ancient sources. There is a further problem with this reasoning. We are told that in terms of conventional understanding there is a chariot which is made of parts, but when we analyze *how* the parts and whole are related there is no coherent relationship. Yet, we build the chariot from the parts, which is certainly a simple relationship but is termed conventional. It is under the ‘ultimate’ analysis of the sevenfold reasoning that no coherent relationship is found. One way to interpret this reasoning is that it is mere word play, playing with different ways of analyzing words such as ‘dependency’ or ‘possession’, more than actually simply relying on the empirical situation that we build the chariot out of parts, and can take it apart and

put them back together and there is a chariot. That action is dismissed by some Madhyamikas as being merely conventional, as are empirical actions generally, while rational analysis is considered to give us ultimate understanding. We find this problematic, and discuss it further in later chapters. We find similar word play arguments in Western analysis of compositional puzzles, and also question the entailment that is demonstrated by that analysis from semantic puzzles to metaphysical actualities. Rather, we take the view that metaphysical actualities should entail creation of a philosophical view which corresponds with them. However, another way to interpret sevenfold reasoning is that it indicates a deep problem with our basic assumptions which assign inherent nature to entities, and this is the more important interpretation. Thus, the profound conclusion of this argument is that we need to purge our thinking of any such assumptions.

The second argument we examined is *neither-one-nor-many*, which is a different approach to the same deep problem. In this argument we found use of classical extensional mereology without consideration of modern physics, which is of course not a surprise. If we use modern physics we cannot actually consider atoms in the way that this analysis considers them. Modern atomic theory is significantly at odds with the naïve atomism exhibited in that argument, even if we interpret the ‘atoms’ as ‘atomic simples’, which today would be the elementary particles (leptons, quarks and gauge bosons) or even strings (the existence of which currently, however, lack sufficient empirical evidence to be considered more than mathematical constructs). Therefore, we must limit the conclusions that this argument entails to a denial of that naïve atomism, not to a denial of any modern conception of matter. However, we find some rather interesting and

potentially fruitful hypotheses about the nature of elementary particles if we analyze matter in that way, and these hypotheses will be tested against contemporary quantum field theories. Additionally, we find need for the domain contextualization used by Physics Pluralism.

In the spirit of using this chapter as a map for analysis to follow, we point out that the Abhidharma argument that rejects composite objects from our ontology but keeps atoms is similar to those of Unger (1979), van Inwagen (1990) and Merricks (2001), which are also eliminative of composites while retaining atoms. Merricks rejects the *principle of composition as identity* in order to support his argument. The question of relations without independent relata—or without any kind of relata—is discussed in the literature of philosophy of science pertaining to structural realism. From the Madhyamaka point of view, the problem is that for a relation to exist between two entities, they must have something in common, thus the entities are neither independent from each other nor from the relation. A major justification for structural realism in philosophy of science is the indistinguishability of quantum particles and their ‘intrinsic relationality’,<sup>86</sup> which, we shall see, may be interpreted as something similar to the Madhyamaka perspective.

A classical interpretation of Madhyamaka two truths analysis of composition is first that conventional entities such as chariots and tables are unities with their own nature—this is a common sense understanding—yet if we analyze further we find parts, which also have parts, *ad infinitum*, so that ultimately nothing with any inherent nature can be found, hence what we thought of as unities have no inherent nature at all. Yet, as we find in further chapters, there is justification to argue that there are some ontic

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<sup>86</sup> From Teller (1989).

domains in which some entities must be considered as unities without parts. However, when looking at those same entities in other domains we find parts. The former is the relative (local) truth, while the latter exhibits the ultimate (global) truth of relationality. We cannot simply say that everything is relational and nothing has inherent nature, since we do find local domains—even ontic domains—with entities that have unitary inherent nature, and these cannot be dismissed. However, looking at those same entities in other domains we find parts, and in some sense we may even be able to explain or derive the unity in one domain from the parts in another. In that way, we must acknowledge a global relationality, which can be interpreted as the ultimate understanding, leaving the local domain unities as the relative or conventional understanding. We discuss relevant issues in *Chapter Four: Metaphysics of Composition*, *Chapter Six: Physics Pluralism*, and *Chapter Eight: Physics of Composition*.

## ***E. Impermanence and momentariness***

Observation of ubiquitous and inevitable change and resultant awareness of the impermanence of all things is one prime motivation for all Buddhist philosophy:

When they hear those doctrines, they understand dependently originated compounded [composite] phenomena as being impermanent. They know them to be phenomena that are unstable, unworthy of confidence, and changeable, whereupon they develop aversion and antipathy toward all compounded phenomena. (*Samdhinirmocana Mahāyāna Sūtra*, Powers 1995 p107).

Impermanence is that nothing lasts forever, and has two relevant varieties. The first is called momentariness: things last for only one moment. This Abhidharma view was disputed by Madhyamikas, who promoted what I call radical or continuous impermanence: nothing lasts for even a moment, as long as we indicate by ‘something’ as ‘something with inherent nature’. Momentariness is that...

...all phenomena...pass out of existence as soon as they have originated and in this sense are momentary. As an entity vanishes, it gives rise to a new entity of almost the same nature which originates immediately afterwards. Thus there is an uninterrupted flow of causally connected momentary entities of the same kind... (Rospatt 1995, 1)

Momentariness is a common Abhidharma Buddhist understanding of impermanence.

Madhyamaka offers a critique of momentariness due to the attribution of inherent nature in that moment of an entity’s existence. By my interpretation, Madhyamaka rather attributes continuous impermanence without even a moment of inherent nature. We will first discuss basic Buddhist views in some depth, followed by the Madhyamaka critique.

### ***E.1. Views that are not explicitly Madhyamaka***

Change is ubiquitous:.

In asserting the primacy of change, Buddhism differs not only from Nyāya but from most traditions, both in India and the West. Thinkers such as Plato, Aristotle, Uddyotakara, Kumāriila and Śāṅkarācārya all consider being as the

central philosophical notion in relation to which fleeting elements must be explained. They also understand being to imply the existence of stable and unchanging entities such as substance, universal, form, essence, and substratum. Buddhism, in contrast, holds that change is more fundamental to reality than stability. Like Heraclitus, Buddhists think that everything is in perpetual motion. For the Buddhists, this denial of stability is not necessarily a denial of being but an assertion that being must be understood first and foremost as change. (Dreyfus 1997, 60).

A central Buddhist position—Abhidharma and Madhyamaka—is that since change is apparent throughout reality, there are no enduring substances, since enduring substances would not change. Change is frequently taken as a starting point in discussions—not quite an assumption, but rather an initial stance that is then defended through arguments similar to ones we have examined which deny substantialist views in its many forms. The Nyāya substantialist stance to which many Buddhist arguments were addressed was that “substances come into existence in dependence on causes and conditions, endure, and only later disintegrate. Their disintegration depends on special causes of destruction...Until they meet these causes, substances abide without change” (Dreyfus 1997, 63) although non-essential qualities may change.

From impermanence with some duration the philosophical position migrated through analytic refinement to momentariness: That things arise, abide for merely one moment, and then cease. A moment may have a definite duration, and that duration may be quite small, or time may be continuously divisible and therefore ‘a moment’ may be no time at all, although the latter is more of a Madhyamaka position. Note that momentariness in Buddhist thought is not about time, but rather about entities’ “...existence within time. Rather than atomizing time into moments, it atomizes phenomena temporally by dissecting them into a succession of discrete momentary

entities” (Rospatt 1995, 1). We still require further justification for such momentariness, including consideration of the causes for it: why it is that entities cease to be?

Our previous discussion of causality—of arising and ceasing—may be viewed as a critique of discrete sequences of events, due to the inability for such a single discrete event to influence another one, since the first has already ceased before the next has begun.<sup>87</sup> This is supporting evidence for a conjecture that much of Buddhist thought, and especially Madhyamaka, pertains to the philosophical ramifications of the concepts of zero (a non-philosophic translation of *śūnyatā*), infinity, discreteness, continuity and infinitesimals in relation to time, space and matter. In contrast to the atomistic and discrete Abhidharma philosophies, we find references in the classical Buddhist literature to the infinite basic space (*dharmadhatu*) from which arising and ceasing phenomena seem to *appear* as production and annihilation of discrete entities, but *actually* nothing fundamentally different arises and ceases. Extensive examination of this concept will take us beyond the scope of this dissertation, yet we should be aware of the idea as we discuss space, time and matter from different perspectives in later chapters in support of a dependence theory of causality centered around the idea of conserved quantities taking different forms.<sup>88</sup>

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<sup>87</sup> See Russell (1912) for a similar critique of causality, also discussed in *Chapter Seven: Physics of Dependence*.

<sup>88</sup> *Dharmadhatu* is the environment—open space, *śūnyatā*—and *dharmakāya* is the body, the person, the mind of the Buddha—and the clear open mind of anyone without the confusion of samsara. See Tulku Urgyen (1999, 31-32). Dharmakaya is mentioned in the *Prajñāpāramitā Sutra in Eight Thousand Lines*, but in another context, and in the *Laṅkāvatāra Sutra* as “ultimate reality”: “*In this world whose nature is like a dream, there is place for praise and blame, but in the ultimate Reality of Dharmakaya which is far beyond the senses and the discriminating mind, what is there to praise*” (Lankara, Chapter I, 42)? Also, “What we teach is Tathagatahood in the sense of Dharmakāya, Ultimate Oneness, Nirvana, emptiness, unbornness, unqualifiedness, devoid of will-effort” (Lankara, Chapter VI, 58). In Cittamatra, dharmakāya is identified with the eighth consciousness, *ālāyavijñāna*.

Underlying many Buddhist arguments for impermanence (Madhyamaka) and momentariness (Abhidharma) is our observation of the ubiquity of change, followed by the analytic application of Leibniz' Laws. If an entity changes, then it is not the same, i.e. if there is change of characteristics then there is change of the entity to a different entity. This view has similarities to those of Hume, Thomas Reid, and Roderick Chisholm presenting and defending a view of Bishop Butler,<sup>89</sup> although the oddity of those views in the context of Western philosophy does not contradict Dreyfus' general characterization mentioned previously.

Hence, one major justification for impermanence and momentariness is ubiquitous change and application of Leibniz' Laws. Beyond change and impermanence alone, there are two relevant arguments for momentariness (*kṣaṇikatva*): (1) Introduced by Vasubandhu (4<sup>th</sup>-5<sup>th</sup> Century) in the Abhidharmakośa and auto-commentary and later

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For tantric references from the Dzogchen tradition, see, for example, Longchen Rapjam's (2001, 3-29): "In simply arising, forms are by nature empty. From what is unborn there manifests what seems to be born, but even as it manifests, nothing whatsoever has been born. From what is unceasing there manifests what seems to cease, but there is no cessation. These are illusory expressions of emptiness. Even with abiding there is nothing that abides. There is no basis on which anything could abide. Within the context in which there is no coming or going, regardless of what manifests, it never exists as what it seems to be, and so one is reduced to merely labeling it as 'having no independent nature.' Sensory appearances, moreover, arise naturally due to the dynamic energy of awareness, and so their nature is described in a purely symbolic way as one of 'interdependent connection.' Even in the very moment that things seem to arise due to that dynamic energy, they do so without being subject to extremes or divisions with no question of whether or not something arises-and even 'dynamic energy' is just a symbolic term, with no finite essence whatsoever. So within the context that is never subject to transition or change, nothing strays in the slightest from awakened mind" (Longchen Rapjam 2001, 27-29).

The relationship between madhyamaka and tantra is complex, but many (and I) see no inconsistency between them. However, note, as Siderits (2003, 124-5) points out, that the basic space must be considered permanent, hence with inherent nature, at least from one perspective, yet as pointed out in further texts, it must also be śūnya. See Siderits and O'Brian's (1996) comparison of Zeno and Nāgārjuna, Grunbaum's (1963, 1967, 1969) and Salmon's (1970) analysis of Zeno and McEvilley's (2002) Chapter 12 analysis of infinity and atomism in Greek and Indian thought.

<sup>89</sup> Chisholm (1976, 92); Hume in Treatise Book 1, Part IV, Section VI, Prometheus edition (1992, 255); and Reid in Essays on the Intellectual Powers of Man, Essay 3, Chapter 4, p.134 in <http://www.earlymoderntexts.com/pdf/reidip3.pdf>.

enhanced by Dharmakīrti (6<sup>th</sup> century), the *vināśitvānumāna* argues for “the inference of things perishing [spontaneously]”.<sup>90</sup> (2) Developed by Dharmakīrti himself, the *sattvānumāna* argues for “the inference [of things’ momentariness] from the [mere] fact of [their] existing.”<sup>91</sup>

Tillemans characterizes the first argument from Vasubandhu as follows:

The first argument...turns on the long-attested Buddhist idea that perishing must be of the intrinsic nature of any object. Perishing due to its intrinsic nature, something will always perish as soon it exists. The point is that such moment-by-moment destruction is spontaneous (*ākasmika*) and is the uncaused real nature of things, because it cannot be an effect of any cause. The effect of such a cause, i.e., the absence of the entity, would have to be a type of non-being (*abhāva*), and non-being is unreal...A key underlying principle of the *vināśitvānumāna* is that negative facts, such as absences, are not part of the ultimate furniture of the world, but are just fictional conceptual constructions, as they are devoid of causal powers. (Tillemans, 2011, 3).

Vasubandhu<sup>92</sup> concludes that an entity will “perish immediately after having acquired its being” by arguing as follows in the *Abhidharmakosabyasa* (hereafter AKBh). Note that I am providing original exegesis here, yet find the original arguments unconvincing when analyzed in isolation from a larger context. After that, I provide further analysis by Dreyfus and Tillemans, which provides further clarity.

...all conditioned things are momentary. What is understood by ‘momentary’ (*kṣaṇika*)? *Kṣaṇa* means to perish immediately after having acquired its being; *kṣaṇika* is a dharma that has *kṣaṇa*...A conditioned thing does not exist beyond the acquisition of its being; it perishes on the spot where it arises; it cannot go from this spot to another. Consequently bodily vijñapti [action] is not movement...

It is proven that they are momentary, “since they necessarily perish;” for the destruction of conditioned things is spontaneous; it does not come from anything; it does not depend on a cause.

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<sup>90</sup> Quoted from Tillemans’s (2011, Section 1.3, pp3-4), insert his. See also his note 14, 15 and 16 for comments and references for details of this and other ‘proofs’ of momentariness.

<sup>91</sup> See previous note.

<sup>92</sup> See Chapter One, Section B.3 for more about Abhidharma and Vasubandhu.

[First] That which depends on a cause is an effect, something ‘done,’ ‘created.’ Destruction is a negation: how can a negation ‘be done’ or ‘created?’ Therefore destruction does not depend on a cause. (Vasubandhu, AKBh, 553, bracketed inserts mine).

Here we see what Tillemans was referring to: Vasubandhu’s argument relies on the idea that destruction, as a negation, cannot exist as an entity, and only entities have causal efficacy as a cause or an effect. Hence destruction is not caused.

[Second] Destruction does not depend on a cause: hence a conditioned thing perishes as soon as it arises; if it did not perish immediately, it would not perish later, since it would then remain the same. Since you admit that it perishes, you must admit that it immediately perishes. (AKBh, 553).

If the conditioned thing did not perish immediately, then it would require a cause to perish, yet it was concluded previously that this could not be the case. Hence, its destruction must immediately follow its production.

[Third] Would you say that a conditioned thing changes and that, consequently, it is later subject to destruction? It is absurd to say that a certain thing change, becoming another thing, staying the same thing that you say shows it modified characteristics. (AKBh, 553).

Change—with modified characteristics—entails becoming another thing, which means that the original thing has perished. Here we see the strict reliance on Leibniz’ Laws.

There follows by Vasubandhu a detailed analysis of a few examples to counter the arguments of the promoters of other schools of thought. During the course of this he says that while “correct knowledge” is more decisive if based on direct perception than on inference, destruction is based on inference since the absence of something is not seen. However, this does mean that we cannot have correct knowledge, just that it requires good reasoning. Thus Vasubandhu is able to argue against the reasoning of others who cannot now base their conclusions on direct perception. Vasubandhu thus argues that destruction is spontaneous:

We have already said that destruction, being a negative state, cannot be caused. We would further say that if destruction is the effect of a cause, nothing would not perish without a cause. If, like arising, destruction proceeds from a cause, it would never take place without a cause. Now we hold that intelligence, a flame, or a sound, which are momentary, perish without their destruction depending on a cause. Hence the destruction of the kindling, etc., is spontaneous. (AKBh, 554).

These examples are then analyzed in some detail, followed with a conclusion:

[Lastly] Let us conclude. The destruction of things is spontaneous. Things perish in and of themselves, because it is their nature to perish. As they perish in and of themselves, they perish upon arising. As they perish upon arising, they are momentary. Thus there is no movement, no displacement; there is only arising in another place of the second moment of the series: this is the case, even in the opinion of our opponent, for the fire which consumes firewood. The idea of movement is a false conception. (AKBh, 555).

This argument echoes Zeno's arrow argument, and, I argue, is similarly dealing with the issue of discrete vs. continuous times and relying on rational analysis to entail metaphysical consequences, rather than taking the empirical stance by observing motion and concluding that our concepts need to be adjusted accordingly.

Vasubandhu's arguments, especially his analysis of the aforementioned examples, proceeds in a way that Tillemans' characterizes as "obscure and unconvincing... a number of non-sequiturs going from [the] difference in efficacy and reality between absences and presences to the idea that perishing is somehow the real nature of things, that it must be intrinsic to them, and that therefore things must perish spontaneously moment after moment" (2011, 3, insert mine). This analysis of Vasubandhu's argument seems right, and is supported by the apparent need for Dharmakīrti's new argument.

Indeed, much as we find this argument obscure and inconclusive, Rospatt states (3) that it dominated the controversy, even with Dharmakīrti's enhancements, until Dharmakīrti developed a new argument. Dharmakīrti's newer argument is from the *Pramāṇaviniścaya*. Dreyfus (1997, 63) summarizes the argument this way: The cause of

disintegration of entities is either fortuitous or not. If fortuitous, why is eventual disintegration of all entities inevitable (as it ‘clearly’ is)?<sup>93</sup> Hence, it is not fortuitous, and there must be a cause of eventual destruction inherent in the very existence of a thing. As summarized by Tillemans (2011) the argument goes like this: (1) The distinction between existence of one thing from another is based on differences in their causal efficacy, the powers to produce effects; (2) things are always, at every moment, causally efficient—although note (and this will be important for our discussions of reductionism in this context, below) that “the difference between effects would be subtle ones that often escape our perception” (Tillemans 2011, 1.3); and (3) nothing causes anything new while remaining itself the same—involvement in a causal interaction changes the cause. Recall that the “criterion for something being real [i.e. a particular vs. a universal, a thing vs. a non-thing such as a thought] is that it must have ‘causal powers’ and ‘perform causal roles’” (Tillemans 2011, 1.2, insert mine). The central assumption is that physical entities are always involved in causal interactions, hence are changing, and change of any sort entails change of identity, i.e. the first thing disappears and a new thing appears (which is, however, causally related to the previous thing), and this is momentariness.

“Disintegration is constitutive of the things themselves. The disintegration of the jar requires no other causes than those necessary to its production” (Dreyfus 1997, 63), hence such disintegration is directly uncaused, and is the nature of things. It is not that the disintegration is uncaused indirectly, because its mere existence as a produced and conditioned entity (as opposed to an idea or universal which may be permanent) was sufficient cause for its demise.

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<sup>93</sup> I take issue with this assumption in *Chapter Nine: Physics of Change*.

## ***E.2. Inherent reductionism in these arguments***

Before we turn to Madhyamaka treatments of impermanence and momentariness, we should take stock. Consider a vase sitting on the table. First, is there really anything in the vase, either in its existence or production, which necessitates its eventual destruction into shards? It is a fundamental conclusion of several Buddhist arguments that anything produced will decay or be destroyed. However, we can imagine our vase being moved, buried, yet intact for thousands of years, if not millions, since similar artifacts have been discovered intact in archeological digs. Perhaps this vase will be put on a spaceflight mission and sent into space, to last until the big crunch reversing the big bang. Or maybe there will never be a big crunch. Perhaps the original Voyager spacecraft (which are still out there after 35 years) will be such an entity, lasting throughout eternity. There may be many non-essential relations that change, but what is essential and necessary to what the entity is does not seem to necessarily be impermanent, at least on a gross level of analysis.

Yet this is irrelevant to Buddhist logic—certainly they were familiar with things that seemed to last a very long time, such as vases and other artifacts of historical significance, or simply family heirlooms. Recall our note from Tillemans (2011): “the difference between effects would be subtle ones that often escape our perception”. Hence, even while an entity might *seemingly* last forever, there will always be—at the very least—microscopic change. Alternatively, we could hypothesize that there are macroscopic changes that occur so rapidly that we cannot notice them, and this perhaps was what the ancient Buddhists had in mind, with the object somehow changing form and then reverting back to its original, leaving the original in sync and apparently unchanging, in flashes like old high speed analog film. However, through results of modern

instrumentation of high speed photography at rates of the order of millions of frames-per-second, I think this hypothesis may be discounted.

Hence, we are left with microscopic, reductionist changes that may result in macroscopic ones, slowly over time. Our spacecraft or vase within it will suffer from the effects of solar particle radiation and cosmic rays, with innumerable subatomic particles within it being transformed into different subatomic particles. Similarly, there will be radioactive isotopes in the makeup of the vase, and they will decay. Furthermore, ‘quantum foam’ of chaotic destruction and annihilation will be occurring throughout the vase. I submit that in order for any of the Buddhist arguments for impermanence or momentariness to work they must eventually rely on non-apparent changes at microscopic scales. And since the argument will be that such changes entail changes in the composite entity itself, the arguments rely on reductionist analysis.

We previously had demonstrated a foundational view that the arguments for momentariness require that any change of any properties, including any physical parts, entails a change of identity, which essentially is one of a Leibniz’ Laws. We noted that this foundational view in terms of parts utilizes the idea of mereological essentialism (that all parts are had by an object essentially) which, in combination with Leibniz’ Laws, demonstrates mereological reductionism which stipulates that since parts change the whole changes.<sup>94</sup> Yet, this kind of reductionism is not necessarily abhorrent to a non-Madhyamika, for whom there is a basis for constructing the world from these components since they already accept partless particles, the ultimate physical components

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<sup>94</sup> Mereological essentialism is that all parts of a partite entity are had by that entity essentially. As noted above, Leibniz’ Laws are that indiscernible entities are identical and conversely identical entities are indiscernible, i.e. that they have the same properties. By combining these two, if a part of a partite entity changes, then what results is not the same entity, which is what I call mereological reductionism.

of matter, and their momentary existence. We would expect Madhyamaka to divest the analysis of any remnant of reductionism.

### ***E.3. Madhyamaka critique of impermanence and momentariness***

Buddhist ideas of impermanence predated Nāgārjuna, while Vasubandhu's and Dharmakīrti's arguments for momentariness came centuries later. Hence, any interpretation of Nāgārjuna's arguments in light of momentariness might be an anachronistic reconstruction. However, we will focus on relevant ideas from MMK for two reasons. First, both of the later authors expressed some views that were consistent with several Buddhist philosophic schools (*Vaibhāṣika* and *Sautrāntika*), which also included views that Nāgārjuna was expressly criticizing.<sup>95</sup> Second, Nāgārjuna's MMK is a foundational text which presents the fundamental principles of Madhyamaka that should be applicable to this topic generally, as confirmed by further historical developments in Madhyamaka commentary based on his works.

We will focus on MMK 21, which is a direct investigation of “becoming and destruction” (Garfield 1995, 267-274) or “occurrence and dissolution” (Kalupahana 1970, 292-301). We also note in that chapter (as also in the previous MMK 20) critique of cause and effect as the relationship between the discrete momentary existences of a phenomena, hence they contribute to our analysis of causality as well as of impermanence, supporting the idea that the three components of relationality are not themselves independent, as argued in Section A.2 of this chapter.

Garfield's interpretation is that MMK 21 pertains generally to all phenomena, while Kalupahana states that the discussion addresses the life cycle (*samsāra*) of a person

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<sup>95</sup> Vasubandhu first wrote the standard compilation of *Vaibhāṣika*, and then in his commentary wrote a critique of it which became a foundation of *Sautrāntika*, while Dharmakīrti is generally considered to have expressed the latter view.

specifically. Hence, for the former when Nāgārjuna discusses birth and death he is relating to the first appearance, becoming or occurrence and final destruction of a phenomenon, while for the latter it is birth and death of an individual person. I take Garfield's lead and generalize the discussion to all phenomena, just as we generalized the discussion of mental aggregates (skandhas) to parts of the chariot in our previous discussions. However, Kalupahana's translation and commentary provides somewhat different insights into the meaning of the text, hence we use that as well.

In particular, Kalupahana points out that Nāgārjuna is directly denying the Sautrāntika view of Vasubandhu we discussed previously, that dissolution is inherent in occurrence or production:

MMK 21:1-3

Dissolution does not exist either without or with occurrence. Occurrence does not exist either without or with dissolution.

How can there be dissolution without occurrence, death without birth, dissolution without uprising?.

How can there be dissolution along with occurrence? Indeed, simultaneous birth and death are similarly not evident. (Kalupahana 1970, 292-293).

Kalupahana interprets the first two verses as an argument against the personal self or soul that was considered by non-Buddhists to be eternal, in the context of this section of chapters which argues for the non-substantiality of the person. Death cannot come without birth, nor at the same time, and there is no birth without death. However, in the third verse we see

...an explicit rejection of the metaphysical view that death is inherent in birth. If the life-process...were to be understood as a series of momentary existences,...as the Sautrāntikas believed, then the seeds of death should occur at the very moment of birth. This logical explanation was not acceptable to the empiricist Nāgārjuna. (Kalupahana 1970, 293).

As commentary to the fourth verse, “How can there be occurrence without dissolution, for the impermanence in existences is never not evident.” Kalupahana states that “Occurrence (*sambhava*) as an absolute new beginning is rejected here, when Nāgārjuna affirms that without dissolution occurrence does not take place” (293). This verse and interpretation is also important in relationship to our contention that Nāgārjuna does not reject causality altogether, but rather is rejecting a production theory of causality (“an absolutely new beginning”), while supporting a dependence theory of causality (dependent arising).

Garfield’s gloss on the first six verses<sup>96</sup> starts as an apparent contradiction to Kalupahana’s view, but then resolves the situation with the former’s emphasis on the lack of independence interpretation: Each of the pair of birth and death, becoming and destruction, and occurrence and annihilation are mutually incompatible if taken as independent, hence they are mutually dependent.

This is the argument to this stage: Becoming and destruction are mutually contradictory. So they cannot be properties of the same thing at the same time. But everything that is coming into existence is at a stage in a process that culminates in its destruction. So everything that is becoming is at the same time being destroyed. (Garfield 1995, 269).

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<sup>96</sup> For Kalupahana (293-295) the next three verses are: (4) “How can there be occurrence without dissolution, for the impermanence in existences is never not evident.” (5) “How can occurrence be evident along with dissolution? Indeed, simultaneous birth and death are similarly not evident.” (6) “The occurrence of things, either together or separately, is not evident. If so, how can their establishment be evident?” For Garfield (267-268), the first six verses are (For concision, I have removed the capitalizations and line spaces of the first words of lines in a verse that are mid-sentence, consistent with Kalupahana’s conventions.) (1) “Destruction does not occur without becoming. It does not occur together with it. Becoming does not occur without destruction. It does not occur together with it.” (2) “How could there be destruction without becoming? How could there be death without birth? There is no destruction without becoming.” (3) “How could destruction and becoming occur simultaneously? Death and birth do not occur simultaneously.” (4) “How could there be becoming without destruction? For impermanence is never absent from entities.” (5) “How could destruction and becoming occur simultaneously? Just as birth and death do not occur simultaneously.” (6) “How, when things cannot be established as existing, with, or apart from another, can they be established at all?”

Note that while destruction is occurring at the same time as becoming, Garfield does not go so far as to say that destruction is *inherent* in becoming. Nāgārjuna's argument is against any and all reification of the becoming and destruction processes. They cannot co-exist, nor can they transmit any substance from one to the other, for then they would not be discrete. The argument is that some kind of continuity must be retained, but continuity is not consistent with momentariness. Garfield continues:

Everything that is being destroyed is at a later stage of a process that earlier resulted in its coming into existence and, indeed, is coming to exist in some other form. So everything that is being destroyed is also becoming. So becoming and destruction cannot coexist, but cannot exist apart. Hence they cannot exist independently at all. (Garfield 1995, 269).

As both Garfield and Kalupahana point out, Nāgārjuna closes his argument at the end of the chapter (verses 18 to 21) with an attack on the momentariness view of non-Madhyamaka Buddhist analysis. This final argument is based on the foundation of the earlier attack on discreteness begun in the first verses of the chapter. Once arising has ceased, ceasing cannot arise since there is no transfer of a cause: If there were a cause of ceasing due to the arising, then the arising should still be there when the cause began, but then there would be arising and ceasing at the same time. This is similar to Russell's argument against productive causality that we discuss in *Chapter Seven: Physics of Causality*, and is consistent with Nāgārjuna's analysis of arising in his first chapter.

If the momentary phenomena prior to a present momentary phenomenon has ceased prior to the arising of the present one, there is no basis for that arising. But if it has not ceased, then its destruction cannot be an occasion for the arising of the subsequent event. So the prior momentary phenomenon can neither have ceased nor not ceased...if we say that the cessation of the previous momentary phenomenon is simultaneous with the arising of its successor, then being simultaneous but distinct, the two phenomena are separable and hence independent. If so, there is no basis for positing any connection between them. This is yet another application of the principle of the independence of separable phenomena...Finally, we don't want to identify arising and ceasing, claiming that

they are the same phenomenon, since they are by definition contraries. (Garfield 1995, 273).

The conclusion that we cannot coherently either separate cause from effect nor actually combine them, as long as we ascribe independence or inherent nature to them separately, is supported by the analysis in the previous chapter MMK 20, which is worth briefly mentioning. That chapter examined the relationship of combination between cause and effect, which is causality itself, hence is quite relevant to our previous analysis also. With no inherent nature in entities, perhaps there is inherent nature in their harmonious combination, in the causal relationship itself. This is dismissed by Nāgārjuna, and in the process he also denies the possibility of discrete moments:

MMK 20:10-11

How can a cause, having ceased and dissolved, give rise to a produced effect?  
How can a cause joined with the effect produce it if they persist together?...Moreover, if not joined with its cause, what effect can be made to arise? Neither seen nor unseen by causes are effects produced. (Garfield 1995, 262-3)..

Garfield interprets these chapters within the context of rejection of any kind of substantialism, of any kind of independence of phenomena. Thus, attribution of any inherent nature to even the momentary existence of an entity is denied, in favor of the interdependence or mutual dependence of phenomena which is discussed in MMK 24 as dependent arising, as noted previously. We still have impermanence—although with no inherent nature in the impermanent entities or in the relation of impermanence itself. However, momentariness is rejected.

How does this analysis relate with the reductionism mentioned previously which was found in non-Madhyamaka views? With no inherent nature even in a moment of existence, there is no basis for momentariness and the inherent nature that Sautrantikas

suggested. However, even without this kind of momentariness, Madhyamikas must still have impermanence, although this concept cannot be reified either. Hence, we cannot have independent yet impermanent entities: Impermanent entities are interdependent with each other and with their parts.

However, there still seems to be no easy solution to the reductionist tension. For there to be impermanent and interdependent entities like the vase and its component parts that are each impermanent and interdependent, even in the face of the vase simply sitting still, unmoving and apparently unchanging, potentially forever, how can we obtain impermanence? It would require change of some property, yet it just sits there. The only thing left is appeal to unseen, microscopic and continual flow and transformation—atomic and subatomic motion, electron-positron annihilation and re-production, etc. The dependence of the characteristic of impermanence of the whole on the impermanent characteristic of the parts is a reductionist dependence, and furthermore argue that it is unjustified physically for many entities and domains. I argue throughout this dissertation that a pluralist and structural realist view, acknowledging parts (analyzed within one domain) that may change while the whole (analyzed in another domain) maintains its identity, is more justified for many phenomena. We examine these ideas in *Chapter Five: Metaphysics of Change*, and *Chapter Nine: Physics of Change*.

## ***F. Summary***

We discussed elements of a Madhyamaka view concerning inherent nature, thus forming a basis for discussion in the rest of the dissertation. Inherent nature has three components: it is causally independent, mereologically unitary and temporally unchanging. *Madhyamaka causality arguments* promote the view that entities involved in

causal interactions cannot be considered causally independent, and the causal process itself cannot be inherent in universal causal powers, or what Hume called ‘occult’ powers. I find these arguments in need of revision, to be worked out in later chapters, but the conclusions of the revisions may be similar to at least a plausible interpretation of basic Madhyamaka views if we interpret these pluralistically, i.e. distinguishing local inherent nature as relative truth and global relationality as ultimate truth.

*Sevenfold reasoning* analyses whole and parts in order to deny the coherence of mereological relationships when dealing with independent parts, hence no such parts exist: whole and parts lack mereological independence. *Neither-one-nor-many* argues that the concept of atomic simples is similarly incoherent, hence even the most basic constituents of matter cannot be independent or unitary. I especially find these arguments sorely in need of revision in light of contemporary philosophy and modern physics, although again there is some indication at this point that the conclusions may be similar, and thus the general Madhyamaka principle may be found valid: Mereologically, phenomena are *śūnya* if we interpret the situation pluralistically.

The Madhyamaka impermanence arguments are based on fundamental observations and arguments common to Buddhist thought: It seems that simply nothing in our experience ever stays the same. From that observation and inference some non-Mādhyamikas concluded that there was still inherent nature in the momentary existences, even if they are flashing in and out of existence as sequences of causally connected bits of phenomena which, when strung together by cause and effect provide us with the appearance of continuously existent things. With the Madhyamaka critique that there is no inherent arising or ceasing of inherently existent entities, change—as implying

that something with inherent nature becomes something else that also has inherent nature—is argued to be a fallacious characterization.

An alternative interpretation may be proposed, which is an anti-realist or nihilist conclusion that is frequently offered in some commentary: Change is unreal because entities are unreal, hence there can be no real causation. This view has been expressed in some form by some Madhyamikas, such as Gorampa and some of his followers. As far as I can tell it is not that of Tsong-kha-pa (see Wood 1994 for the nihilist interpretation and Thakchoe 2007 for a detailed comparison of these two views). As noted several times in this chapter, I reject that alternative interpretation and adopt the latter as being more consistent with current physics knowledge and at least some modern philosophical perspectives that I also adopt here, as discussed in detail throughout the rest of the dissertation.

There are Madhyamaka objections to Abhidharma momentariness in order to divest Buddhist thought from any reliance on a unitary inherent nature for a discrete moment. This leaves us with a radical, continuous impermanence. However, in analysis of the ‘relative’ or ‘conventional’ natures of composite objects, the arguments concluding that these objects are impermanent apparently rely on mereological essentialism, which embodies a reductive perspective.<sup>97</sup> This is somewhat problematic in light of Madhyamaka insistent opposition to reductionism in other arguments. When we apply contemporary physics analysis we will find that some entities may indeed be persistent within specified domains. We can interpret such persistence *within a domain* as a

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<sup>97</sup> Both Kalupahana and Garfield interpret the first 21 chapters of MMK as dealing with relative phenomena. Ultimate analysis, climaxing in Chapter 24, is that Madhyamaka is dependent arising. My understanding of the two truths is that one is no more true than the other, and they are consistent with each other.

conventional designation, and the fact that there is lack of persistence in other domains combined with a comparison between domains demonstrates the three dimensions of relationality to be a coherent and consistent understanding of *śūnyatā*. However, we must avoid the following: conventionally (classically) the vase is permanent, but ultimately (by quantum field theories of the vase's fundamental particles) it is impermanent due to quantum chaos. If we say this then we are being reductionist in an extreme fundamentalist way, and that is certainly not the intent of Madhyamaka. It is the identity of 'ultimate' equal to 'reductionist' that violates basic Madhyamaka intentions.

By intent Madhyamaka arguments and conclusions are anti-reductionist, which is consistent with some aspects of modern physics and contemporary philosophy of physics in their rejection (at least in quantum domains) of reductionism and local realism upon which it is based, as justified by evidence of violation of Bell's inequality. However, we found remnants of reductionism in Madhyamaka analysis of the lack of inherent nature in matter as an answer to the problem of composition, and more blatant reductionism in mereological essentialism that is invoked as part of a solution to the problem of change. Commentary concerning composition frequently states that 'just as the parts have this characteristic of no inherent nature, therefore the whole has this characteristic' which seems reductionist, and in order to interpret these statements in a non-reductionist context, we can apply two conclusions. First, we must say that the lack of inherent nature is not a characteristic. It is the lack of a characteristic. Therefore, we must say it like this: 'because parts lack inherent nature therefore the whole lacks inherent nature', but this relies on the idea that the whole is built from parts. Alternately, we may say that 'there are no parts with inherent nature upon which we can base a construction of inherent

nature in the whole.’ We could argue that these arguments are not reductionist, since there is no foundational entity with inherent nature at the end of our reduction.

Alternatively, we could argue that this is a negative kind of reductionism, since there is no basis, no positive characteristic of the parts upon which to base a characteristic of the whole. However, neither statement in quotes provide explanations of *why* the whole would lack that characteristic if we cannot apply a mereological reductionism of adding parts (that lack something) to make a whole (which therefore lacks it). And we cannot apply that kind of reductionism to atomic parts due to the entire argument’s reliance on the many assumptions of naïve atomism which do not apply to matter as we know it through modern physics—real components just don’t add up that way. My conclusion is that the arguments do not stand up to close scrutiny. Second, we require a particular interpretation which entails a very significant hypothesis about the nature of the presumably non-composite elementary particles of quantum field theory, i.e. that they have relational parts (even while being non-composite). We see how this is cashed out in *Chapter Eight: Physics of Composition*.<sup>98</sup>

We now turn to an examination of the three components of relationality from various points of view in *Part II: Western Metaphysics*. The next *Chapter Three: Metaphysics of Dependence* examines the causal component of independence and relationality, i.e. in regard to ‘other’ phenomena, hence examines the synonyms of ‘inherent’, in particular ‘intrinsic’, and their relational opposites. *Chapter Four: Metaphysics of Composition* examines the mereological component of relationality, i.e. independence and dependence in regard to parts, and *Chapter Five: Metaphysics of*

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<sup>98</sup> There are a few issues that will be further discussed in Chapter Eight which deserve mention here. First, any discussion of composition must be done extremely carefully if one is to avoid a reductionist view. Second, inherent nature in the whole as stable structures may arise from parts that don’t have stability.

*Change* examines the temporal component of relationality, i.e. independence and dependence in regard to time. In each of these three chapters *śūnyatā* will be examined mainly in the semantic dimension, providing only pointers to the epistemic and ontological dimensions which are fully discussed in *Part III: Physics*.

## **CHAPTER THREE. METAPHYSICS OF DEPENDENCE.**

### ***A. Introduction***

Madhyamaka arguments promote the view that no phenomena have inherent nature. Inherent nature can be considered to represent a lack of relations or dependencies. Another way of putting this is that the inherent nature of something, or the properties that the thing has inherently, cannot interact with anything else. Since such a thing, or the inherent properties of it, cannot interact, it cannot have any materially relevant or causal relationship with anything else, with its own parts or with time—hence cannot change. Yet things do interact, have parts, and change, hence phenomena and properties rather are relational. Relational and inherent natures are seen as mutually exclusive, at least in a fundamentalist/universalist way of thinking. Consistent with the Madhyamaka literature, we categorize relationality into three kinds of dependencies which inherent nature should lack: lack of dependence on other phenomena, which we call causal independence; lack of dependence on parts, which we call mereological unitarity; and lack of dependence on time, which we call persistence. In this chapter we look closer at the possibility of phenomena's lack of causal dependence on other phenomena—a lack that Madhyamaka arguments say cannot exist. In fact, the issue of causal dependence will also become the central issue in the other two components of inherent nature and relationality. This is because mereological independence or dependence on parts and an object's persistence or impermanence is understood in terms of the causal relationships between the whole and its parts or between an object in one time and the object in the next time. Hence, it is

appropriate to discuss causality first, just as Nāgārjuna discussed it first in his *Fundamental Treatise*.

There are several purposes for this chapter. The primary purpose is to show how the literature of contemporary Western metaphysics can illuminate the Madhyamaka account of relationality, and specifically to demonstrate concepts in that literature that can be used to more clearly understand what is ‘inherent’ about inherent nature. Those concepts, we shall see, are embodied in an understanding of the terms ‘intrinsic’, ‘essential’ and ‘necessary’. In addition, we will see how the Western literature has confused several issues about independence of physical entities by failing to apply the principle of contextualization, which in this instance requires consideration of physics, or as I call it *grounding in physical relevance*. The source of that confusion is found in many philosophers’ distrust of physics, as discussed below. When attempting to ground the discussion in physical relevance, we can also see how at least some Madhyamaka arguments are untenable, since they also are similarly not grounded.

Questions concerning dependence of phenomena on other phenomena in terms of non-living physical phenomena are questions about causal relations. Nāgārjuna’s seminal work *The Fundamental Wisdom of the Middle Way (MMK)* begins with an examination of causality and argues that all phenomena are causally interrelated and also that causality itself is not some inherent property of the phenomena or of the world embodied in some sort of occult power. This latter has also of course been famously argued by David Hume. In *Chapter Seven: Physics of Dependency* we examine causality as it is understood by physics and philosophy of physics, and go further into Humean and various kinds of conceptions of causality categorized as production or dependence types. In this chapter

we examine dependence and independence as understood by contemporary Western analytic metaphysicians. This topic has been analyzed throughout Western philosophical inquiry; the ancient and early modern inquiries are more commonly known, hence we will focus solely on a subset of the work conducted over the past few decades.

We begin by relating notions of independent existence in the Western analytic metaphysics literature to Madhyamaka ideas. In both sets of literature independent existence is having properties and nature which are intrinsic, internal, natural, essential and/or necessary, and in Madhyamaka these are synonyms for *svabhāva*, what we have been translating as inherent nature. If all properties are causally interconnected in the way proposed by Madhyamaka arguments, then all properties that we can at least know about, or perhaps the only properties that exist, are relational, since intrinsic properties cannot interact to be known. This statement assumes that ‘intrinsic’ and ‘extrinsic’ properties are exhaustive and exclusive categories, and relational is synonymous with extrinsic, and those are good assumptions, at least for now. We do not directly discuss causality here, leaving that for *Chapter Seven: Physics of Dependence*, but rather discuss the concepts used to describe and understand independence, which we then interpret as causal independence.

Then we introduce the Western analytic method of ‘duplication’ that has recently been used to define intrinsic properties. We are told that of all the possible properties that an entity may have, if the entity is duplicated and isolated—a ‘lonely duplicate’—then no relational properties will be included in the isolated possible world. If this is true, since there would be nothing to relate with, all properties of the lonely duplicate would be intrinsic. This concept is further refined to make the intrinsic properties those which are

independent of being either lonely or accompanied, what is called ‘independent of accompaniment’. Several problems are entailed by this analytic process, and we discuss them in turn. We find just how the arguments are flawed due to the lack of their grounding in physical relevance.

Throughout the chapter I argue that the metaphysical analysis requires—and typically misses—such proper grounding. The latter is a concept which requires utilization of both physics and an interpretive framework which relates philosophical concepts with the actual, physical world that is described by physics theories. Physical relevance or similar concepts have been promoted by various philosophers in their advocacy of the use of ‘naturalness’ which, however, has also received some criticism. That advocacy in the analytic metaphysics literature has typically also fallen short of the reliance on physics that I advocate here. I argue that the best physics that is available to us at this present time must be applied if we wish our metaphysical concepts to be as relevant to physical reality as we can possibly make it. Another way of saying this is that having metaphysical commitments consistent with physics is epistemically virtuous. We demonstrate that the mistrust which restrains some philosophers from relying on modern physics is pathological. It is pathological, as explained in more detail in Section B.5 below, because those philosophers base their mistrust on the following argument: (1) Analysis of the history of physics is strewn with false and therefore discarded theories; (2) since such past physics theories were found to be false, it is more than likely that all current theories are false also; hence, (3) modern physics theories cannot be trusted. It is because of this mistrust that they say we cannot use modern physics, yet some physics must be used in describing physical objects and the physical environment from which

those objects are supposed to be independent, hence they use the physics that corresponds to their intuitions: ancient atomic theory and middle school level classical mechanics. Yet those were precisely two of the ‘theories’ (in scare quotes because it is not clear that each of these were actual physics theories by modern standards) that were discarded and found to be false by their own analysis. Hence, because they mistrust modern physics since it may be false, they use theories which are definitely false, thus making the mistrust pathological. In *Chapter Six: Physics Pluralism* we dispute the entire argument and paradigm of mistrust, thus allowing us to select theories which are *true in their domain* as long as the phenomena that they describe are confined to their well-understood domains of applicability.

## ***B. Intrinsic Properties***

In this chapter we examine some of the literature of independence and intrinsicity. The problem that literature is attempting to solve is how to understand the concepts involved with the independence of a property of an entity and/or the entity altogether from another property or entity. It is first determined that intrinsic properties should be independent, but that just kicks the can down the road, since it has been difficult to formalize the concept of intrinsic property, even if an intuitive notion might be commonly understood.

The literature we consider starts with Lewis (1986) and the duplication process: We duplicate an entity from one possible world to an otherwise empty possible world, leaving all properties of the duplicate as independent and intrinsic. However, it is argued that we still don't know what properties to duplicate without first knowing what the intrinsic properties were. This circularity problem consumes the attention of much of the discussion. I argue that the only coherent way out, when dealing with physical entities and causal independence, is by grounding the discussion in physical relevance, hence by using the best physics that we have. I am therefore critical of much of the literature, although I find some support from some of the arguments by Lowe and Shalkowski.

We begin by noting the relevance of this discussion to Madhyamaka by examining the meanings of *svabhāva*, what we have translated as 'inherent nature', although it has also been translated as intrinsic and independent. We then introduce the duplication process and examine the two categories of abundant and sparse properties which have been used in an attempt to distinguish those properties which should not from those which should be duplicated, respectively. The sparse properties are those that have

physical relevance, although much of the literature fails to ground the discussion in our best physics which I argue is needed in order to understand what the requirement for such relevance entails. We then look at naturalness, which is a concept that should represent such grounding, which brings us to a discussion of natural kinds. We look further at the distrust in physics which many philosophers demonstrate (implicitly and explicitly) and then re-examine the duplication process with the insights gained so far. A slightly different concept is then introduced, the idea that properties are had *in virtue of* the entity itself. This brings us to the concepts of internality, essentiality and necessity as further attempts to understand independence and intrinsicity.

The main conclusions of this chapter are that (1) discussion of physical phenomena must use our best physics in order to be the best discussion, i.e. to achieve the best (most coherent, plausible and consistent) understanding; and (2) an entity has properties which are independent of other entities if and only if those properties are intrinsic, essential and necessary to that entity being what it is; and (3) what an entity is—its intrinsic, essential and necessary properties, if any—must be inventoried by physics. I argue that these conclusions importantly apply to Madhyamaka views as well as those of Western analytic metaphysics. Some of that application is outlined here, but most await Part III.

### ***B.1. Relevance to Madhyamaka understanding of svabhāva***

In this section we both introduce some of the terms to be examined within the chapter and also identify the way some of the Madhyamaka literature uses those terms. For example, Hopkins (1996, 36) lists 17 synonyms for *svabhāva* or the ‘self-nature’, of

phenomena, what we translated as ‘inherent nature’,<sup>99</sup> including inherent existence, ultimate existence, true existence, existence as its own reality, natural existence or existence by way of its own character, substantial existence, objective existence, and existence through its own entitiness. *Svabhāva* is directly related to independence. We noted the classical argument that independent phenomena must also be unitary and permanent as outlined in Section A.2 of Chapter One. From independence, we can also derive synonymous characteristics such as being essential and being necessary, which we proceed to analyze in this chapter.

Westerhoff (2009)<sup>100</sup> extracts two relevant senses of *svabhāva* from Candrakīrti’s works: essence-*svabhāva* and substance-*svabhāva*. Essence-*svabhāva* relates with the essential qualities of an entity and Westerhoff distinguishes these from all of its merely “specific characterizing properties”<sup>101</sup> (21)... “The specific quality of an object is the unique combination of properties which distinguishes the object from all others” (22), hence these are viewed as epistemic qualities. “An essential property is something an object cannot lose without ceasing to be that very object” (22), hence this is viewed as ontic. In Westerhoff’s terminology and interpretation the essential, ontic properties together describe the essence-*svabhāva* of an object, and Madhyamaka argues that all

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<sup>99</sup> Since self-nature is considered a fiction, these synonyms are called ‘hypothetical synonyms’ because they all refer to a non-existent. See Hopkins (1996, 37).

<sup>100</sup> Westerhoff divides *svabhāva* into ontological, epistemological, cognitive and semantic dimensions. My semantic dimension somewhat includes his cognitive, although I think it somewhat belongs in my epistemological dimension. His epistemological dimension relates to *pramana*, the highly complex and detailed theory of perception and knowledge developed by Dignāga and Dharmakīrti (see Dreyfus 1997) from the 6<sup>th</sup> and 7<sup>th</sup> Centuries. I include *pramana* as one factor of scientific knowledge, since it pertains to topics in cognitive science. The lines between the categorizations of *svabhāva* and *sūnyatā* do get blurry, however, especially acknowledging interdependence.

<sup>101</sup> In the *pramana* theory as developed by Dignāga and Dharmakīrti that some interpret as an adaptation of the *pramana* logico-epistemological approach with Madhyamaka and hence that has been adopted by some Madhyamikas, this term describes the trope of any physical, spatio-temporal object, as opposed to ‘general characterizing property’ which describes the property or universal.

essential, ontic properties are relational—and of course all epistemic and accidental properties are relational, so all properties are relations. Hence, there is no independent essence-svabhāva. However, I argue that epistemic and ontic qualities relate to each other because how we understand the nature of an entity through involvement with explaining its causal relationships requires use of evidentiary procedures of perception and measurement, and physics theories. These procedures are used whether we utilize a naïve realism, more sophisticated realism (Hacking, 1983 or Psillos, 1999) or structural realism of any variety. (It may not apply if we use instrumentalism for unperceivable entities since in some views their existence and nature would not be confirmed.) We therefore see the distinction between specific and essential qualities to be less distinct, contra Westerhoff, since the specific characterizing qualities—including their essential ontological properties—serve the epistemic function to distinguish one object from another.<sup>102</sup> We interpret essential characteristics as the characteristics which distinguish one class of objects with intrinsic properties from another (which may be identified as similar to some interpretations of ‘natural kind’), while the ‘nonessential’ specifically characterized properties may serve to describe the particular which is a member of that class. Yet the latter are essential to the particular, just not essential to the class. Note again that I argue for a pluralist domain-specific interpretation of natural kinds which may have properties that are considered intrinsic within a domain but not intrinsic in

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<sup>102</sup> As we shall see, this will significantly depend on semantic context, the domain of discourse or epistemic domain of applicability.

other domains. We see in later chapters that there are intrinsic properties which allow identification of natural kinds only within their domains.<sup>103</sup>

Another aspect of *svabhāva* is what Westerhoff calls substance-*svabhāva*, what he considers to be the more purely ontological quality which is the way an entity exists “in a primary manner, unconstructed and independent of anything else” (24). He states that Nāgārjuna is only analyzing essence-*svabhāva*. We interpret Madhyamaka as critically analyzing both substance and essence, what it is that makes an entity essentially and necessarily what it is in a fundamental, substantial sense independent of accidental properties, including both as a kind and as a member of a kind. Of course, how we define essential, necessary and accidental properties is central to this discussion, as we proceed to it in this chapter. As a segue to the contemporary Western analysis of intrinsic properties, we use a footnote in Westerhoff’s analysis of substance-*svabhāva*, where he cites some contemporary Western Buddhist commentaries that equate *svabhāva* with intrinsic properties,<sup>104</sup> defining the latter by quoting Lewis: Intrinsic properties are those properties “‘that things have in virtue of the way they themselves are’, while extrinsic properties are had ‘in virtue of their relations or lack of relations to other things’” (Lewis 1986, 61).

In this sub-section we introduced some terms used by both Madhyamaka and Western metaphysics to describe non-relational properties of phenomena. In some sense, even Madhyamaka analysts agree that phenomena have essential properties, and it is

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<sup>103</sup> For example, mass in many domains but which is a result of interaction with the newly discovered Higgs field in a high energy effective field theory of the standard model of particle physics, which makes mass relational and not intrinsic in that latter domain.

<sup>104</sup> Westerhoff cites Tillemans (2001, 14, n. 24) and Siderits (2004, 117), although these terms are equated more commonly than just these two references indicate.

unclear in a contemporary non-pluralist context how those properties might also be considered relational and causally dependent. I argue that the way to resolve this tension is to recognize the pluralist multi-domain nature of our world and compare those properties and entities between different domains, but most of that argument will await the physics chapters. In the following sub-section we introduce the analytic duplication process which has been used in order to conduct conceptual analysis of intrinsicity and associated terms.

### ***B.2. Duplication 1***

We are told by many metaphysicians that the task of metaphysical analysis is to distinguish the intrinsic properties without having to rely on physics, but simply by analyzing the concepts, comparing with their intuitions (which they presume represents common sophisticated intuitions), understanding our language, and modeling the physical reality accordingly. However, those metaphysicians eschew using the most mature and accepted contemporary physics theories and empirical content in that modeling process since those theories are viewed as being contingent and amenable to drastic change or being discarded, while their intuitions, conceptual analysis and logic are considered less fragile. I intend to demonstrate (throughout this dissertation) that their approach is both inconclusive and occasionally misleading or completely false, but nonetheless somewhat helpful in order to clarify certain concepts that can be used later in order to help us evaluate or illuminate relationality and inherent nature when we actually do apply the best current contemporary physics, which I find and intend to show as absolutely necessary in analysis of physical phenomena. There are several flaws that arise in the duplication process as used by many metaphysicians in their attempt to understand the

concepts of independence and intrinsicity, and some of those flaws come from lack of attention to modern physics. In this section we introduce that process.

Contemporary Western analysis of intrinsicity begins with Chisholm, Lewis and Kim in their attempt to conduct a rationalist, *a priori* metaphysical analysis of the concepts of independence and intrinsicity based on what is supposedly understood in an intuitive fashion. However, attempts at formalization of that intuitive understanding rapidly uncover flaws in the original analysis. By formalization, these analysts indicate their attempt to clearly define, with use of formal logic, a definition of intrinsicity that will be comprehensive, coherent and without counterexamples. In some sense, those analysts found that it is the process of formalization of our intuition that produces issues, rather than the intuitions which some analysts presume that we all share. It is frequently said in the literature that we know what it means for something to be intrinsic, yet it is found that coming up with a precise enough definition of it to avoid counterexamples or contradictions has proved difficult. This is partly because different analysts have different intuitions, but mostly due to the formalization process which brings out just how specific common intuitions are, and therefore how easy they are to provoke counterexamples when attempting a generally applicable formalization. Those intuitive understandings are frequently trivial, as it is said “You know what an intrinsic property is: it’s a property that a thing has (or lacks) regardless of what may be going on outside of itself. To be intrinsic is to possess the second-order feature of stability-under-variation-in-the-outside-world” (Yablo, 1998, 479). The stability is supposed to be established by duplicating the entity and isolating the duplicate.

Yet, flaws in the formalization arise from trying to devise concrete ‘imagination’ experiments involving duplication. These are not quite like the ‘thought experiments’ famous in physics since those involve the use of actual physics, rather than just commonsense intuitions, which may only be valid in Newtonian domains, or even flights of fancy outside of any known physics. I understand thought experiments to perhaps require currently unavailable technology but still utilize actual physics.

The first flaw in devising these experiments is that we don’t know where the entity ends and other entities begin in order to determine what should be duplicated in order to isolate only the intrinsic properties. We would think that only ‘internal’ properties should be considered, but we don’t know how to decide what is internal and what is external. Moore defined an internal property in the following way: *P* is *internal* to *a* iff  $(x)(x=a)$  entails *Pa*, or “anything which were identical to A, would, in any conceivable universe, necessarily have [P]” (Moore 1919-1920, 54). Hence, given that a particular entity *a* exists, if we know that there is a necessary material implication from its mere existence to the fact that *a* has the property *P*, then *P* is an internal property. However, how do we know which properties satisfy such an implication? Perhaps the natural properties of the entity should be considered intrinsic, what Westerhoff called the essential properties, i.e. those which enable categorization of the entity as a member of a class of entities which are distinguished by their intrinsic properties within a domain, if there are any such properties. Yet we don’t know which properties are natural and which are not, hence we don’t know which are intrinsic, and don’t know how to categorize these classes in a consistent and comprehensive manner. The literature on natural properties

associates the classes and natural properties with natural kinds, which defines one vague and problematic term by use of another sometimes vague and problematic term.

The second flaw that has been discussed in the literature in the formal duplication process is that even lonely duplicates—the duplicate in its own possible world with nothing else existing—will have relations to what are called the ‘non-natural abundant properties’, which includes mathematical truths; abstract properties such as the set of which the entity is an element; the property of being lonely or accompanied; and disjunctions of such properties. ‘Natural’ properties—we shall see—are those which have causal, physical relevance to the entity, and are also called ‘sparse’ properties. Analysts have tried to formalize their intuitions about intrinsic properties in order to limit them to the class of natural or sparse properties because it makes sense (to their intuitions—and to mine) that a property *of the entity* should have some relevance to what the entity actually is in a relevant and causally physical way. The non-natural abundant properties do not express anything about what the entity is in that way. I label the non-natural abundant properties as ‘irrelevant’.

The third flaw, not as important to some analysts compared to others and myself, is that in order to determine which properties are internal and which are external, and to know which to reject as irrelevant, a concept of physical relevance which involves causality is required, and that requires grounding in our best physics. I argue that being physically relevant is not sufficient to determine whether properties are intrinsic or not, but it is necessary, as long as our discussion is within a domain of discourse pertaining to physical reality. In other words, in order to be intrinsic a property must be physically relevant but not all physically relevant properties are intrinsic—some are relational. In

order to utilize physics, we must get over the pathological distrust of it, but that therapy must await a later chapter.

In this sub-section we introduced the duplication process which has been used to conduct a conceptual analysis of intrinsicness and associated terms. Many agree that we informally understand what an intrinsic property might be, but the attempt to formalize those intuitions has uncovered difficulties that arise from consideration of counterexamples. The main flaw in my estimation is use of physically irrelevant properties—I am less concerned with logical formalization since we are discussing the real world that just does not always align with common intuition-guided rational requirements—hence in the next sub-section we examine the distinction required to ground the analysis in physical relevance. That analysis will also uncover further obstacles to our understanding.

### ***B.3. Abundant and sparse properties: physical relevance***

The flaws that are uncovered in formalization of an intuitive understanding of independence, intrinsicness and associated concepts revolve around the attempt to distinguish between *sparse* and *abundant* properties. Those flaws are generally due to the inability of formalization to account for all counterexamples. In comparing universals that are the basis of Armstrong's (1978) analysis of natural laws, Lewis writes:

A distinctive feature of Armstrong's work is that universals are sparse. There are the universals that there must be to ground the objective resemblances and the causal powers of things, and there is no reason to believe in any more...It is quite otherwise with properties. Any class of things, be it ever so gerrymandered and miscellaneous and indescribable in thought and language, and be it ever so superfluous in characterizing the world, is nevertheless a property. So there are properties in immense abundance...Because properties are so abundant, they are indiscriminating. Any two things share infinitely many properties, and fail to share infinitely many more. (Lewis 1983b, 345-6).

I interpret properties which “ground the objective resemblance” and properties that have “causal powers” to be essentially the same class of properties, which I identify as properties with direct causal relevance. Abundant properties include any feature of the world, either analytic or synthetic (using these terms loosely), as well as the sparse properties that are limited to those which have direct causal relevance. An example of an analytic ‘property’ which has no physical relevance—a feature of our mathematical systems, which is of the second type of flaw listed above—is a property ‘of an entity’ formed as a relation to a mathematical truth such as ‘ $3 > 2$ ’. Hence, it is said that the teacup may be described as ‘the teacup is such that  $3 > 2$ ’, i.e. that any physical entity has the property which is the conjunction of all mathematical truths. This may seem bizarre, but this is the meaning of non-sparse abundant properties, as described by Lewis and many others. Although some philosophers have entertained the notion that a mathematical truth might be a property of a physical object, it seems absurd to others (and myself).<sup>105</sup> I argue that such mathematical truths are properties of abstract systems, not properties of physical entities; they are not even in the appropriate domain of discourse, hence it would be a gross category mistake to even consider them as properties of the teacup and therefore potentially relevant to the topic of physical independence and intrinsicity. This point is now generally accepted, and one of the desired features of a formal definition of intrinsicity of physical objects is that it excludes such ‘properties’. However, Lewis’ comment demonstrates just how unconnected his concept of properties are to any sense of grounding in physical relevance.

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<sup>105</sup> Lewis will later limit his discussion of intrinsic properties to those which are ‘natural’, which closely relates with what I call properties that have physical relevance.

An example of a synthetic feature is ‘the height of the Washington Monument is 555 feet’, hence a synthetic abundant property of our teacup would be described as ‘the teacup is such that the height of the Washington Monument is 555 feet’. However, it is conceivable that there may be some physical relevance between the teacup and the exact height of the monument, so we need to consider this property as a candidate for being either intrinsic or relational to the teacup. In the literature of independence and intrinsicity both the analytic and synthetic properties of a teacup are categorized as relational properties, hence are not intrinsic to the teacup, hence the teacup would not be considered to be entirely independent since it has relational properties. Since any physical object has such relational properties (with or without physical relevance to the particular problem at hand) and even excluding analytic truths, no physical object in the actual world may be considered independent. Now, we imagine a duplicate that is isolated in a possible world with no other entity or phenomena, hence is ‘unaccompanied’. But what is duplicated must be only the single entity, without anything ‘outside of itself’; the duplicate must have only the intrinsic properties of the original. The problem remains that we cannot know which properties are intrinsic until we duplicate only the intrinsic properties and isolate the object’s duplicate, but we don’t know which properties to duplicate, so we are stuck in circularity. One possibility might be to simply put our imaginary finger on the object, say ‘duplicate this object’ or simply remove everything else, but then we would have to formalize what we mean by ‘this object’ and ‘everything else’. Intuitively, this could be a simple process, especially for simple entities. Yet to formalize it in a generally applicable fashion requires detailed physics of the composition including the precise boundary between ‘inside’ and ‘outside’, i.e. what is internal and

what is external. This would require trusting physics, and is precisely what some philosophers do not do, as we shall see below. It also is just not as easy a process as one might imagine, as we shall see later in *Chapter Four: Metaphysics of Composition* and *Chapter Eight: Physics of Composition*.

Abundant properties are those that correspond to any predicate that can be applied to an object or phenomenon, without limits to relevance, purity or combinatorial procedures found in the calculus of first order logic. However, allowance of such abundant properties to the carefully formalized distinctions between intrinsic and extrinsic is what produces fallacies when faced with ingenious “designer” counter-example properties meant to contradict the definitions (Figdor 2008, 6). Sparse properties don’t entail such problems. Sparse properties are also called ‘basic’ or ‘natural’, and it is the latter term that is used more often in this context. But which are the sparse or natural properties?

Once confined to the domain of discourse of physical relevance which determines the sparse from the abundant properties all we have to do is decide which of the sparse properties are intrinsic and which are relational. However, in order to determine such relevance and then to determine which properties are intrinsic we would have to apply physics. In order to apply physics we need an epistemic framework that can establish trust in physics, and we do this in *Part III: Physics*. Hence, until we get to Chapter Six we are confined to mostly conceptual analysis with bare hints of what I argue is actually needed.

For now, we attempt to work out the criteria that the definition of such a domain must satisfy. I propose a first order informal litmus test for determining the class of

intrinsic sparse properties: A property is intrinsic and sparse iff when we destroy the object then the property is destroyed and when we destroy the property then the object is destroyed, which may be interpreted as the object necessarily transformed into something entirely different, with different intrinsic properties. Note that other objects which have a physically relevant relation to our destroyed object could also be significantly changed. There is a symmetric dependence of each entity involved in a causal relation, as expressed in Newton's Third Law of equal and opposite reactions.<sup>106</sup> Abundant non-sparse 'analytic' properties such as the ' $3 > 2$ ' are not changed if our teacup is destroyed.

The idea behind this informal 'litmus test' is at least partially captured by the distinction between a *genuine* change compared with a *mere Cambridge* change, as initially described by Geach (1969, 71-72) and discussed by Chisholm (1976, 127), Kim (1982, 59-60) and Lewis (1983a). A genuine change of an object's properties is one that involves a change of properties that are in some sense internal, intrinsic, relevant, or inherent in an object itself. A mere Cambridge change involves changes in properties that are in some sense external, extrinsic, or in virtue of something that is relevantly independent of the properties of the original object and of the object itself. Rest mass of an entity, for example, is generally considered to be intrinsic to that entity in the domain of classical (relativistic or non-relativistic) physics and some quantum domains.<sup>107</sup>

Consider the mass of pebble  $P$  in relation to the mass of rock  $R$ . A *genuine change* of  $P$  in

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<sup>106</sup> This is the first example of symmetry and conservation relationships to the physical world, which will become important in our analysis of the conserved quantities approach to defining causality in *Chapter Eight: Physics of Dependence*. There we discuss more domain sensitivity to some intrinsic properties.

<sup>107</sup> While it may be relational in domains of quantum field theories, as discussed in *Chapter Eight: Physics of Composition*, and in domains of general relativity as discussed in *Chapter Nine: Physics of Change*.

‘relative mass of  $P$  to  $R$ ’ results from changing the mass of  $P$ .<sup>108</sup> A mere Cambridge change of  $P$  in ‘relative mass of  $P$  to  $R$ ’ results if the mass of  $R$  is changed. The latter would, however, result in a genuine change in the ‘relative mass of  $R$  to  $P$ ’.

Hence, a genuine change of  $x$  requires change of intrinsic properties of  $x$ , while a Cambridge change in  $x$  would involve a change of intrinsic properties of another object to which  $x$  has some relationship. The latter would therefore result in only relational changes in  $x$ . Recall that we are dealing only with “sparse” properties here, so any changes to such properties that may be candidates for being intrinsic must be changes describable within a relevant domain of scientific discourse of relevant and causally physical properties.

In this sub-section we discussed one of the most important concepts of the dissertation: grounding in physical relevance. I have argued and will further argue that if we wish to understand the physical world then we must ground the discussion firmly in such relevance, and to do so requires consideration of our best physics theories as understood by a highly plausible epistemic framework which would allow application of those theories in order to ground the discussion. In this sub-section we discussed two important factors that must be understood in order to ground the discussion accordingly. The first is the distinction between sparse and abundant properties: The former are properties which are based on causal, physical relevance and the latter is more inclusive.

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<sup>108</sup> This mass change could perhaps be accomplished by combining it with other masses through chemical reactions, for example, and ignoring the view that would identify it now as a different pebble. Later we approach the idea that intrinsic properties cannot change, but we still may have a genuine change if an accidental property of the entity changes, for instance the color of paint on it, or some secondary accessory which is not unchangeably intrinsic but is still a property of the entity. The primary-intrinsic and secondary-accidental distinction could be the basis for natural kind vs. particular member of the kind. Drawing the line between an intrinsic property—which in this chapter is considered to be internal and independent of the external environment—and an internal property which is not truly intrinsic, like an accessory, will remain a sticky point until we look at natural kinds through the lens of physics and philosophy of physics.

The second distinction is that between a genuine vs. a merely Cambridge change in an entity: The former is a change in the entity's sparse properties which might be classified as 'intrinsic' if we had a better handle on what that term means, while the latter is a change of a property of some other entity which entails a change of relational property of our entity but which could not reflect a change in an intrinsic property of our entity. We still rely on use of that term—intrinsic—and now we turn to an investigation of a similar term, 'natural', which might elucidate our use of intrinsic, and the associated concept that is frequently used in this literature: 'natural kinds'.

#### ***B.4. Natural properties, natural kinds and physical relevance***

If the sparse properties—those properties that have direct, causal relevance, be they intrinsic or extrinsic—are defined in certain ways in distinction from other non-sparse properties, it is found that those sparse properties will not produce counterexamples when testing the formal definitions of intrinsic and extrinsic. This means that we can have a precisely phrased and perhaps clearly understood definition of intrinsicity, as opposed to just relying on intuitions which may vary from person to person. Sparse properties defined in this way are called natural, and we are told by metaphysicians and physicists alike that it is physics which provides the inventory of natural properties from the inventory of 'natural kinds'.

According to the intrinsicity literature, natural properties are the properties that objects categorized as members of natural kinds share with others in their kind. Previously, we have occasionally used an ill-defined notion of natural kinds as classes of entities which are distinguished by intrinsic properties—if there are any—and which may have different properties in different domains. This, of course, makes the definition of 'intrinsic' pluralistic and domain-specific, hence we emphasize the 'local' nature of the

classes, i.e. specific to domains, rather than the global nature which ‘natural kinds’ usually implies. At this point, since the literature refers to natural kinds, we must approach some understanding of the relationship between our ‘classes’ and these kinds, although the pluralism of domain-specific intrinsicity and natural kinds will be worked out more fully in further chapters.

According to the intrinsicity literature the kinds are natural, in that the categorization boundaries are not a matter of convention, but are determined by physical properties. The sparse properties are natural: “...they carve at the joints, they are intrinsic, they are highly specific...there are only just enough of them to characterize things completely and without redundancy” (Lewis 1986, 60). Physics has a list of “‘fundamental physical properties’” (Lewis 1986, 60), and that list is ever-expanding. This is the list of natural properties that distinguish the natural kinds of fundamental physical entities. These are the intrinsic properties. A typical example of natural kinds classification is the periodic table of the elements. For instance, hydrogen—including all three of its isotopes—is the natural kind category of matter containing only atoms with only one proton. This is not a convention, nor does it have an indistinct boundary like many biological kinds. According to the realist view of natural kinds, the classification is apparent in nature and we just pick it out, hence it is called ‘natural’. Thus, in that view natural kinds are ontological, and are used in discourse and explanation. Concerning natural properties, Lewis writes:

The name is borrowed from the familiar term ‘natural kind’; the contrast is meant to be with unnatural, gerrymandered, gruesome<sup>109</sup> properties. The name has proved to have a drawback: it suggests to some people that it is supposed to be

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<sup>109</sup> Something that is green until a certain date and then becomes blue, such as an emerald, for no other reason than the date, a construct of Nelson Goodman.

*nature* that distinguishes the natural properties from the rest; and therefore that the distinction is a contingent matter, so that a property might be natural at one world but not at another. I do not mean to suggest any such thing. A property is natural or unnatural *simpliciter*, not relative to one or another world. (Lewis 1986, 60-61 fn 44).

As Taylor, who responds to Lewis, states it: "...at least some predicates stand for *natural properties*: they record objective cleavages in nature, schisms in things independent of human psychology or convention, marking entirely mind-independent similarities between things" (1993, 81). The objective and non-contingent nature of such properties is central to understanding them.<sup>110</sup>

Now that some notion of the naturalness of properties is indicated, if not precisely defined, Lewis can express the restrictions with which he will attempt to take us out of the definitional circularity: "On my analysis, all perfectly natural properties come out intrinsic. That seems right" (1983b, 357). This is a very potent statement, yet it may be the case, as suggested by Madhyamaka arguments, that what we normally call natural and intrinsic (hence independent) are actually relational (hence dependent), at least comparing across domains. There are some intrinsic properties sometimes called "powers" which are natural and internal to an entity yet entail relationality, such as rest mass, charge and spin. For example, we generally consider mass to be an intrinsic property of all matter (although this may become complex in domains of quantum field theory).<sup>111</sup> However, every mass affects all surrounding masses by warping that region of

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<sup>110</sup> However, the epistemic issues that must be considered, viz. how we know which properties are natural, will of course be quite problematic.

<sup>111</sup> We will discuss this further in later chapters, but for now a foreshadow may be helpful: In domains of classical mechanics the rest mass of an entity, such as a block of iron, is a given intrinsic property of that entity relating to the quantity of matter. Take off a chunk, and the mass changes, but that does not change the intrinsicity of that property to the amount of matter prior to or after taking off the chunk, just the precise value. The concept is more that given what the matter is made of we know precisely what the rest mass is. In an attempt at a reductionist derivation, the rest mass of such an block of iron is based on the

spacetime (although we may simply use the Newtonian description and say that a gravitational field accompanies the mass). The warped spacetime (or gravitational field) in turn necessarily changes all surrounding masses. After Teller, we call this *intrinsic relationality*. From the Madhyamaka point of view it could be called interdependent arising (*pratitya-samutpada*). In other words, it is the nature of things that they are relational. Teller uses the term for quantum particles, but I propose that it is appropriate in other domains as well. An intrinsic sparse property with causal relevance that could be called intrinsically relational is the electromagnetic field. Charge is intrinsic to an electron, it is a state-independent property, and one of the electron's characteristics is to 'have' an electromagnetic field. The field is by its nature interactive, both with other charges and even with the electron itself. Thus, the electron is intrinsically relational.

In this sub-section we further discussed natural kinds and the associated concept naturalness of properties. In the metaphysics literature of intrinsicity the naturalness of some properties and kinds is assumed, but left for physics to inventory. However, those same analysts demonstrate a distrust of physics, which we examine next.

### ***B.5. Distrust of physics***

We rely on physical and causal relevance to define the class of sparse properties—especially in *Part III: Physics*. I argue that this is what is entailed by use of terms such as 'naturalness' in the philosophic literature of intrinsicity. In Part III we

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number of iron atoms which each have their own intrinsic rest mass, added to the mass of the bonding energies, plus the relativistic mass of atomic motion. Hence, the intrinsic property of mass of the iron natural kind is also a function of its temperature, which entails a change in the motion of the atoms in the block. The rest mass of the atoms comes also from the rest mass of their components plus their bonding energies plus the relativistic mass of the motion of the components. The rest mass of a hadron, e.g. a proton, is largely the relativistic mass of its quarks. In this way we find how in different domains mass must be considered partly intrinsic and partly relational. I argue that this attempt at a reductionist derivation demonstrates the necessity of a pluralistic understanding of at least some intrinsic (state-independent) properties, and provides further indication of what I mean by 'intrinsic relationality', discussed further in the physics chapters of Part III.

determine that within any particular domain, some of those properties may be intrinsic; some may be relational, and some may be intrinsically relational. However, we will also show how even those properties that are intrinsic in one domain are relational or intrinsically relational in others, thus demonstrating the cross-domain relationality that we have been offering as a way of understanding the Madhyamaka claim that all phenomena are relational.

However, this reliance on physics must in turn rely on a clear understanding of theories and empirical content of physics. That reliance flies in the face of much of analytic metaphysics on the topic of intrinsicity. Analysis in much of the contemporary metaphysics literature describing independence and intrinsicity of physical phenomena displays on the one hand an attempted balance between *a priori* conceptual analysis which presumably is embodied in what are imagined as our commonly-held intuitions, and on the other hand inclusion of the least amount of physical science which cannot be avoided. However, we determine such attempted balance to be significantly pathological, as extensively discussed by Ladyman and Ross (2007). The pathology is due to some analysts' demonstrated implicit and explicit lack of trust in modern science combined with their need to include some science:

If we relied on our physical theory to be accurate and exhaustive, we might think to define duplication in physical terms. We believe that duplicates must be alike in the arrangement of their electrons and quarks – why not put this forward as a definition? But such a 'definition' is no analysis. It presupposes the physics of our actual world; however physics is contingent and known *a posteriori*. . . Nor does it capture what those ignorant of physics mean when they speak – as they do – of duplication. (Lewis 1983b, 356).

Several points referenced here require my comment. First, while we will consider what is possible within this actual world, which translates into consideration of possible worlds,

what is only possible within the infinitely flexible and physically impossible-to-instantiate imagination of some philosophers will not be given much attention in this dissertation. For instance, imagining a possible world in which everything is the same except one thing, e.g. that salt is not soluble in water, generally entails a change of just about everything, and certainly does in this example.<sup>112</sup> In this actual world, some things, e.g. many laws of nature, are necessary, not contingent—although they may be dependent on context, i.e. domain. Natural laws and their necessity are further discussed in the physics chapters.

Second, this dissertation is designed for those who either are not ignorant of physics or who are at least open to finding out what it has to contribute. We justify this designation and attempt to dispel distrust of physics in *Part III: Physics*. By itself, such distrust would not be pathological, and might even be wise. However, it becomes pathological when some science but not the best science is included in the analysis. The pathological nature of this distrust can be seen when we recognize a contradictory set of practices that appear in the analysis of many of these philosophers. (1) They do not reject all physical science, since to discuss physical things requires inclusion of some kind of understanding of science, either explicitly or implicitly. (2) Their distrust of science is explicitly based on historical changes in theories: since (we are told) we now know that

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<sup>112</sup> See Bird (2001, 2002) in his responses to Kripke (1980) and Bird's argument that laws of nature are not contingent but necessary. The conclusion to that debate which I take from it is that the practice by some metaphysicians of changing just one property in order to compare possible worlds may be impossible. For example, consideration of a world that is identical except that salt does not dissolve in water entails a change in either the structure of electrostatic attraction or at least values of its constant, and that would entail a completely different universe, probably one in which no atoms formed after the big bang. Thus, at least in our universe, it is necessary that salt dissolve in water. I would argue that such imaginary impossible worlds belong to the realm of speculative fiction, similar to alternate histories where Nazi's won WWII, rather than philosophy. That is because events of the actual world are śūnya, i.e. interdependent, through place and time, and any change might change everything..

those older theories were false (although I take some issue with this comment in later chapters), how can we believe what physicists currently tell us? (3) They utilize either only a modest level of pre-18<sup>th</sup> century classical physics which is drastically incomplete by today's standards, or outdated and rejected theories of atomic physics, thus accepting what they reject under (2).<sup>113</sup>

Yet do we really need to rely on such controversial frameworks as Physics Pluralism? Many of the philosophers discussed in this chapter say not only that we need not, but that we should not. Lewis, in his (2001) defense of his joint suggestions in Langton and Lewis (1998), discussed below, offers that “The vegetarian<sup>114</sup> conception [of an ontology of properties] that meets our needs is one in which properties are natural to the extent that they—more precisely, predicates expressing them—play the central and fundamental classificatory role within regimented physics (or perhaps within future unified science)” (Lewis 2001, 382, n. 5). Lewis isn't promoting relying on physics, because he rejects the idea that we have or perhaps will ever have a complete physics that can be used. What he is suggesting is that with his and Langton's general, philosophical definition of intrinsicity relying on the associated notion of naturalness, supplemented with some complete physics someday to determine the inventory of natural properties, we will eventually be able to specify what properties are intrinsic. Witmer et. al. (2005, hereafter WBT) point out that it is impossible to rely on naturalness because “our judgments about which properties are intrinsic end up, on this account of naturalness, being defeasible on empirical grounds in a way that seems plainly inappropriate” (WBT,

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<sup>113</sup> Later we see that the use of accepted, mature and well-understood physics theories within their confined domains where we know they are valid as interpreted by Physics Pluralism is a necessary part of any coherent metaphysical analysis in the context of physical phenomena.

<sup>114</sup> Which I believe means commonplace, but lacking in meat, i.e. substance—or something similar.

329). They defend this view by suggesting a property that is physically unlikely to be an intrinsic or natural property of our object, e.g. considering the object as our teacup and the property as the exact height of the Washington Monument,<sup>115</sup> and then pointing out that this property could be considered natural “if and only if it could turn out that this property plays a central and fundamental classificatory role in physics or some successor, unifying theory [and also relates with the nature of our teacup]. We can see no way to rule out such a role... We find this an absurd consequence.” (WBT, 330) Hence, if we rely on the idea that we can use eventually accepted and unified physics, then any property that could potentially come into play as causally relevant in some imaginary instantiation of that physics—such as the height of the Washington Monument—must be included as potentially physically relevant, and possibly natural and intrinsic. While we would not call this absurd, but rather simply keeping an open mind about what we may discover in the future, it certainly is a serious barrier to excluding any property as candidates for being intrinsic. It is a criticism of any proposed dependence on current or future physics in order to determine the inventory of what properties are intrinsic and what entities are independent: How can we possibly know what factors may someday be determined to be relevant in a future, perfected physics?

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<sup>115</sup> Actually, WBT’s proposed example is “being either a lonely solid or an accompanied liquid”, which satisfies the independence of accompaniment criteria in that this property is independent of being lonely or accompanied—the object can be solid if lonely and liquid if accompanied. They then say that this could conceivably be intrinsic in some future completed physics. But actually, if a liquid on Earth (accompanied) is then put in space with no external source of heat (lonely) it will become solid. So, we need not project into a future physics. I therefore changed the example to make it less realistic to be physically, causally relevant to my teacup, at least in current physics. However, it doesn’t seem that their example is of an intrinsic property, even though it passes the independence of accompaniment criteria, since its state (solid or liquid) is entirely dependent on external factors, hence relational, yet even though relational its behaviour given those external factors is entirely determined by its internal composition and structure, hence intrinsically relational.

In later chapters we will see how reliance on a future physics is not necessary: There are many phenomena that are sufficiently explained by several physics theories that are complete and entirely acceptable within their well-defined and well-understood domains, in that the theories provide a comprehensive explanation of the phenomena of their domains and the referents of their relevant terms refer to actual features of the world. In this chapter, however, we try to find out if there is another way that proves less controversial. Again, this is attempted in the literature through the analytic process of creating a duplicate entity placed in its own possible world and making sure that the only properties it can possibly have are those that are intrinsic, and it is to more detailed examination of that process that we now turn.

### ***B.6. Duplication 2***

The formalization of intrinsicity by Lewis (1983a) is attempted through the technique of analytically placing an imaginary duplicate in its own possible world. We will see that the evolution of this technique is a two-step process. First, if a duplicate is made of a given object, yet the environment in the duplicated possible world is void of other objects (hence the object is now called ‘lonely’), hence we are told that all the lonely object’s properties will be intrinsic, since there is nothing to have relations with. The second stage is to realize that what we need is assurance that the properties are independent of accompaniment altogether: Intrinsic properties are not changed if they are either accompanied, (i.e. if there are other entities nearby) or if they are lonely (i.e. if there is nothing else in the universe). They have what Yablo calls “stability under variation,” as previously mentioned.

First, we define intrinsic properties as those that belong to a lonely duplicate. However, as previously mentioned, while the properties that belong to a lonely duplicate

must be limited to the intrinsic properties of the original, we do not know what properties to duplicate without knowing which are intrinsic and which are relational: we cannot define intrinsicity by that which is possessed by the lonely duplicate without first knowing what is intrinsic. Thus we are still caught in circular definitions. Kim attempted to define intrinsic properties as those which are internal, and Lewis adapted it to his purposes, but the circularity still obtains. In common analysis of the duplicate, even its loneliness and its accompaniment are both considered relational properties *of the duplicate*, thus isolation of the duplicate in its lonely world entails relationality.

Frankly, I argue that it is quite strange to classify loneliness as a relational property of the entity's duplicate. Lewis (1983, 199) justifies this classification by saying that while some extrinsic properties are positive, in that they are actual properties of physical relationships, loneliness is an example of a negative extrinsic property. By this he means that an object's loneliness implies that there is no other object, and that lack of object is an extrinsic property. Clearly, if there is another entity in the possible world with the duplicate, then the duplicate will have a relation with that other entity, physically relevant or not. However, if our duplicate is all alone in the world, it will have no relationship with any other entity. I argue that classifying its loneliness—its lack of relation—as relational is reifying our classification as a property of the duplicate, while in actuality the classification has nothing to do with the duplicate and more to do with our own semantics. This entailment from semantics to ontology is a symptom of a deep malaise in some metaphysics analysis, as pointed out by Ladyman and Ross (2007). I find this particular instantiation of the malaise similar to reification of *sūnyatā* as the lack of inherent nature being an inherent nature: Considering the lack of inherent nature as an

inherent characteristic is a mistake, rather than realizing that the lack of inherent nature itself lacks inherent nature. Establishing the view of *the śūnyatā of śūnyatā* is a significant part of Madhyamaka arguments, as discussed extensively in text and commentary. Chapter 24 of Nāgārjuna's MMK is relevant here.

Nonetheless, what can be used from these discussions is the reasonable requirement to find the properties of the duplicate—or rather the properties of the original entity—which are independent of either accompaniment *or* loneliness and therefore stable under arbitrary variation of its environment. The characteristics which never change, regardless of the environment (at least while the entity exists), are the intrinsic characteristics. Langton and Lewis (1998) respond to Kim by refining these concepts and attempting to open up the circularity in a way that captures these intuitions about intrinsicity. WBT<sup>116</sup> provide motivation for these steps and the duplication process altogether by noting that we need to not “focus on the idea that intrinsic properties are independent of *the way* other things are” but rather to “focus on independence from *whether* other things are—that is, on independence from whether other things exist in the first place” (WBT, 327). Langton and Lewis provide five steps for this focus. First, they focus on the first two steps and their conjunction: (1) An intrinsic property is had whether or not it is lonely or accompanied, i.e. it is independent of accompaniment; and (2) the loneliness of a thing is not what makes its properties intrinsic. Rather, the properties are intrinsic and therefore are unchanged and independent of being accompanied or being lonely. We can then derive the following condition: (1+2) “having or lacking the property is *independent* of accompaniment or loneliness” (334). This means that a lonely thing can have or lack the property and an accompanied thing can have or lack the property.

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<sup>116</sup> Witmer et. al. (2005).

It should be noted that they are limiting the discussion to the ‘pure’ or qualitative properties: ‘Impure’ or haecceitistic properties, the ‘thisness’ of particular things, are excluded. Hence, we are looking at the generic characteristics of what they call natural kinds, not the specific properties of particular instances of those kinds. They are also not including ‘case-referential’ properties made from explicit references to the four cases in (1+2). The four cases are having the property and having accompaniment; having the property and being lonely; not having the property and having accompaniment; and not having the property and being lonely. WBT also does not include disjunctive properties like the one we will call *D*: “being either cubical and lonely or else non-cubical and accompanied.” All of these ‘impure’ properties are considered somewhat pathological and we must find some way to exclude them when we formalize our intuitions. The most insidious issue is what is called ‘the disjunction problem’. It is pointed out that the above disjunction *D* can only be considered intrinsic by stretching our intuitions beyond their intended usage, yet it passes the four cases of (1+2):

If a property is independent of accompaniment or loneliness, its negation also is independent. Yet if a property is intrinsic, so is its negation; and if a property is not intrinsic, neither is its negation. So we would expect trouble with negations of disjunctive properties. The property of being neither cubical and lonely nor non-cubical and accompanied is independent of accompaniment or loneliness: all four cases are possible. Yet it is not intrinsic. So the definition proposed so far fails in this case too. (Langton and Lewis 1998, 335).

In response to this failure Langton and Lewis pull what I call a ‘fast one’, a sleight of hand which, admittedly, has some traction with me in the face of some philosopher’s insistence on using any imaginary abundant properties. Langton and Lewis appeal to the need to talk about natural, sparse, physically relevant properties only, distinguished from the unnatural abundant properties (discussed above). If we do not

grant such a distinction, they go so far as to “say farewell to those who will not make so free, and carry on without them” (336). While this might superficially appeal to my physics intuitions, it smacks of arrogance and ignores the realities: We really cannot know what physics will discover; how complete it is now or can be; and what actually might divide natural from unnatural or physically relevant from irrelevant, until such time as we are 100% confident in our complete physics. That certainly is not the case now, and most probably never will occur. Can our philosophy be immune from such doubt? It is both the frustrating part of analytic metaphysical investigations and the benefit of it that such lingering doubt must be attended to. I will answer these objections with Physics Pluralism in Chapter Six, but before that is presented and justified we should not simply assume the problems away.

With these limits in mind, and especially their insistence that we must accept characterization of natural properties, Langton and Lewis try to break the synonymy circle that we are stuck in when defining *duplicates* as things which have the same intrinsic properties and defining *intrinsic properties* as those which never differ between duplicates. To break the circle they define *basic intrinsic* with the next of their five steps: (3) A property is *basic intrinsic* if it is independent of accompaniment or loneliness. Then (4) “Two things are (intrinsic) duplicates iff they have exactly the same basic intrinsic properties” and (5) “a property is *intrinsic* iff it never can differ between duplicates; iff whenever two things (actual or possible) are duplicates, either both of them have the property or both of them lack it.” (337)

Here is a concrete example of my own which may become a bit complicated, but hopefully will serve to demonstrate both how it fits with WBT’s analysis and how it does

not. Consider a rock as a prime and somewhat simple example of a physical, non-living entity—an example that we shall see much more of throughout the dissertation. First we would need to determine what is internal to the rock and what is external. However, its mass carries with it a gravitational field that is generally considered to be external, but is intrinsically part and parcel of the rock. Any mass in the universe warps the regions of spacetime near it (in general relativistic terms), and that is what we call a gravitational field if we are in domains of Newtonian physics. Since any mass always has such a field all around it, or in other words the mass has such an effect on local spacetime, regardless of where the rock is and what other objects are or are not accompanying it, then it is clear that this is an intrinsic property of the rock. It actually is part of what it is to be a rock. According to the general theory of relativity, to have mass means to warp spacetime. This intrinsicity is contrary to an interpretation of Madhyamaka which denies that there are any intrinsic properties. I am arguing that there most definitely are, however I apply a pluralistic analysis to show that many intrinsic properties are relational when considered in cross-domain analysis.<sup>117</sup>

Confining ourselves to classical domains, even with general and special relativity, a duplicate rock will be identical to the original in having mass and its accompanying warp of spacetime, but have nothing of the ‘external’ environment of the actual world—the spacetime of the new possible world would have to be a ‘different’ spacetime, with no other entities. Regardless of whether there are other entities or not, this duplicate will have all of its properties independent of either loneliness or accompaniment, since we can

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<sup>117</sup> Below I define intrinsic as requiring the property to be necessary and essential. The warping of spacetime around a mass, or in other terms the gravitational field of a mass, is an intrinsic property of any matter because it is necessary—in that to have mass necessarily entails that it has a field—and essential—in that the mass cannot be a mass without having a field. Physics shows us that intrinsic properties such as these exist.

say that those properties of the rock (mass, composition, hardness on an objective scale, etc.) would be duplicated and would not change whether or not the rock is accompanied by other entities. Spacetime in the new possible world would then be warped just as in the actual one. Hence, those properties are basic intrinsic. It may therefore not be difficult to determine which properties are intrinsic and which are relational. However, it does require some physics to do so, some way to determine what properties are ‘natural’ to the rock which form the inclusion criteria of properties to define the natural kind—if this can be defined consistently—of which the rock is a member, and to distinguish the particular within the kind.

Additionally, there is the problem of spacetime in domains of quantum field theory. Consider the physical duplication process. Picture our solitary rock, alone in the universe. Is there space? Without space there is no meaning to the situation at all. But quantum field theory describes a vacuum quantum field which permeates all of space, or is space, depending on your point of view. For any object that exists in ‘space’ then there is interaction with the space: Higgs particles congregate around our object’s massive particles and virtual charged particles congregate around the charged particles of our object. It is hard to imagine how the rock, e.g. its atoms bound by EM fields, could be duplicated without the Higgs field of the surrounding space, but it is also hard to say that the Higgs field is part of the rock. In some sense, since Higgs fields permeate the vacuum in our old actual and also in our new possible world, nothing can be lonely, ever, anywhere, in any possible world, at least when we consider all domains.

The five steps of Langton and Lewis result in as strong and clear a notion of independence as can be found, yet they rely on a concept of naturalness and therefore

natural kinds and should rely on physics. However, naturalness and natural kinds is a concept that is too rooted in physics for some philosophers, and they propose instead to use the idea that intrinsic properties of an object are had *in virtue of* being that object, and they think that this will obviate our reliance on naturalness. We need physics to operationalize naturalness in order to categorize the natural kinds which is the fundamental concept upon which naturalness of properties is based. Determination of natural kinds requires knowledge of causal relationships, but we have to exclude externally dependent causal relationships and only include internal causal relationships, so we have to distinguish internal from external. Causally relevant, internal, natural properties are sometimes called ‘powers’, or ‘dispositions’, but these terms do not change the fact that we have to figure out what they are. Only then can we operationalize ‘loneliness’ from our operationalization of naturalness as something like ‘in the presence of no causal influences outside of itself’. However, the requirement for operationalizing *naturalness* will continue to be objectionable to many philosophers. We discussed naturalness previously, and now we turn to an examination of *in virtue of* as a response to the inability to isolate what is natural without reliance on ‘too much’ physics.

### ***B.7. In virtue of***

WBT attempt to cleanse intrinsic properties of naturalness by relying instead on the *in virtue of* locution. They prefer this notion to naturalness, which they say is—along with natural kinds—insufficiently understood and can also be avoided. Note that their analysis is informed by the commonly found mistrust of current physics as being either false or at the very least incomplete.

WBT react to a response by Lewis (2001) to a suggestion by Marshall and Parsons (2001) that naturalness has too high a cost. Lewis writes:

Dan Marshall and Josh Parsons have misgivings about the very idea of judging comparative naturalness. Well, anyone should prefer to do without these judgements, since they rest either on contentious ontology or on a primitive distinction. But such judgements are in fact made, often with confidence, and if you had to do without them, inability to define “disjunctive property” or “intrinsic” would be the least of your worries. (Lewis 2001, 381-2).

WBT argue that “It’s on all hands agreed that an appeal to ‘naturalness’ is a theoretical cost that should be avoided if possible. The question is if it *can* be avoided” (328). They say that Lewis’ perspective is misleading: it is not a question of calculating cost and benefits of using naturalness. “Rather, the problem is a matter of having no clear concept of the costs and benefits of which can even begin to be assessed.” (WBT, 329) They note that Lewis earlier (1983b, 356-7 and 1986, 60-61) and Langton and Lewis (1998) were neutral on how to decide what properties were natural, but simply assumed that some theory of properties using an ontology of sparse universals or sparse tropes could be used. But that wish, WBT point out, is not sufficient to proceed.

They also reject another approach, from Lewis (1983b, 13) where Lewis suggests that some “elite” natural properties could be picked out by using universals such that those properties determine resemblance between two objects. WBT point out that this really means “*resemblance with respect to intrinsic properties*” (WBT, 331), which bring us back to circularity:

We maintain that (i) any talk of resemblance must be understood in terms of resemblance with respect to some class of properties; and (ii) the ordinary talk of resemblance which so impresses Lewis can be understood as implicitly restricted to resemblance with respect to intrinsic properties. (WBT, 331).

WBT conclude their analysis of naturalness by stating that whatever we use to define intrinsicity should be better understood than the term defined, and naturalness does not fill the bill.

In a two-stage process, WBT attempt to ground the concept of intrinsicity without relying on naturalness by first using the idea of accompaniment and then associating it with the concept of *in virtue of*. First, WBT Stage One: “Property  $P$  is intrinsic iff, for any possible individual  $x$ , if  $x$  has  $P$ ,  $x$  has  $P$  in an intrinsic fashion” (WBT, 333). Having a property in an intrinsic fashion means that the property is independent of accompaniment, i.e. the property is had by the object regardless of whether the object is accompanied by other objects or is totally lonely in its own possible world. The second stage in WBT’s formulation is an attempt to deal with the disjunction problem in a generally applicable and principled way. This is done by formalizing the idea that if the property  $P$  is not itself fundamental then any more fundamental properties upon which our property  $P$  rests is also had by virtue of properties that are independent of accompaniment. We must also try to define what is independent and intrinsic without appeal to intuition, and at least for WBT especially without appeal to intuition about what is natural, hence WBT Stage Two: “ $x$  has  $P$  in an intrinsic fashion iff (i)  $P$  is independent of accompaniment and (ii) for any property  $Q$ , if  $x$  has  $P$  in virtue of having  $Q$ ,  $Q$  is also independent of accompaniment” (WBT, 333). Pathological disjunctions are rejected due to the requirement in the second clause. We can now understand that the disjunction which we have been using as an example is formally non-intrinsic, thus matching ‘our’ intuitions. Since the property  $D$ <sup>118</sup> can be had in virtue of being ‘cubical and lonely’, which is not independent of accompaniment (since it is lonely, it cannot be accompanied), therefore  $D$  is not intrinsic by the above definition. While we had intuitively felt this, now we have a formal definition that matches the intuition and does not rely on naturalness, but rather uses *in virtue of*.

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<sup>118</sup> ‘being either cubical and lonely or else non-cubical and accompanied’

But do we understand *in virtue of* any better than we understand naturalness? WBT's answer is emphatically yes. Indeed, it has been used during previous analysis, although it has not previously been seen as being any better understood than intrinsic. Lewis, in pointing out that the class of all properties is not exhausted by being either intrinsic or extrinsic, writes:

In general, something has an intrinsic property solely in virtue of how that thing itself is; it has a purely extrinsic property solely in virtue of how accompanying things, and its external relation to these accompanying things, are; and it has a non-intrinsic but not purely extrinsic property in virtue partly of the former and partly of the latter. (If we had a clear enough understanding of 'solely in virtue of', we would need no further definition of 'intrinsic'.) (Lewis 2001, 384).

WBT respond to this by stating that “The claim here seems to be that the ‘in virtue of’ locution is both essential to understanding intrinsicity and itself in need of clarification” (WBT, 335). WBT defend their use of it against three objections, the obscurity, circularity and utility objections, and we need only focus on the first. The obscurity objection is that *in virtue of* is as obscure a notion as that of natural property. In response to this objection, WBT “freely admit that we lack anything like a definition”. However, they say that they are confident that they (and presumably we) “have a *facility* with the concept—how confidently we use it, whether we can reach agreement on its proper use in a reasonable range of cases, whether our judgments involving it are stable and not subject to inexplicable shifts, and so on.” (WBT, 336) In comparison with naturalness, WBT suggests that *in virtue of* is understood much better than the former term.

I respond that this is not necessarily the case. We still need to have some understanding of properties that are had in virtue of the entity being the entity that it is. Hence, we must understand what the entity is, and that requires some understanding of what is physically relevant to it being the kind of entity that it is, hence bringing us to a

need to understand how physicists and philosophers of physics understand natural kinds and the physics of properties of the members of that kind. Note the attempt in the second clause of their Stage Two to ground properties which are intrinsic yet derivative of more fundamental properties by requiring that the more fundamental properties also are intrinsic, i.e. independent of accompaniment. Without some foundational ground, this requirement can yield an infinite regress which may be vicious, or may again put us into circular reasoning. We find that foundational ground in empirical reality represented by *a posteriori* science, even if it is understood in a way that is shy of 100% confidence. Hence, while *in virtue of* has more ways of distinguishing sparse properties, it is no more or less obscure and no more or less in need of grounding in physical relevance than naturalness. Once we have grounded the discussion in what properties are physically relevant, we would still need to determine the inventory of what are intrinsic and what properties are relational, if indeed there is a distinction. Note that it may be quite likely that some properties of some phenomena are intrinsic throughout all domains, some may be intrinsic within some domains but not throughout all, and some may be intrinsically relational in some domains or all. Determination of this inventory would require more physics and such tasks would require an epistemic framework, such as Physics Pluralism, in order to interpret the physics theories and empirical results.

I agree with WBT that *in virtue of* has utility, within our discourse concerning independence and intrinsicality. This utility extends at least to what WBT call the intuitive understanding of “orienting characterizations”, such as the following: an intrinsic property, it is said, is one which “things have in virtue of the way they themselves are” (Lewis 1986, 61) (which is a quote used by Westerhoff referenced at the

beginning of this chapter in reference to Madhyamaka). It is a property “that is *internal* in the sense that whether an object has it depends entirely upon what the object is like *in itself*” (Francescotti 1999, 590). A property had in virtue of the object itself alone is one “just in case a thing’s having it (at a time) depends only on what that thing is like (at that time), and not on what any wholly distinct contingent object (or wholly distinct time) is like” (Vallentyne 1997, 209).

One of two themes in these orienting characterizations is that intrinsic properties do not depend on other things, and this goes to the heart of the Madhyamaka understanding according to which everything is dependent on other things, or rather that things are mutually dependent. Indeed, Madhyamaka would accept these orienting characteristics, but deny that such independent objects exist—at least unless we apply my pluralist interpretation allowing for local independence with global relationality. Another, yet similar theme in these orienting characteristics is that intrinsic properties are had *in virtue of* the way the object is in itself. However, this also would give us problems since the physical relational property of ‘being 10 feet from an aquarium’ is a property had by the object itself—that’s the way the object is. Yet, this property of the object seems to be contingent, neither essential to the nature of the object as it is, nor in virtue of the way the object is essentially. Hence, what we need is that intrinsic properties are had *in virtue of* the way the object is *essentially*, what *necessarily* makes it what it is. These are the *internal* properties, not the ones which relate to external objects like our aquarium across the room. Hence, since these orienting characterizations do not let us escape circularity without the ground of physical relevance, we try to provide formal definitions that will, by trying out essential, necessary and internal. We are not yet ready to make conclusions

concerning the relationship between the analysis we have been conducting and Madhyamaka relationality until we examine the ramifications of using those three terms.

**B.8. Essential nature: necessity and internality**

As some contemporary Western analytic metaphysicians present it, for a property to be intrinsic is only controversially related to its being essential—no consensus exists concerning the relation of these two concepts. Stalnaker (1979, 343) defines an essential property as “...a property that a thing has in all possible worlds in which it exists.”<sup>119</sup> An accidental property “...is a property that a thing has in the actual world, but lacks in some other possible world.” Yablo (1987) analyses the concept in this way: we start by making a complete profile of what object  $\alpha$  is. This immediately brings up a problem that Yablo does not mention, in that there are effectively an infinite number of properties in the complete profile that includes both abundant properties and their conjunctions. But the properties that are essential to an entity are those that are physically relevant to the entity being what it is, and being a member of its so-called natural kind, the identity criteria, “the set of all properties that  $\alpha$  possesses essentially, or what can be called the *complete essence* of  $\alpha$ ...the essence of an entity ought, one feels, to be an assortment of properties *in virtue of which* it is the entity in question” (Yablo 1987, 297). We were presented with some indications of what it means for properties of an object to be had in virtue of itself alone: That the object is independent of accompaniment and that the object has those properties regardless of whether there are other objects in the universe or not. It would

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<sup>119</sup> The way I interpret possible worlds talk is as follows: if something is said to occur in all possible worlds then it is logically necessary and therefore must exist in the actual world, i.e. it is necessary. If something is said to occur in only some possible worlds but not all, then it is logically possible in the actual world, but not necessary.

seem that those properties would also be the essential and necessary properties, if we could relate these concepts to each other and to intrinsicality.

As mentioned, Moore (1917-18) defined an internal property in the following way: *P* is *internal* to *a* iff  $(x)(x=a)$  entails *Pa*, or “anything which were identical to *A*, would, in any *conceivable* universe, necessarily have [*P*]” (Moore 1919-1920, 54, italic mine). In a paper that has received a lot of attention, Fine (1994) also takes this to be the definition of an essential property. Hence, given that a particular entity *x* exists, if we know there is a necessary material implication from its mere existence to the fact that *x* has the property *P*, then *P* is an internal and essential property. I interpret this condition not as an analytic one, but more synthetic—although Moore perhaps considered it analytic—since it requires physics to determine, and therefore I would modify Moore’s conceivability criterion in his definition to ‘...in any *physically realizable* universe...’ in order to ground our analysis in physical relevance. This criterion would determine the properties and entity to be independent of accompaniment, hence can connect us back to the previous formalizations of intrinsic and internal. There is one wrinkle yet to iron out, though, in that Fine rejects one leg of the entailment between essence and necessity that is part of the modal aspect of essentiality: While if *P* is an essential property then it is necessarily a necessary property, Fine rejects the idea that a necessary property is necessarily essential. How could this be the case? It is due to Fine’s inclusion of various kinds of properties that we have already excluded: abundant and physically irrelevant properties, including abstract sets, necessary truths and physically irrelevant relationships.<sup>120</sup> Excluding these, as supported by previously presented arguments and

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<sup>120</sup> One of these latter are global existential entailments, described in the following way: “Among the necessary truths, if our modal theorist is to be believed, are statements of essence. For a statement of

further suggestions of Lowe (2008) and Shalkowski (2008),<sup>121</sup> necessary properties and essential properties become mutually entailing.

We still have to use physics to itemize the inventory of internal, essential and necessary properties that satisfy the material implication. Lowe writes: "...if X is something of kind K, then we may say that X's *general* essence is *what it is to be a K*, while X's *individual* essence is *what it is to be the individual of kind K that X is*, as opposed to any other individual of that kind." (Lowe 2008, 35). This definition restricts us within the potentially infinite Yablo-profile list of properties that an individual might have, confining the profile to those which relate to its particular or general kind of thing.

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essence is a statement of necessity and so it will, like any statement of necessity, be necessarily true if it is true at all. It follows that it will [be] part of the essence of any object that every other object has the essential properties that it has: it will be part of the essence of the Eiffel Tower for Socrates to be essentially a person with certain parents, let us say, or part of the essence of Socrates for the Eiffel Tower to be essentially spatio-temporally continuous. O happy metaphysician! For in discovering the nature of one thing, he thereby discovers the nature of all things" (Fine 1994, 5-6). See Also Fine (2007)

<sup>121</sup> Pertaining to the first two of those types of properties excluded from Fine's analysis Shalkowski criticizes the primacy of formal semantics which seems to be part and parcel to the formalization of the distinctions between intrinsic and relational that we analyzed in this chapter: "...the mistake the serious essentialist's critic is prone to make is to confuse the task of formal semantics with philosophical insight. The merits of the familiar extensional semantics are many and well-known...It is a mistake, though, to think that there is something sacrosanct about the tacit framework of the semantics for fruitful philosophical theorizing" (Shalkowski 2008, 52). The use and misuse of formal semantics is a large topic that would rapidly take us outside the scope of this discussion. I agree that flaws in formalization of an intuitively understood concept frequently indicate flaws in the formalization procedure as much as flaws in our grasp of the concept.

### **C. Conclusion**

Abstract mathematics is a perfect example of *a priori* reasoning that is quite successful. However, in order to apply it to the physical world an interpretative framework must be adopted that represents the *meaning* of mathematical ‘scratches’ on a paper as applied in the actual, physical world. We uncovered serious flaws in much of the metaphysical analysis referenced in this chapter due to what I identified as a pathological desire to maintain the purity of *a priori* metaphysics that should be applicable to all possible worlds, without reference to what is actual in our one physical world, as explicated in Section B.5.

I call the use of physics theories as the empirical foundation upon which to stop the circularity of conceptual analysis ‘grounding in physical relevance’. I argue that there is need for such grounding in Madhyamaka analysis as much as for Western metaphysics. Such grounding is cashed out as knowledge of the causal relationships, or what may be called powers, dispositions and physical characteristics. We have been calling them the intrinsic, internal, necessary and essential properties of the object. These are what make that entity—or at least those aspects of the entity—independent of any relational, external, accidental and inessential properties and entities. It remains to be seen if there are any intrinsic and non-relational properties, or if the alternative is true, that any physically relevant property must necessarily be relational. In other words, we do not take ourselves to have refuted the existence of intrinsic properties absolutely, hence there is the possibility of entities possessing causal independence—that they do not interact—(the first component of inherent nature), hence our investigation continues. However, that investigation would require first trust in physics and then use of physics, both of which

will be discussed in *Part III: Physics*. The current exploration of metaphysical analysis of one component of Madhyamaka—causal dependence on other entities—has provided us with criteria to examine any proposed inventory of intrinsic properties in order to enable more confident judgment of their independence, in order to determine if there actually are any independent phenomena. We will be applying those terms and concepts—intrinsic, independent of accompaniment, necessary, essential, internal, in virtue of—to that inventory and to the associated concepts as understood by physicists and philosophers of physics. Now we turn to a metaphysical analysis of the other two components of Madhyamaka in the next two chapters—mereological dependence on parts and persistence—respectively.

## CHAPTER FOUR. METAPHYSICS OF COMPOSITION

### A. *Introduction*

In *Chapter Three: Metaphysics of Dependence* we examined some philosophical concepts that relate to the causal independence or dependence of one phenomenon on another. We examined the intrinsic/extrinsic dichotomy particularly closely through analysis of various interpretations of independence, intrinsicity, necessity, essentiality and other terms which are used in an attempt to capture our intuitive notions of what determines that an object or its properties are independent of other entities. In this chapter we examine the mereological independence or dependence of a phenomenon on its parts. We focus here on physical objects, what J. L. Austin (1962, 8) called “moderate-sized specimens of dry goods”, and our examination comes down to deciding if an object is unitary or composite in some sense or other, or if there are no composite objects at all, but only unitary ones such as atomic simples. Recall that the Madhyamaka discussion of the mereological dependence of a partite object on its parts was presented as a response to Abhidharma and other Indian reductionist arguments which promoted the view that while partite objects may be conventionally discussed and conceived, they had no ultimate inherent nature, yet the atoms which compose them do have such nature. Although Madhyamaka arguments have the express intent to be anti-reductionist, we found that maintaining this view required a particular interpretive gloss to some of the statements in ancient and contemporary texts and commentaries made in reference to the *neither-one-nor-many* argument. We found that interpretation not directly indicated by those statements as much as by the context of antireductionism within which those statements reside. One way to assess this interpretation is to evaluate three specific

hypotheses about the nature of the ultimate elementary particles that seem to be implied by it, and which will be tested in later chapters: The elementary particles are relational without inherent nature; there are no ultimate particles; and/or the entire Madhyamaka analysis is incoherent in light of modern physics. I will argue that all three have some relevance.

In this chapter we first look at some recent Western metaphysical reductive arguments which seek to eliminate the whole partite entity from our ontology in favor of ‘atoms’, with a similar conclusion if not argument to that of Abhidharma. The arguments are based on parsimony, causal redundancy and the supposedly insoluble puzzles of composition and co-location which result from the assumption that partite entities exist as entities rather than as mere collections of atoms. These Western arguments bear many similarities with Madhyamaka versions of *sevenfold reasoning* and *neither-one-nor-many*, although the latter continues to eliminate the inherent nature of atoms as well due to their argued partite nature.

The Western eliminativist arguments examine the composition of objects with some discussion of atomic constituents, and we find in these arguments substantially more attention to the complexities of physics than were found in the arguments concerning causal dependency on other phenomena discussed in *Chapter 3: Metaphysics of Dependence*. However, the level is still frequently limited to an admittedly ‘comfortable seventeenth-century physics’ or demonstratively to an extremely simplified ‘high-school’ or ‘cartoon’ view of modern physics. Again, I argue that these non-contemporary and oversimplified models are insufficient to the task of analyzing composition in this context, just as they were insufficient for analyzing causality. Some

metaphysical arguments do, however, go further towards what I judge to be a more complete physics treatment (e.g. Lowe 2003, 2005), and we may think of them as pointing the way forward.

We discuss several problems with the arguments examined here. First, we examine Unger's (1979) eliminative position based on puzzles of constitution, collocation and Sorites. Unger concludes an entailment from semantic characterization with simplified models to a metaphysical characterization of the actual world that does not match those models. Those mismatches are called 'paradoxes'. I argued that the entailment of metaphysical consequences from semantic arguments is not justified unless the semantic argument has grounding in physical relevance (and then it would not merely be a semantic argument). I argued that solutions are available with diligent application of the contextualization aspect of model-theoretic semantics which—since we are dealing with physical entities—requires us to work within the domains of discourse pertaining to physical objects. However, our domains must utilize physical models which are more accurate characterizations of the physical reality than the ones Unger uses. Since, as I show below, these puzzles have solutions that do not involve elimination of the furniture of our world, they do not motivate ontologically eliminative stances. The Sorites puzzle, which is examined in some detail, demonstrates a fallacy of abstraction, in that it utilizes a model that is abstracted from actual physical characteristics such that the resulting model is relevant to classical mereological treatment—atoms that can be 'added'—thus hiding just those differences between the collection and the partite entity which are at the center of the 'puzzle'. Unger's argument—which is very similar to many Sorites expressions—begs the question by assuming no bonding between parts to demonstrate

that there is no bound whole. With diligent attention to actual conditions and based on the principle that we must identify and utilize a causal context of phenomenon to understand what an entity is, the so-called puzzles are puzzling no more.

Second, van Inwagen's (1990a) eliminative arguments demonstrate an extensive and elaborate additional example of begging the question. They utilize comparison between partite non-living objects and living objects, saying that combination techniques, e.g. contact, gluing, etc., applied to a pair of living objects do not produce a composite living object because there is no such thing as a composite living object, and since it is assumed that the same criteria must apply to non-living objects, therefore it is concluded that the same techniques applied to non-living objects will not produce a composite object of that sort either.<sup>122</sup> Not only does this analysis represent an application of absolutist reasoning to what I identify as different domains—living and non-living—but the arguments employ at least an unjustified assumption, and probably a fallacy of begging the question, of assuming the conclusion in the argument: It is assumed that non-living entities cannot combine in order to conclude that non-living entities cannot combine.<sup>123</sup> This is an example of what I call *the living object fallacy*, a larger view that is used frequently in metaphysical analysis, that living things are the guide to

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<sup>122</sup> Clearly the assumption that living objects are not composite is highly controversial, if not completely false, but attending to this issue would take us out of the scope of this dissertation. Even with human beings, more frequently considered as unitary objects in this literature, mitochondria in each cell evolved from an invasion by external bacteria, and our digestion could not function well (or could not function at all for very long) without the help of billions of separate organisms.

<sup>123</sup> It is worth noting that Buddhist philosophy generally—Abhidharma and Madhyamaka—accepts the view that living organisms are partite humans in particular are made of aggregates (*skandhas*) and the 'self' (*atman*) is a mere conceptual construct inferred from that aggregation, as opposed to being the persistent, unitary and independent entity that most Western philosophy typically describes.

understanding non-living things. We discuss instances of this fallacy in this and the next chapter.

Merricks (2001) attempts an argument based on causal redundancy: The atomic simples which are supposed to be the ultimate proper parts of our conventionally-identified partite object, have (in his view) the entire causal efficacy of the object, and by parsimony and the argued requirement that there be no overdetermination, the partite object does not deserve ontological autonomy as being other than a mere collection of atoms. However, in Merricks' analysis the separate atomic simples, arranged 'object-wise' are, again 'arranged' according to an archaic model that is not consistent with modern physics. While not relying on the metaphysical puzzles which Unger, for example, relied on in his eliminative argument, Merricks motivated his causality-based argument on those puzzles, and our analysis of Unger reduces that motivation. Yet the causality-based argument deserves to be taken seriously, and has inspired numerous detailed responses, some of which I find sufficiently useful to examine. Again, we see that Merricks' treatment is insufficient in a way that is not dissimilar to the flaw found in Unger's Sorites, and find Lowe's substantially more rigorous and consistent with the actual, physical state of affairs in solid objects, thus pointing us towards the even more complete treatment which will come in *Chapter Eight: Physics of Composition*.

As we saw in *Chapter Two: Madhyamaka, sevenfold reasoning* arguments have similarities with these Western arguments, either to demonstrate the fallacies of reductionism or to conclude from our lack of solution to the puzzles that composite entities are merely conventionally-designated collections without inherent nature. We can see that inherent nature is required for membership in an ontological category within the

modern context for many analysts, as discussed in the previous chapter as what is intrinsic, necessary, essential, and internal to the entity in virtue of itself alone. However, through *neither-one-nor-many* Madhyamaka also denies any inherent nature in the ultimate components, i.e. denying that they are atomic simples, but arguing, for example, that they must have relational parts. Hence, Madhyamaka denies the conclusion of all of these eliminative arguments because they don't eliminate enough. We point to some similarities between Abhidharma and Madhyamaka arguments with Western eliminative arguments.

## ***B. Metaphysical puzzles***

In this section we discuss several metaphysical puzzles which have resulted in some analysts questioning the existence of composite entities in a somewhat similar fashion as Abhidharma and Madhyamaka arguments. As with the latter, I argue that many of the puzzles as discussed in some of the contemporary analytic metaphysics literature are puzzling only because they fail to ground the discussion in our best physics which acknowledges the various contexts of discussion and domains of validity of the theories which should be used.

There are several classical metaphysical puzzles in the categories of Sorites, vagueness, co-location, coincidence and constitution which result when we assume the independent existence of objects with many proper parts rather than their being merely a collection of independent parts. Actually, ‘collection’ (in the guise typically of ‘heap’) is also a target of the puzzles. We are concerned here more with what we usually call ‘partite’ or ‘composite’ objects, or “moderate-sized specimens of dry-goods”. The contention that there are no philosophically satisfactory solutions to those puzzles at least motivates arguments which eliminate such partite objects from our ontology, in favor of the atomic simples that presumably compose the objects. Some philosophers find their lack of solution compelling by itself. These puzzles are generally well known, are presented in some detail by Unger, van Inwagen and Merricks as part of their eliminative arguments, and will therefore only be examined briefly here—but in sufficient detail to offer a solution to Sorites as an indication of how to solve all of them.

To motivate our analysis and demonstrate how easy it is to generate a paradox purely on the basis of language without ontological consequences, consider the liar

antinomy: “This sentence is not true.” If the sentence is true then it is not true, and if not true then it is true. This is a paradox of self-reference, but we could create a non-self-referential liar antinomy with two sentences that each refer to the other: Sentence A: “Sentence B is true” and Sentence B: “Sentence A is false”. These particular sentences are confined to the domain of natural language, but similar sentences of arithmetic identified in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries motivated the drastic changes in the foundations of mathematics and development of meta-mathematics, modern set theory and alternative logic systems of the 20<sup>th</sup> century.<sup>124</sup> Sorites, however, sets up a situation which attempts to establish consistency in a representation from language to the physical world, and establish that its semantic puzzle represents something puzzling about that physical world. I rather agree with Sider:

If paradoxical conclusions emerge in the area, it is hard to justify attributing them to the postulation of ordinary objects, as Unger did, rather than to an inadequate understanding of vagueness. Similarly, the right moral to draw from Zeno’s paradoxes is not that motion is impossible but rather that an adequate philosophical theory of motion is needed; the right moral to draw from the paradox of the liar is not that truth and falsity are incoherent categories, but rather that we need an adequate philosophical theory of truth. (Sider 2001, 188).

Unger (1979, 118-125) examines a version of the classic Sorites puzzle concerning a “heap” of sand or beans. We know what a heap of sand is, but how many grains constitute a heap? Surely not none, and surely not just one. Can we arrive at an objective minimum number of grains that defines heap, say a hundred? What about 99? Where do we draw the line? What constitutes a heap may be considered a purely

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<sup>124</sup> These types of semantic paradoxes were known in ancient times and have been examined into modern (see Graham Priest 1984 “The logic of paradox revisited” *Journal of Philosophical Logic*, 13:153-179). Russell, of course, offered his short identification of a paradox in Frege’s system in 1901, collapsing the effort to formalize mathematics, and resulting in the *Principia Mathematica* with Russell and then the Hilbert Programme to axiomatically formalize mathematics and Gödel’s work identifying the limits of such efforts; see <http://plato.stanford.edu/entries/hilbert-program/>.

semantic puzzle with no ontological commitments required—we can say that ‘heap’ is a conventional term denoting a collection of contiguously piled grains and we can arbitrarily denote different collections as ‘heap’ if 100 or more grains; ‘pile’ for 10 to 99; and ‘few’ for 2 to 9. Your arbitrary convention may be just as valid as mine, and we may not really care which is used, as long as we can consistently adopt one of them in our successive discourses. But can we apply this same ‘solution’ to a stone? Surely, a stone is generally considered to be an object in its own right—composite, for sure, but more than merely a collection of atoms. Unger formalizes the argument in this way:

- (1) There is at least one stone.
- (2) ... it consists of many atoms but a finite number.
- (3) ... the net removal of one atom, or only a few, in a way which is most innocuous and favorable, will not mean the difference as to whether there is a stone in the situation. (Unger 1979, 120).
- (4)

Unger finds the propositions of the argument to entail an inconsistent set, and his eliminativist solution (also called nihilist) is to deny the initial premise, i.e. to eliminate ‘partite’ objects but retain atoms in our ontology. Progressive removal of more and more atoms eventually results in an object that cannot be classified as a stone. Since there is no reasoned place to stop the removal process, Unger argues that there was no stone to begin with, but rather simply a collection of atoms. He then generalizes his conclusion to the idea that there are no inanimate composite objects, while there are atomic simples. Unger is not the only one who has come to eliminativist conclusions from this or similar expression of the basic Sorites puzzle. There has been considerable work on vagueness from the mid-70s to the present,<sup>125</sup> and eliminating the composite in favor of the atom is one of the standard reactions.

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<sup>125</sup> See Smith (2008)

It is important to note some background assumptions which inform Unger's analysis. First is local realism, which we discussed in Section C.7 of Chapter One and discuss further in later chapters. Briefly, local realism starts with the idea that causal interactions are spatially and temporally local, that there must be physical and temporal contact between a cause and an effect. Local realism continues to conclude that global phenomena result from the sum of local phenomena: "Once the local facts have been determined, all one needs to do is distribute them throughout all of space to generate a complete physical universe" (Maudlin 1998, 58-59). Another background assumption with similarities to local realism is based on the assumptions of classical extensional mereology: We can consider a partite object to be the simple sum of its component parts.<sup>126</sup> Unger, van Inwagen and Merricks apply both of these assumptions, and yet they are both denied by empirical results and theories of modern physics in certain domains of applicability. In quantum domains, local realism has been effectively denied by experimental violations of Bell's Inequality. In domains of even classical electrodynamics and even more so of modern condensed matter physics, a composite is a unified object made of a collection of atoms *which are bound into a solid whole* and which may be analyzed as a simple sum of independent atoms only in certain domains and only to limited approximation, while for extensional mereology such composites are only simple sums. In other words, the 'unified object' for extensional mereology is always a simple sum, while in for physics it is frequently more complex and not amenable to analysis by classical extensional mereology. Classical extensional mereology countenances composition of anything with anything, while for physics the relevance of

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<sup>126</sup> See Simons (1987/2003)

bonding into the composite is foremost. However, the relevance of these assumptions and their falsity to the puzzle is yet to be seen.

Sorites is a form of induction. While Unger does not express his version of Sorites as a formal induction, all the required steps are implicit within his argument. In order to evaluate Unger's conclusion we begin with a mathematical induction, which is the more precise presentation and is modeled in this way:

Mathematical induction

1. Given a well-formed formula  $F(n)$  for any non-negative integer  $n$ , *such that*
2.  $F(n)$  is true for  $n=0$ , and
3. (Inductive premise) For any  $n$ , if formula  $F(n)$  is true, then it is true for  $n + 1$ .

Therefore:

4.  $F(n)$  is true for all non-negative  $n$ .

The formula  $F(n)$  must first be established as well-formed. To reiterate, the sentence '1+1=3' is false, but well-formed, while the phrase '1+1=' is not a well-formed formula of the language of arithmetic, hence is not even a valid sentence in the domain of that language, which is assumed here to be standard Peano arithmetic within standard Zermelo-Frankel set theory. Given the validity of the first provision in our induction, steps 2 and 3 still require proof, and if both are established as true then if our classical logic can be applied then the conclusion is true in this domain. The third step is called the inductive premise. We can reword Unger's presentation of this classical Sorites argument in the following way to enable comparison with the mathematical form. A non-algebraic statement is first provided as motivation for each step:

Sorites

1. S is a stone with many atoms: Given the well-formed formula  $F(M,n) = \text{“}S(M,n)$  is a stone with  $(M \text{ minus } n)$  atoms” for non-negative integer  $n < M$  such that
2. If no atoms are taken away then S is still as stone:  $F(M,n)$  is true for  $n=0$ , i.e.  $S$  with  $M$  atoms is a stone, and
3. (Inductive premise) No matter how many atoms we take away, up to leaving no atoms, then it is still a stone: For any  $n < M$ , if  $F(M,n)$  is true, then  $F(M,n+1)$  is true.

This translates as the requirement that *for any*  $n$  such that  $M \geq n \geq 0$  two things must be true:

- (i) If we start with a stone with any number of atoms larger than one...: for any  $n < M$ , for a given number of atoms  $(M \text{ minus } n)$  in our object, if we admit that it is a stone of  $(M \text{ minus } n)$  atoms...
- (ii) ...then taking away one atom still leaves a stone: the resulting object with  $\{M \text{ minus } (n+1)\}$  atoms is also a stone;

In other words, taking one additional atom away does not change our initial judgment that the object is indeed a stone—how could it, it’s only one atom! Therefore

4. A stone with any number of atoms from zero to  $M$  is also a stone:  $F(M,n)$  is true for all  $n$  such that  $M \geq n \geq 0$ .

The conclusion is false, since for  $n = M$  (when all  $M$  atoms are removed),  $F(M,M)$  means ‘an object with zero atoms is a stone’, which is clearly false. But we know that  $F(M,0)$ , an object with  $M$  atoms, where  $M$  is quite large, say  $10^{24}$  (which for quartz would

be 100 grams worth)<sup>127</sup> is certainly a stone. The Sorites puzzle is that somewhere along the way between M and zero, the object lost its stone-ness, and the assumption is that there is no principled way to identify that point, because the difference between one and the next would be only an atom. Unger tells us that the *logic* of the induction is clearly valid, hence the error must be in one of the assumptions. Others dispute this by suggesting that the error is in general application of classical logic (Smith, 2006, 2008). In particular, some say that the error is in the use of bivalent truth values of classical logic, which work well for us in standard arithmetic but do not work well in what ‘apparently’ (by some estimates although not mine in general context) is a vague physical world (Wright, 1973). Unger and Merricks accept the logic, but say that the error is in assuming that there is a stone in the first place.

Before we toss out classical logic, bivalent truth, or stones, let’s first look at the inductive step #3 and the way in which it models the physical world. We agree that there is a problem with the use of classical logic, but not because the physical world is vague, whether it is or not. Rather, it is the way we apply this logic as if the world were arithmetical, i.e. as if it were additive and hence conforming to classical mereology, while in fact many phenomena do not simply add without combining into something more than a simple sum. The problem with the inductive step is that *we must prove it before we can apply it*. This applies to the mathematical form as much as for the verbal Sorites form and the physical world. For this problem it means that we must model the world in an accurate way if we wish our logic to reach accurate conclusions. The core of the Sorites puzzle is the inductive step: We cannot imagine how removal of just one out

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<sup>127</sup> A molecular weight of a substance has Avogadro’s number,  $6.02 \times 10^{23}$  of molecules. Quartz, for example, is silicon dioxide,  $\text{SiO}_2$  and has a molecular weight of 60, hence has 60 g/mole.  $10^{25}$  molecules would therefore be about a 100 grams, which is a decent size for a stone.

of trillions of atoms could make a difference, so whenever we start with an object that we identify as a stone then removal of just one atom we think that it will still leave us a stone.

Yet, hidden in the logic is the assumption that a stone is just a mereological sum, really a collection of atoms, and removal of one atom does not change anything—the collection is just one atom smaller. But does removal of just one atom actually make a difference? By mereological essentialism a stone has all of its parts essentially, hence removal of just one atom gives us an entirely new object. Assuming the truth of mereological essentialism is how Madhyamaka logic determines that objects do not persist in time, and we will see below that Merricks depends on denial of mereological essentialism in his justification for there not being any stones to begin with. It seems that a similar denial is hidden in the Sorites also. But we need not buy into mereological essentialism to solve the puzzle. An alternate view is structural realism, that the atoms *per se* have less significance to the identity of an object, and by some versions the atoms do not exist independently in the first place (and Madhyamaka can be interpreted to say this) while what is significant are the structural relations. These structural relations are essentially the causal relationships which entail the object's identity. Hence, the river parts go elsewhere, but the river persists, and the stone's quantum particles are transformed from one form to another in a highly chaotic quantum foam, while the stone persists. Note that Madhyamaka would dispute this as conventional and not 'ultimate'.

Recall that Madhyamaka in the interpretation that we are using does not deny the existence of empirical objects or other kinds of phenomena, either conventionally or ultimately. Madhyamaka simply denies that phenomena have inherent nature. It is only

the kind of 'existence' that is interpreted to entail inherent nature that is denied. So there is a stone according to Madhyamaka, both conventionally and ultimately. However, the stone's nature is dependent on other phenomena, dependent on its parts and is impermanent. Additionally, the label 'stone' and its identity are labels which are dependent designations (semantic relationality); are dependent on our explanatory schemes (epistemic relationality); and the nature of the stone is dependent on different contexts (ontic relationality).

Hence, the issue comes down to how we identify the object as this particular object in the first place: What is essential and necessary to it being this object? It must come down to causality within the context or domain of discourse of a particular phenomenon. According to Physics Pluralism we must first specify what phenomenon we are discussing in relation to the object under examination, and then we can decide which physics theories apply—which domain of applicability we are in—whereupon we may know how to model the object and its causal relationships. Once we have an accurate model, we then can decide if the destruction of one atom makes a difference to its identity.

Therefore, the supposed puzzle of Sorites is puzzling only because we are abstracting just one characteristic of the object to form a mereological model: It has a certain number of atoms. This model is that the stone is a collection, not an object, while the problem at hand is to distinguish a stone from a collection. Sorites in Unger's analysis assumes that the object is a mere collection in order to conclude that it is a collection, hence begs the question.

But there is generally much more to such an object than being a collection. If we are dealing with a stone, then we must understand how a stone's atoms are bound together in a way that distinguishes the stone from a heap of unbound atoms.  $\text{SiO}_4$  atoms dumped one at a time in a heap do not all of a sudden transform into a quartz crystal, but the Sorites puzzle assumes that there is no real difference. In order to have a stone of quartz the atoms must be crystallized under various chemical and physical conditions into one of several structures, which generally takes millennia and/or high temperatures and pressures in various specific chemical and physical conditions. We must have a certain number of atoms to begin with in order for them to fuse into one of the essential structures.<sup>128</sup> If the atoms of a quartz crystal are chipped away, at some specific point the structure will fall away and we will be left with a heap of atoms, or at least something that does not have the chemical and physical properties of quartz. That minimum number can be set as the lower limit for  $M-n$ , i.e. an upper limit for  $n$  in our induction, and then there is no puzzle. If we identify the quartz 'stone' as the crystal used in transforming the scratches on our vinyl recording to music then a certain number is enough and either more or less will not function optimally. We must be specific and place the object in a context. Then we have no puzzle. Therefore, we can see how Sorites is merely a semantic puzzle borne of abstraction within *a priori* metaphysical reasoning sorely in need of physical context and comprehensive physics, thus by itself without ontological consequences. I submit that the other classical puzzles of vagueness, co-location and

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<sup>128</sup> The example used here turns out to be complex, but instructive. Quartz is  $\text{SiO}_2$  in total, made of successive  $\text{SiO}_4$  molecules with two extra oxygen atoms shared between two molecules. It seems that one  $\text{SiO}_4$  molecule would therefore not make quartz, and I suspect would not be stable in any case. Two  $\text{SiO}_4$  molecules would still have an extra pair. It seems there may be a legitimate question to decide how many  $\text{SiO}_4$  molecules make quartz, i.e. when the extra  $\text{O}_2$  get somehow loosely bound into the rest of the structures and don't make a difference. However, it is not a Sorites puzzle, but rather an empirical question which I assume is answerable by someone better versed in such things.

constitution should probably be similarly characterized, and once a proper analysis with similar methods were conducted, they would not be puzzling anymore. I submit that they actually involve either arbitrary conventions of discourse or fallacious models of the physical world. This conclusion applies to Western as much as Buddhist arguments.

### C. *The Special Composition Question*

Van Inwagen's (1990a) book *Material Beings* initiated a considerable and relevant discussion over the past two decades in response to his eliminativist-nihilist view. First, he formalized the Special Composition Question (SCQ): "When is it true that  $\exists y$  [such that] the *x*s compose *y*" (30) or more practically: "Suppose one had certain (non-overlapping) objects, the *x*s, at one's disposal: what would one have to do—what *could* one do—to get the *x*s to compose something" (31)? In other words, 'what is it to be a composite object?' Van Inwagen's answer is that there are no inanimate composite objects, hence the entire object-oriented ontology that we are used to should be limited to metaphysical simples and living organisms.<sup>129</sup> He considers various ways to combine various kinds of parts into wholes, but rejects them as insufficient to retain the composite object itself as an existent entity separate from its ultimately elementary parts.

Van Inwagen defines composition: "...the *x*s compose *y* as an abbreviation for the *x*s are all parts of *y* and no two of the *x*s overlap and every part of *y* overlaps at least one of the *x*s" (29). Overlap is defined as entailing a common part. This is notable in dismissing out of hand a relevant model of the actual way in which chemicals bond, the sharing of electrons. He then considers various ways in which these parts can be combined into a whole object, and rejects each in turn. He considers four types of combination: contact, fastening, cohesion and fusion. He notably does not consider

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<sup>129</sup> Van Inwagen mentions "bosons, leptons and quarks" as candidates for metaphysical simples. Bosons actually include photons, which are elementary, and mesons, which are composite objects of two bound quarks. Gauge bosons are the force carriers, i.e., the quantized force particles. Photons are gauge bosons of the EM force. Leptons include electrons and neutrinos and are also elementary, and quarks are also. Hence, perhaps van Inwagen meant to modify his use of "bosons" with "gauge", since his sense is that there are only ultimately elementary particles (in the non-living class of objects). We will, of course, discuss the physics further in Part III.

entanglement or even any accurately modern account of molecular bonding in the context of classical chemistry, let alone quantum chemistry. He ignores the nuances or even the obvious facts of modern physics and addresses instead a “comfortable seventeenth-century physical world, a world that consists entirely of material objects of various sizes—solid objects having surfaces and made of stuffs” (34). If van Inwagen’s analysis were not dealing with bonding, but rather phenomena relating to other features of solid objects, then Physics Pluralism might determine a domain of applicability of an accepted and mature theory, such as classical mechanics, which might provide valid answers to certain questions—although it would have to be a contemporary, or at least 19<sup>th</sup> Century version of the theory rather than a literally Newtonian version. However, the appropriate theory relating to bonding is at least classical electrodynamics and modern chemistry if not its quantum chemistry variation in combination with condensed matter physics, and I argue that those theories provide significantly different answers to van Inwagen’s questions.

Van Inwagen applies the following assumptions, given by stipulation: (1) the same criteria must be applied to determine identity and persistence for both living and non-living objects; (2) persons (and by extension any living organism) are unitary wholes;<sup>130</sup> and (3) persons and organisms cannot be materially combined to compose a “larger” object.<sup>131</sup> For example:

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<sup>130</sup> He assumes that persons “are material objects, in the sense that they are ultimately composed entirely of quarks and electrons” but they are “a very special sort of material object” (6). However, this is merely to establish that persons can persist while their parts change, therefore excluding mereological essentialism. Therefore, my statement that van Inwagen assumes that organisms are in some sense unitary is my own attribution of an assumption that seems to me to be inherent in his analysis.

<sup>131</sup> It is not entirely clear to me why van Inwagen has this second requirement, but since it is not my current context we will not discuss it here.

Any bonding relation that can hold between any two moderate-sized specimens of dry goods can (I should think) hold between two human beings, and it is pretty clear that one cannot bring a composite object into existence by bonding two human beings—or two living organisms of any sort—to each other. (62).

These three assumptions together entail that there can be no non-living physical object above and beyond metaphysically atomic parts, hence his analysis is entirely consistent with these assumptions.

I argue that his analysis is faulty. The analytic process that he repeats for several potential combination methods is the following. He uses various examples of what he calls mere collections of atomic simples (“dry goods”); combines them in various ways; compares each combination with what would result if living organisms were combined in those same ways; concludes for each method that the combination of those living organisms does not make a composite object, but rather merely makes a collection of two organisms; invokes the universality clause that non-living objects must be similar in this regard; and finally concludes that the dry goods cannot be combined to make a composite object, but merely makes a larger collection.

I find several problems with this analysis. First, he assumes that living organisms are unitary. While this view is disputed by Abhidharma and Madhyamaka, and is probably false in light of biological science, it is a common Western metaphysical view, probably relating to a theological question of the unity of the soul, hence not in our domain at all. Here, we may concede this point as part of the background assumptions of Western metaphysics, since nothing rides on it in the context of this dissertation. Then, since living organisms are unitary, any physical means of combining the surfaces of them—actually limited to shaking hands or bonding hands together—cannot entail more than a collection of two unitary organisms with their hands bonded together. I accept this

as a reasonable conclusion to the original assumption of unitarity, for the sake of argument. However, he further assumes that non-living objects must work in the same way. This last assumption, of course, entails that no similarly superficial means of bonding will produce more than a mere collection. This last assumption, which I call ‘universality’, is what I identify as faulty, or at least entirely unjustified. There is no justification provided by van Inwagen for holding this assumption, and it certainly seems counterintuitive—not that this would be a final arbiter. The only reasons to hold this assumption is if one also assumes that (1) non-living objects are unitary to start with, and (2) their unitarity cannot be modified by any of the bonding techniques examined. But the unitarity of non-living objects is what is being tested, hence he is assuming what he is trying to prove, i.e. he is begging the question. Without any good justification for the universality assumption we can see that van Inwagen’s arguments are fallacious.

His analysis is an elaborate book-length example of fallacious reasoning, but was worth briefly examining because several other analysts apply similar reasoning styles and actually have taken his analysis seriously.<sup>132</sup>

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<sup>132</sup> See Sider (1993), Markosian (1998a, b), Merricks (1999a, 2001), Nicholas (2009), Miller (2008a,b) for comments pro and con, discussion and further references, but generally minimal attention to the actual physics of the situation nor acknowledgement of the fundamental flaws that I identify here..

#### ***D. Merricks' causal redundancy***

I argue here that Merricks offers a more interesting analysis, but one which is still fallacious due to its inaccurate modeling of physical realities. In *Objects and Persons* (2001) Merricks asserts that there exist atoms ‘arranged object-wise’, i.e, arranged into what looks like or might be loosely referred to as an ordinary composite inanimate object. However, he denies the actual existence of those objects themselves. While the main reason Merricks proposes that composite inanimate objects do not exist is the issue of causal redundancy, which we discuss below, Merricks initially has several other reasons for at least motivating or acclimatizing us to his conclusion, including the Sorites puzzle mentioned by Unger. I argued that these puzzles are only puzzling if the following approaches are taken seriously: Contemporary physics is irrelevant and semantic puzzles entail ontological problems. I argue that if we are talking about physical objects then physics is relevant. Indeed, these arguments use some kind of usually very bad physics, ignoring modern mathematical physics of the physical situation described by the problem, frequently ignoring the continuity of space and time, and instead the arguments create an abstract representation of an intuitive position that does not correspond with physical reality. I also argue against the second assumption of these arguments—that semantic puzzles entail metaphysical puzzles. Here is the basic argument: (1) ‘Our’ intuitions (those of the author) as instantiated in our language are presumed to represent physical reality; (2) if there are no language-specific solutions to the puzzles then from the previous point there must be a puzzle in the physical reality; and (3) there are no language solutions. I argue throughout this chapter (and throughout the dissertation) that these approaches are unsupported, and rather that (a) our language must be *shown* to

match the physical reality, not taking this as a presumption; (b) if there are no language-specific solutions to the puzzles then it may indicate that there are problems with the representational dimensions of our intuitions and/or language, hence a testing hypothesis should be generated in order to correct them; (c) the result of testing should correct our intuitions and language. Therefore one or the other of the following choices may be correct: (d) Our corrected intuitions and language will have no puzzles with ontological consequences; or (e) the physical reality is not representable by intuitions and language. If (e) has been determined, but we use mathematical language rather than natural language, and dismiss intuitions from the conjunction, we may still determine (f) the physical reality is representable by mathematical language. An example of the latter is the formalism of quantum mechanics.

One major puzzle that Merricks analyzes is *the water in the pool*. His argument is an attempt at causal justification: “Instead of any big wet chunky thing that fits snugly into the pool, [suppose that] there were only many, many H<sub>2</sub>O molecules” (31). And it is the molecules that keep a high diver from hitting bottom. At first blush, this is an interesting and provocative attempt to show that molecules can be assigned the entire causal efficacy that we normally attribute to objects. However, it is only consistent with a very naïve level of mereological reductionism that is common in even contemporary metaphysics, and which ignores modern physics and philosophy of physics. Its use of classical mereology excludes acknowledgement of anything about the electromagnetic fields, or the atoms bound with and structures formed by those fields which are part and parcel of the molecules that Merricks considers. Indeed, it is the fields which produce the surface tension and similar cooperative phenomena of the whole that resists the high

diver, not the tiny independently acting billiard ball type of atoms of ancient atomic theory which is used by Merricks.

***D.1. The form of the argument.***

To Merricks, causal relations can be traced to the atoms, so the whole partite object is redundant, hence does not exist. This is his *overdetermination thesis*: that there are atoms arranged in the shape and function of a larger object does not entail that the atoms compose such an object. Merricks motivates some of his analysis with scientific reductionist descriptions given by reductionist philosophers who write that “there is nothing more to large-scale material objects except the fundamental particles and the relations they have to each other” (Swinburne 1995, 395); “The most important form of reduction is ontological reduction. It is the form in which objects of certain types can be shown to consist of nothing but objects of other types...For example, material objects in general can be shown to be nothing but collections of molecules...” (Searle 1992, 112-3); and “...once we are done specifying all of the microphysical things there are, we have specified all of the things there are” (Kornblith 1993, 53). These views certainly could motivate an eliminativist perspective: composite objects do not exist independently (in some sense); rather there are only atoms and other microphysical components. However, we will see how the motivation should arise only if the physics that should be the basis of philosophical pronouncements is ignored. As indicated, I argue that any philosophy which has some aspect of the physical reality as its topic must attend to the physics of the topic in order to have any credibility. Merricks’ view is an example of a little knowledge being a dangerous thing, ignoring the significant physics hidden in the ‘relations’ referenced by Swinburne. Thus, Merricks is rather ignoring the causal, structural

ontology which structural realism stresses, in favor of an Aristotelian object-based ontology where atoms simply add when they combine.

Merricks' views are similar in a relevant sense to various reductionist views of classical extensional mereology as introduced in *Chapter One: Introduction*:

Let us call a canonical set of properties and relations of the parts which may or may not determine the properties and relations of the whole the supervenience basis...*Physical Property Determination*: Every qualitative intrinsic physical property and relation of a set of physical objects from any domain *D* subject only to type *P* processes supervenes on qualitative intrinsic physical properties and relations in the supervenience basis of their basic physical parts relative to *D* and *P*. (Healey 2008, 5).

...according to mereological reductionism, *the relations* between basic parts are themselves reducible to the intrinsic properties of the relata. The implicit ontological assumption is that the most fundamental physical level (whatever that turns out to be) is ultimately the “real” ontology of the world, and anything else that is to keep the status of real must somehow be able to be “mapped onto” or “built out of” those elements of the fundamental ontology. (Silberstein 2002:81).

These views are also similar to our own categorization in *Chapter One*:

*Strong reductionism*: there are ultimately basic proper parts and their nature determines the nature of their whole.

*Very strong reductionism*: the nature of a whole is relevantly *the same* as the nature of its ultimately basic parts.

But the above views suggest that the whole is determined by the parts and the whole is essentially the same as the parts in their arrangement. As we see later, these reductionist views are not valid in many domains of composite objects, but neither acceptance nor rejection of certain kinds of reductionism will help Merricks—he must reject any kind of property determination, any kind of derivation of properties of the whole from properties of the parts. If Merricks is to deny composite objects their causal role and therefore membership in a valid ontology, he cannot say that they are even derivative of the parts;

he must eliminate the composite objects altogether. Hence, the idea that the composite is essentially identical to the parts must be rejected by Merricks—and this is his view—since if there is some kind of derivation then if the parts exist then the composite would also. Since Merricks accepts that the ultimate atomic simple parts exist, at least as he understands the nature of those parts, if he accepted *composition as identity* then he would be forced to admit that composites do also. *Composition as identity* is defined loosely as follows: “The sum is just the parts taken together” (Lewis 1991:81); “...it is the parts ‘counted loosely’ ” (Baxter 1988:580); “...it is, effectively, the same portion of reality, which is strictly a multitude and loosely a single thing” (Varzi 2009, 29).

Merricks’ assembles an *Overdetermination Argument*. He uses the example of a baseball shattering a window:

1. The baseball—if it exists—is causally irrelevant to whether or not its constituent atoms, acting in concert, cause the shattering of the window.
2. The shattering of the window is caused by those atoms, acting in concert.
3. The shattering of the window is not overdetermined.
4. If the baseball exists, it does not cause the shattering of the window. (Merricks 2001, 56).
- 5.

Causal irrelevance is defined intuitively, such that an object *O* is causally irrelevant to an event *E* if *O* is not one of the causes of *E*.<sup>133</sup> In this context, *E* is the shattering of the window and *O* is the baseball, or rather the collection of atoms acting “in concert”. A “Causal Principle” is stated in a negative way, so that *O* does not cause *E* if *O* is causally

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<sup>133</sup> [*Causal irrelevance*]

Suppose that

- *O* is an object; and *x*s are objects.

*O* is causally irrelevant to whether the *x*s, acting in concert, cause a certain effect *E* iff

- (1) *O* is not one of the *x*s;
- (2) *O* is not a “partial cause” of *E* alongside the *x*s;  
(*O* would be a partial cause of *E* if it is that case that *E* could not have occurred without the participation of *O*)
- (3) *O* is not “an intermediate in a causal chain between” any of the *x*s and *E*; and
- (4) *O* does not cause any of the *x*s to cause *E* (taken from Merricks 2001, 57-58).

irrelevant to whether the collection of objects, acting in concert, cause *E*, that the collection *does* cause *E*, and also *E* is not overdetermined.<sup>134</sup> Now Merricks provides his *overdetermination argument*. An effect *E* is *overdetermined* if:

1. *E* is caused by *O*;
- 2.
3. *O* is causally irrelevant to whether some other—i.e. numerically distinct—object or objects cause *E*; and
- 4.
5. the other object or objects do indeed cause that effect.
- 6.

Merricks' conclusion is that "the Causal Principle is obviously and demonstrably true"

(58). And since, "for macrophysical objects to be is to have causal powers" and also "to be is to have non-redundant causal powers" (Merricks 2001, 115) *O* does not exist. This argument states that "a complete causal explanation *wholly in terms of the microphysical*" is all the explanation one requires. Hence, no "emergent" causal powers or other emergent properties could possibly be found to have causal efficacy that could not be explained in terms of the microphysical.<sup>135</sup> Central to Merricks' argument is the distinct nature of the atoms and the object, item (2) in the overdetermination argument. Here is Merrick's rejection of *composition as identity*. However, as we shall see, Merricks' conception of the microphysical does not, apparently, include the electromagnetic fields

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<sup>134</sup> [*Causal Principle*]

Suppose that:

- *O* is an object; and
- *xs* are objects.

*O* does not cause *E* iff

1. *O* is causally irrelevant to whether the *xs*, acting in concert, cause a certain effect *E*;
2. The *xs*, acting in concert, do cause *E*; and
3. *E* is not overdetermined. (from Merricks 2001, 58)

<sup>135</sup> As we see in *Part III: Physics*, satisfying this requirement is quite controversial—emergent properties have been suggested for the meso-scale of objects (between micro and macro), and also on the micro-scale in considering quantum mechanical measurement theory. Actually, I show just how difficult—though not always entirely impossible—it is to even describe the microphysical sufficiently to explain anything macrophysical, and how the idea that one can describe the macro by the micro is an unestablished philosophical presumption of significant proportion.

which are part and parcel of atoms, just the atomic ‘particulate’ cores without bonding fields, let alone any quantum entanglement. We see this exclusion as a common feature of many such metaphysical analyses of matter, Western and Buddhist, Abhidharma and Madhyamaka.

### **D.2. *Composition as identity.***

Merricks rejects *composition as identity*, the idea that an object *is just* its atoms arranged object-wise. If this were the case then since the atoms exist the object exists, hence there would be no redundancy: when we talk about the collection of atoms together then we would also be talking about the object as the same thing. However, if *composition as identity* is not true, and if the causal relationships of what we normally think of as an object can all be assigned to the atoms, then the object can now be seen as epiphenomenal, which is what Merricks promotes.

An argument against *composition as identity* is therefore central to his analysis (Merricks 2001, 20-29). He uses two arguments to deny *composition as identity*. First:

One good reason to reject composition as identity is that it implies, obviously enough, that one thing (e.g. a whole) can be identical with many things (e.g. the whole’s parts). But I think that one of the most obvious facts about *identity* is that...it never holds one-to many....So composition as identity is false. (Merricks 2001, 21).

This argument is similar to one of the *sevenfold reasonings*: The chariot cannot be identical to—cannot be “non-other” than—the parts, because if it were then “...just as the parts are plural, so the chariot also would be many; just as the chariot is singular, so the parts would be single...” (LRCM, 279). We respond to both arguments that what one considers as ‘one’ or ‘many’ requires analysis which considers first the context of the discussion (the domain of discourse) and then the way in which parts are assembled and related to each other in this context, which requires use of particular physics theories

which pertain to that context. For instance, I argue that a rock in some contexts (e.g. radioactivity or chemical phenomena) should be considered a loose collection of ‘many’ atoms (at least in first approximation) but in other contexts (quantum entanglement or phenomena amenable to condensed matter physics or classical dynamics) should be considered bound so tightly as to entail ‘one’ unitary object that should not be considered composite at all (again, at least in first approximation). The predicates ‘one’ or ‘many’ are made in different contexts. It is one rock composed of many atoms. We do not say that the rock is one rock and the rock is many atoms; we say that the rock is *composed of* many atoms, and what that composition entails (bonding, entanglement, etc.) requires further elaboration. Consider a rock, perform some experiments with it, and then compare those findings with similar experiments made with a loose pile of dust made from the same rock. They have many causal properties that are quite different, but some that are the same. Hence, we see that the rock is the same atoms bound together as described by chemistry and condensed matter theory. Therefore, we cannot conclude that, in general, the rock *is just* the atoms *arranged rock-wise* unless ‘arrangement’ entails electromagnetic bonding, lattice structure, entanglement, etc. That arrangement would make it absurd to conclude that the rock is *merely* the atoms. ‘Arrangement’ usually means just put next to each other in a loose structure, not bound in such formidable ways. More on this topic in *Chapter Seven: Physics of Composition*.

The second of Merricks’ argument has two parts. First, he states that either *composition as identity* is false or mereological essentialism is true, yet mereological essentialism must be false. We previously discussed mereological essentialism concerning impermanence in Section E of *Chapter Two: Madhyamaka*. Mereological

essentialism is the idea that all parts of an object are had essentially, which means that all parts are essential, which entails that any change in parts entails a change in the whole. Merricks' argument follows in this fashion: assuming that *composition as identity* is true, then an object is *always* identical with its atoms that compose it, i.e., "Composition as identity implies that we have not undergone, and will not undergo, change of atomic parts. More generally, it implies that no persisting object ever changes parts. This implication is false. So composition as identity is false" (Merricks 2001, 22). Merricks tries two kinds of arguments to support this view. The first relies on living beings, and the second does not. The first relies on arguments that are similar to those of van Inwagen, and still just as fallacious in my judgments: (1) human beings are persisting objects; (2) humans persist even though there are changes of parts; (3) therefore *composition as identity* is false; (4) non-living physical phenomena should satisfy the same criteria as humans; hence (5) *composition as identity* is false for those phenomena also.

When Merricks approaches the topic of non-living phenomena without reliance on features of the living, he discusses the possibility of change and how change of the whole would relate with change of parts. He argues that if *composition as identity* were true, then mereological essentialism would also be true (Merricks 2001, 23), which makes sense. Next, he states that mereological essentialism is false, hence *composition as identity* is false. Mereological essentialism implies that any change in parts of an object (e.g., annihilation of an elementary particle that is part of the object) would imply that the object has been annihilated. And "I feel entitled to the commonsense denial of mereological essentialism" (Merricks 2001, 24). He also says that objects change parts but don't change their identity because they are actually 4-D objects—but more on this in

the next chapter. But mereological essentialism is a serious philosophical point of view, and deserves an argument, not simply a denial. We respond to this argument by saying that the rock may be the same, i.e. have the same physical and chemical properties, as a rock with a substitution of one (or all) of its atoms for another of the same kind of atom bound in the same fashion into the rock's structure. It is the rock's structure which determines its physical and chemical properties. We therefore argue that mereological essentialism is indeed wrong in many contexts, but composition as identity may be right in some contexts. In contexts involving entanglement or other quantum phenomena, reductionism may not obtain, and composition may not relate with identity in any clearly derivable fashion. More on this in *Chapter Eight: Physics of Composition*.

Composition as identity embodies some of the *sevenfold reasoning* proposals which Madhyamaka argues against, e.g., that the whole is identical with its parts, owner of the parts, or in its parts. Hence, Merrick's arguments come to a conclusion which is consistent with Madhyamaka arguments concerning the identity of composite objects: They have no independent existence and no existence that can be coherently defined and understood through some mereological relationship with its parts. However, in consideration of the nature of atoms which compose those objects in the *neither one nor many* argument, Madhyamaka and Merrick's part company, and the latter is seen as similar to the Abhidharma atomistic philosophies which Madhyamaka argues against. Merrick states that the atoms (or atomic simples of some sort) exist, i.e. that they have inherent and independent natures, because they have causal efficacy. Composite objects (according to this argument) have no direct causal efficacy that is independent of the

causal efficacy of their ultimate atomic parts in collections that we conventionally call objects.

Merricks' causal redundancy argument examines the dependency relationship between an object and other objects, but also further clarifies the problems which come from considering the relationship between an object and 'its' parts. The entire discussion of causal redundancy will facilitate a discussion of the nature of causal dependency that is central to Madhyamaka reasoning. This dependency relationship is further examined by critics of Merricks, as discussed below.

### ***D.3. Some responses to Merricks' reductive eliminativism***

There have been several varieties of response to Merrick's reductive eliminativism. Sider (2003a) accepts overdetermination and argues that there is nothing wrong with it, that there are frequently two causes for the same actions, depending on how we look at things. He examines Merricks' example of a baseball (or rather the baseball atoms) shattering a glass and argues that:

The shattering of the window is counterfactually dependent on both the atoms and on the baseball; the sequence from either the atoms or the baseball to the shattering can be subsumed under covering laws; both the actions of the baseball and its parts raise the probability of the shattering; a primitive causal relation could hold in a many-one pattern." (Sider 2003a, 721).

Much of his argument is actually stipulation without fleshing out the laws and dependencies in terms of the physics theories which are indirectly invoked. However, Sider does provide further motivation for the pluralist framework that we have been discussing by arguing that in some sense the atoms cause the shattering and in some sense the baseball whole causes the shattering. Hence, there are contexts pertaining to causal descriptions of the whole that are different from the descriptions pertaining to the parts.

Baker (2003) argued that there are instances in which the composite object has causal efficacy according to its *arrangement* of atoms, and the arrangement entails something over and above the atoms *per se*. Thus baseballs cause fans to react; statues cause insurance companies to raise premiums; the moon, rather than its parts, causes tidal action. The latter example is false,<sup>136</sup> and her view is one that corresponds more to the conventions of common discourse rather than any ultimate view of objective reality, unless the former determines the latter, and that is something I expressly dispute throughout the dissertation. Our further discussion in later chapters examines just *how* the arrangement can entail something over and above the parts *per se*, but the central feature in many contexts is at least initially the electromagnetic bonding.

Thomasson (2007) expands on the physical relationship that Baker points out by arguing for an *analytic* entailment between the atomic parts and the whole object, thus denying Merricks' rejection of composition as identity. Both Thomasson and Baker argue that composition *and the arrangement of composita* entail identity. Lowe (2003, 2005) offers what I consider to be the best argument that can still be classified as analytic metaphysics. It is best due to its use of some sophisticated physics, and it is still metaphysics due to its excessive use of *a priori* reasoning that lacks full use of the most modern, mature and accepted physics theories judged to be accepted within a highly plausible and justifiably coherent and comprehensive epistemic framework of empirical science. Even though it is still metaphysics, he includes some significant grounding in

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<sup>136</sup> It seems quite incorrect to think that that the moon rather than its parts causes tidal action, since the great majority of the mass of the moon—probably on the order of 99.9%—comes from parts, and the masses of the parts can be added simply; there is very little mass due to the composite nature or bonding energy. Gravitational forces on the moon do not provide the kind of bonding that EM forces provide in chemical bonds—the former energy is substantially smaller.

physics, hence Lowe's analysis deserves attention prior to our discussions of the more complete solutions in further chapters.

**D.4. "In defense of moderate-sized specimens of dry goods"**

Lowe bases his arguments on physics that is by our estimation substantially closer to the current actual physics understanding of atoms and how they bond than the physics that has generally been applied by other authors. That best physics suggests the possibility that some objects under some conditions should be considered as whole causal entities, not collections. Lowe's analysis also suggests that the qualitatively different natural kinds of our world require a pluralistic set of persistence and identity criteria, rather than a single, monistic set that equally apply to all kinds, of the sort that van Inwagen and Merricks defend.

The arguments of Lowe (2003) are concise and quite suggestive. A reply is given by Merricks (2003). Lowe's responses (2005) are more immune to objection and more comprehensive than the earlier ones. While Lowe goes far towards a final argument, the final argument requires further attention to the details of what we now know of the physics in order to be acceptable arguments against Merricks' elimination of ordinary objects. The reader may therefore take some of Lowe's arguments as preliminary or motivational to some portions of our *Part III: Physics*.

Lowe (2003) starts by considering if Merricks' arguments can work against the metaphysical atoms themselves, in similar vein as *neither one nor many*. Merricks suggests that the overdetermination argument will not work against all of what Lowe calls "microphysical composita"; perhaps there is "atomless gunk" or 'maximally continuous regions' ('MaxCons' in the literature) that presumably cannot be divided. Lowe analyzes actual physical atoms, just to come out of the sometimes foggy

metaphysically possible into the light of actuality. Lowe (2003) examines the most common isotope of a helium atom, composed of two each of neutrons, protons and electrons and tells us that physicists are reductionist in their analysis (something that we would argue is not entirely true), and would therefore know that the characteristics of the helium atom are due entirely to its composition (but only if we ignore *how* they are arranged),<sup>137</sup> yet the atom also functions as an atomic simple, not just through its component parts:

I suspect that physicists will respond to the causal overdetermination argument, as applied to atoms, by saying that *of course* they suppose that the causal powers of atoms can be wholly explained in terms of the properties and relations of their constituent subatomic particles, but that this is no reason to deny the *existence* of atoms: for it's still true that atoms *have* causal powers that are not had by subatomic particles, such as the power to form covalent bonds with other atoms to make various kinds of molecules. (Lowe, 2003:705).

It is important to note that Lowe is not just talking about conventions of discourse, but rather is arguing for independent objective entities. An atom as a whole—he says—forms the covalent bonds with another atom, not the subatomic particles. Actually, the electrons of one atom form the bonds with the electrons of another atom, although they are directly affected to a lesser degree by the presence and interactions with the nuclei and other electrons of each atom in the bond, hence in some sense, more or less, the atoms as a whole are involved in the interaction in a way that cannot be attributed solely to the constituents. For example, there is an increase in the mass of a nucleus due to the bonding energy of its components, in addition to the mass/energy of

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<sup>137</sup> In actuality, this view is quite complex, difficult to prove, and hence quite controversial. There are domains of chemistry and physics in which there is decoupling of the whole from details of the parts, and it is not possible to derive all the physical and chemical characteristics of substances, e.g. water, from the quantum field theory of its elementary particles. To say that the physical characteristics are due to the constituents sounds like it would be a good general principle, but entanglement makes it in principle impossible to derive those characteristics, thus obviating the general reductive approach. More in *Part III: Physics*.

the components individually, and that mass/energy has causal efficacy. Hence, there is a complex interaction of parts and wholes in this common phenomenon. I therefore identify a further question that Lowe's analysis suggests: If we can apply the principles of quantum chemistry derived from Schrödinger's equation concerning the parts in interaction in order to generate the macro-chemical formulae of bonding one atom to another, and further to derive *all* the physical and chemical properties of the macro-chemical composite object from those chemical formulae, then we can place all the causal efficacy in the subatomic parts. Yet, this is substantially beyond any science that we currently know of, and is probably not ever possible due in no small measure to entanglement and other symmetry breaking processes as substantial ontological barriers to ever having such a science, thus requiring a pluralistic view: Subatomic parts, atoms and macro-objects each have semi-independent causal features. This view, embodied in Physics Pluralism, is motivated by results in the renormalization programme of quantum field theory and condensed matter physics, to be discussed in *Chapter Eight: Physics of Composition*.

Lowe (2003) examines a different example by pointing to what we consider to be the more significant issue of this article. Using a suggestion from Paul Teller, Lowe compares a bronze statue that has been thrown towards a window with a collection of separately propelled bronze pellets that just happen to assemble into the shape of a statue at a particular time, in response to Merrick's similar analysis:

However, we should not forget that the bronze particles composing a statue have to be *held together in a certain configuration by certain natural forces*, which is not the case with the bronze pellets merely coming together in that configuration at the point of collision. It cannot be assumed that these configurational forces make no difference to the way in which the window shatters nor, hence, that the

causal explanation of the shattering is indeed the same in both cases. (Lowe, 2003:710).

I offer further examples of light snow in a dust form tossed at a window compared with a compacted snow-ice ball, or dust from a ground rock compared with the rock. It is not simply the shape that is relevant to causal efficacy, but especially the bonding of parts—the actual structure of electromagnetic fields which make up the “configurational” forces, just as Lowe suggests. This selection presents a link to two questions which take us to the heart of the matter as I see it: (a) Can it indeed be shown that there are causal powers due to the atoms being held in some structure, e.g., by electrostatic forces, that are lacking when the atoms are considered as independent parts? (b) Would that structure qualify as the atoms *merely* arranged object-wise, or should the whole rather be considered a unitary object in some particular causal contexts *because* they are bound in such a significant structural form? These questions could be asked also of the atom in relation to its subatomic components, and the components of the subatomic parts, but that would bring us to quantum field theory. Lowe (2005) examines these questions to a degree, but not sufficiently.

Lowe’s discussions provide a good indication of how to develop a valid solution to the mereological problem as part of what I characterize as a much needed effort to naturalize metaphysics.<sup>138</sup> In *Part III: Physics* we discuss elaborations on those principles, and we also consider whether or not those scientific principles can and should be applied to this problem. These examinations are motivated directly by the *sevenfold reasoning* and *neither one nor many* arguments discussed previously: What actually is the nature (based on sound philosophic clarification of concepts and confirmed scientific

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<sup>138</sup> See Ladyman and Ross (2007) for a major contribution to this effort.

principles) of the relationship between parts and whole, and what are the natures of the metaphysically “atomic” and the “ultimate” physical parts anyway? This is a question that Lowe has, it seems, provided a serious beginning to an answer, yet his line of reasoning requires further elaboration and justification.

## ***E. Conclusion***

In this chapter we discussed a selection of views on the identity and composition of non-living objects as analyzed by some Western metaphysicians. We found similarities in argument form, content, method and results to either the Abhidharma or other Indian arguments that Madhyamaka responds to, or to Madhyamaka arguments themselves. We discussed the interdependent and relational nature of whole objects on their parts and suggested that eliminativist arguments which reject the whole are problematic—Indian and Western. Building on results from the previous chapter, we noted further indications that hybrid metaphysical *a priori* reasoning mixed with a certain amount of archaic physics will not stand up to scrutiny—but more work is required to confirm this indication.

Many of the efforts of the Buddhist and Western philosophers were motivated by their need to resolve ancient paradoxes and puzzles of composition, vagueness and constitution of objects that result when we apply what seem to be reasonable and commonsense assumptions. These puzzles relate both to identity at one time and through time. However, through application of Physics Pluralism in the appropriate context of the physics of such objects we found solutions to these puzzles, revealing them as mere word games without ontological consequences.

I argue with Merricks that causality is the glue that ties identity together, yet, with Lowe, that because of that same causality there is indication that we must sometimes consider some composite objects as whole things and not merely collections of unconnected parts. In this chapter we found motivation for a pluralistic view to consider composite objects to have some objective causal efficacy *independent* of any causal

efficacy of ‘its’ atoms, at least in some domains. If causal efficacy is the criteria for attribution of inherent nature, then *sevenfold reasoning* is challenged.

We saw that there are significant problems with both the Madhyamaka analysis and the modern Western eliminativist arguments. There are three basic conclusions I wish to draw. First, Madhyamaka arguments do not stop with atoms, finding no inherent nature to them as well as to the whole of which they are nominally considered to be the parts.<sup>139</sup> The eliminativist arguments discussed in this chapter generally stop with atoms, considering them as wholes, yet Lowe (2003) questioned if that stopping point is valid: Why can’t an atom be susceptible to the same part-whole analysis that Unger, van Inwagen and Merricks applied to macroscopic objects? Hence, the intent of Madhyamaka arguments is good—atoms need to be examined for structure also, and it cannot be assumed that there are atomic simples—but the implementation is incomplete. As we see in *Part III: Physics*, the situation is quite complex, and necessitates application of modern physics, with its own attendant philosophical difficulties. Both Madhyamaka and Western analytic metaphysics demonstrate considerable superficiality that ignore the complexities of modern physics, being at home more with 17<sup>th</sup> century physics, which clearly provides inaccurate models for many purposes. The relevant point is that an atom cannot be analytically ‘taken apart’ any more than a rock, without its destruction.

Second, even just considering merely classical physics applications, i.e., classical consideration of atoms as singular structures that are chemically combined through classical electrodynamic forces, Lowe’s suggestions should be followed to examine how a composite object may or must, for some kinds of objects and in the contexts of some

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<sup>139</sup> Of course their physics is somewhat archaic, to say the least, hence their use of the term ‘atom’ is more like a metaphysical atom that supposedly has no parts if it has inherent nature, but then it is shown to have relational parts, hence doesn’t have inherent nature, hence no singular, metaphysical atom could exist.

kinds of phenomena, be considered as an independent whole. The criteria should be—as Merricks aptly pointed out—causality, but relating to the actual structure of bonding, not some archaic, mereologically acceptable, tiny billiard ball model that coincides with our intuitions borne from classical mechanics which do not apply in these domains.

Third, the relationship between metaphysical analysis (Buddhist and Western) and scientific analysis should be clarified. The former examines the concepts, terms, reference and meaning of our language and their relationships with the physical world which would include our perception of it, while the latter describes that physical world, and there is a strong indication that a well-constructed metaphysics can be quite helpful to achieving a solution to our problem, yet that solution must include details of the physical situation, as in our solution to Sorites. The specifics of the construction of metaphysics which can help must await future chapters.

The question of persistence continues to arise as an issue in the analysis of identity in this and the previous chapter; hence we turn to that now..

## CHAPTER FIVE. METAPHYSICS OF CHANGE

### A. *Introduction*

As I am promoting it, metaphysics should not be beyond physics; it should be about physics. Metamathematics has the rules of how to make mathematics consistent, e.g. without the self-references and other logic antinomies like the liar paradox mentioned previously, but metamathematics incorporates complete knowledge and respect for all that mathematics has to offer. Metaphysics provides a conceptual analysis of language that incorporates intuitive understanding and reflective experience, but I have argued that it always should be grounded in the empirical; sometimes our intuitions are dead wrong.<sup>140</sup> Metaphysics should in some sense be considered transcendental, in that it should describe what must be metaphysically true for the physical world to be the only actual world.

There are two common fundamental assumptions in the literature of change, and we have seen these assumptions before, in Chapters Three and Four: (1) the way we represent the physical reality in common discourse should be true to our intuitions about the nature of reality; and (2) our common intuitions indicate something true about that reality. In a minority of metaphysics literature these assumptions have been mediated by modern physics somewhat (which in this chapter is special relativity) but by and large they still hold sway. We find those assumptions as problematic in relation to this topic as we found them previously.

However, some philosophers of time demonstrate different views. While the physics of modern chemistry and quantum mechanics apparently was irrelevant to some

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<sup>140</sup> There are many ancient examples of this, but one of the best is Einstein's intuitions as formalized in the EPR puzzle, shown to be incorrect over the last 30 years. See Zurek and Wheeler (1985).

philosophers working on intrinsicality and composition, Einstein's theory of special relativity has permeated the philosophy of time as analyzed by some philosophers for most of the past 100 years. The major result from special relativity that must be addressed in metaphysics of time is that simultaneity is frame-relative. That means that the 'now' here is not necessarily the same as the 'now' there—as discussed further in *Chapter Nine: Physics of Change*. Some philosophers of physics argue because of this that the past and future exist in the same way as the present, although others disagree. If past and future exist in the same way as the present, then presentism—the view that only the present exists—is not tenable.

The philosophy of time, persistence and change has an unusual terminology; hence we begin with a brief introduction to it before we apply it to the central issue of the chapter, which is the problem of change. Our main question is whether any phenomena persist over time or all phenomena are impermanent. Yet, before that question can be answered—and the analysis of answers will be in Chapter Nine—we should have a conceptual understanding of what time means, and what impermanence entails, and those are the tasks of this chapter. We generally consider only medium sized dry-goods, which we call 'objects' or 'entities'. Our main question is intimately related to the identity of the object in one time before we look at it in two. From the Madhyamaka point of view, for an object to have an identity typically implies that the identity is independent of relations, i.e. that the object is independent (which, from Chapter Three, is the same as having intrinsic, necessary and essential properties, in virtue of itself alone) hence that there is an inherent nature to the object. For Madhyamaka, since there are no objects with inherent nature, there is no identity *per se* either, hence we cannot even get started examining the

question of identity over time, since there is no identity in one time. This is frequently where Madhyamaka analysis rests, with no thesis about the nature of an object since nature implies inherent nature. However, as discussed in Chapter Two, in other interpretations a positive thesis is accepted as part of Madhyamaka and in my interpretation this is that objects—while having no inherent nature—do have relational nature, i.e. they are interdependent, composite and impermanent. Hence, we can begin to have some idea of the identity of an object, but that identity must be purged from any implication of inherent nature. It will be difficult to point and synchronically say ‘this object’ if all objects are interdependent and composite, and additionally difficult to develop a diachronic view. These difficulties concern us throughout the dissertation.

For some Western analytic metaphysics, objects generally are considered to have intrinsic properties, hence are considered to have an independent identity, and the identity of the object typically persists. Hence, the problem of persistence is typically expressed as a problem of change of an object that has some particular property which has been identified as intrinsic, and that typically then changes over time while the object (perhaps) stays the same. We might say that it is the same object with different properties or we might say that if an intrinsic property changes then it is a different object. This is the ancient Heraclitus problem of change of the river while the river (perhaps) stays the same. Yet, unless we accept a property-less substance, a substratum of the essential *thing-in-itself*—which most generally reject—then what is the object but its bundle of properties? Some then suggest that if an object’s intrinsic properties change then it is a different object, while Madhyamaka says that there are none, and when any of its properties change it is a different object. Any view based firmly in Leibniz’ Laws would

come to the same conclusion that any change entails a new object. Yet it is accepted by most contemporary philosophers that continuity is possible, that an object may maintain its identity even with changed properties. Hence there is a problem: In recent discussions it is accepted that relational properties may arbitrarily change in the same object, but change of intrinsic properties gives us apparent metaphysical puzzles. Hence, contemporary metaphysics literature discusses the problem of change as the problem of temporary intrinsics: If an object is identified by its intrinsic properties, how can the object persist over time while still changing intrinsic properties? We still have not analyzed the inventory of possibly intrinsic properties (if any) which is for physics to provide—the state-independent properties—but we discuss the concepts here in order to lay the groundwork for that analysis to come. In Western analytic metaphysics the intrinsic properties of an object are the ones that are internal in the sense of belonging to the object, being non-relational and causally independent of accompaniment by other objects, but they are not necessarily permanent and unitary as Madhyamaka argues. Indeed, as we see in this chapter, many think that intrinsic properties can change, but also that this change produces a puzzle. Also, what about those properties that satisfy these criteria of being internal, non-relational and causally independent of accompaniment, yet are not necessary and essential to the nature of the object according to its fundamental nature? We will have to answer this question, as summarized below.

We find in the literature of this topic, as we found in others, what I argue is confusion about the relationship between the living and non-living: It is assumed that we, as human beings, persist in time, although we change somehow, and non-living phenomena should be similar. Buddhist Abhidharma generally considers the person as an

impermanent aggregate of changing components, hence has an answer: Properties may freely change and the aggregate is radically impermanent. If we accept this solution, then this chapter is unnecessary. However, it rubs many the wrong way, and there are good arguments against the mereological reductionism and mereological essentialism which, as I argued in Section E of Chapter Two, are at the foundation of Buddhist impermanence. We therefore look for other answers.

Another thesis supported here is that much of the analysis of the problem of change in the contemporary metaphysics literature fails to grasp which properties should properly be counted as intrinsic and which should not. Lewis has been quite involved with the conceptual analysis of intrinsicity, as noted in Chapter Four, hence I find it strange that he should make this error. Yet it is clearly exemplified in Lewis (1986) and the large body of his work and the work of those who responded. In that literature it is Lewis' own shape (sitting or standing) which is used as an example of an intrinsic property. Not only does this example suffer from the previously mentioned fallacy of referring to living beings (with the unique assumptions about their continued identity over time regardless of change in properties, intrinsic or otherwise) as a standard by which to judge the non-living, it is unusual to find what I evaluate as a proper understanding of the difference between an intrinsic property and a merely internal and independent one like this kind of shape.<sup>141</sup> An intrinsic property must also be necessary and essential to the identity of the object, to what the object is in a fundamental and basic sense. Whether or not Lewis is sitting or standing does not qualify. When we limit the analysis to actually intrinsic properties as we defined them finally at the end of *Chapter*

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<sup>141</sup> Shape is internal because it does not have anything to do with other objects, and is independent for the same reason. It is, however, relational to its parts, as Lowe notes below.

*Three: Metaphysics of Dependence*, we find at least clarity in understanding the problem, if not solutions. The third thesis I argue for in this chapter, as in previous ones, is that we will require grounding in physical relevance to cash out these characteristics in actual objects, contexts and phenomena of the actual physical world.

The main question, again, is whether objects persist over time or are impermanent. Buddhist Abhidharma promotes the view that objects exist in the present moment, which is the only moment that has any reality, and the object in each present moment of time has temporal inherent nature. Madhyamaka offers arguments that the existent object in each moment has no inherent nature at all, either in its spatial parts or in its temporal parts. This does not commit these schools to any particular theory of the nature of time, and actually there are various theories put forth by different schools—and some would argue that Madhyamaka has not theory of any sort, including no theory of the nature of time. Rather, these views are about the nature or absence of persistence of objects in time. The object is either radically and continuously impermanent according to Madhyamaka, with no inherent nature ever, or by at least some Abhidharma schools the object changes after one brief discrete moment of existence with inherent nature.<sup>142</sup> In either case, the object(s) in continuous flux or each ‘new’ object is causally connected with the previous one in combination with other causes and conditions. This view of objects is frequently associated with presentism in the West, and presentism has an

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<sup>142</sup> A note about ‘moments’ seems in order, since we make reference to these strange intervals throughout the chapter. For Buddhist philosophy, a moment has a distinct meaning, though variously represented as the duration of one thing or another. One definition is the time of one thought, about a 60<sup>th</sup> of a second, and Hammeroff has identified this with the decoherence of an entangled state of microtubules in neurons of the brain—see Hammeroff and Penrose (1996). George Ellis (as we see in *Chapter Nine: Physics of Change*) identifies the present moment with decoherence of the future into the past, with a duration that varies from place to place and time to time. In classical physics, including relativity, time is continuous, so there is no smallest moment, while in quantum gravity there is, but it is mighty small. It has been a vague concept, and continues to be one.

extensive pedigree in Western metaphysics, although its popularity has waxed and waned periodically, and we discuss it here.<sup>143</sup>

One type of persistence which integrates an interpretation of special relativity is that objects persist as sequences of ‘temporal parts’, while the object as a whole is four dimensional. Properties of each temporal part may be different, relating in a causal way to the successive temporal part, and the object as a four-dimensional whole persists. This is called either a 4D-worm view to emphasize the entire object, or a 4D-stages view to emphasize the temporal parts. A fourth thesis I argue for is that the 4D-stages view is relevantly similar to presentism—in either the Western or Buddhist variety—in terms of our main question: The temporal parts and the successive objects, respectively, may have different intrinsic properties, so there are no puzzles of change.

But what exactly do we mean by a previous moment of an object if there is no past? This has to do with *tensing the copula*, the general issue of tense semantics, and an additional thesis argued for in this chapter is that many of the so-called metaphysical puzzles of time and change are avoided if we pay precise attention to the tenses and other terms used in our expression of the problem and its solution, a further example of application of contextualization and model-theoretic semantics. This means that expressions to which we do not pay such attention are frequently incomprehensible; are incommensurate with expressions based on different theories of time; entail various linguistic puzzles to which are unjustifiably ascribed metaphysical consequences; and/or they fail to accurately model the physical world—typically as having discrete times

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<sup>143</sup> For discussion, see Hinchcliff (1996), Bigelow (1996), Zimmerman (1996), Lombard (1999), Merricks (1999), Hestevold and Carter (2002), Markosian (2003), Meyer (2005), Crisp and Smith (2005), Crisp (2007), and Benovski (2009).

instead of continuous times. However, if precise attention is given, then we can more often know what is being discussed; be able to communicate with others who have different theories of time; avoid ‘metaphysical’ puzzles of change; and have confidence that we are modeling the world as it actually is.

We begin with a brief survey of the terminology and initial outlines of arguments for and against (1) the two standard theories of time and temporal statements, what are generally called the A-theory and B-theory after McTaggart (1908), although we will use present-relational and event-relational, respectively, since the latter labels are more descriptive; (2) tense and tenseless semantics; (3) three-dimensionalism and four-dimensionalism; and (4) endurantism, perdurantism and presentism. We discuss the terminology and its utility in analyzing the problem of change. Next, we focus on the problem of change, which is certainly an ancient and perennial issue, and we base our examination on the revival inspired by the work of Lewis (1986), just as so much of the previous chapters were also inspired by the work of Lewis over the past 30 years.<sup>144</sup>

One set of conclusions from arguments in this chapter is that many metaphysical puzzles of the problem of change may be avoided if we are serious about using tense properly. Once we do this and apply a proper attention to contextualization, we find that change of non-intrinsic properties does not entail puzzles of change, especially if those properties are not essential to the object’s identity; non-living objects should not be analyzed like living objects; our definition of what an object is influences how we

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<sup>144</sup> Armstrong (1980), Mark Johnston (1983) and Haslanger (1985) seem to be the source of much of the terminology and inspiration of the discussion, given focus by Lewis (1986:202-204), disputed by Lowe (1987b), responded to by Lewis (1988) and again disputed by Lowe (1988) and Haslanger (1989). Lewis did not respond directly again until (2002), followed by McCall and Lowe (2006, 2009). Of course, many more joined the conversation throughout this thread.

identify it (yet does not influence what it actually is!); and finally a structuralist view of identity in terms of necessary and essential intrinsic properties should sometimes be used to dissolving the puzzles.

A second set of conclusions results from our analysis of presentism, which is found to not be trivial, and some of those who discount it do so frivolously. It is found to be relevantly similar to a 4D-stages view of time, which many do take seriously, and therefore should take presentism seriously. Third, we find some use of physics (e.g. by Lowe) but conclude that it is not enough.

## **B. *Metaphysical theories of time and persistence***<sup>145</sup>

### **B.1. *Summary of the terminology***

We will define, explicate and use the following terms to analyze the literature and our problem of change:

- A-theory of time (present-relational)
- B-theory of time (event-relational)
- Persistence
- Temporal parts
- Three-dimensional (3D) objects
- Four-dimensional (4D) objects
- Endurance
- Perdurantism
- Dimension of the world
- Block universe
- 4D-worm
- 4D-stages
- Presentism.
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*The A-theory of time*, which we call *present-relational* is defined in this way:

Events are indexed to the moving present, thus requiring attention to tense, the issue of *tensing the copula*. Hence, events were in the past, are in the present, or will be in the future. Events which will be in the future will occur when our present becomes that time and then it will occur at our ‘now’, and later will become past events.

*The B-theory of time*, which we call *event-relational* is defined in this way:

Events are indexed to a fixed date or fixed duration between events. She lived for 59 years, from January 30, 1920 to July 5, 1979. The Space Shuttle Challenger exploded on January 28, 1986. These dates and durations never change, regardless of what I think the ‘present’ may be doing.

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<sup>145</sup> Many articles start with a review of these topics, and those articles and other comprehensive treatments have been the sources for this section. See especially Markosian (2008), Sider (2001), and LePoidevin’s (1998) introduction and article.

*Persistence* indicates objects which exist in or through time with a non-zero duration. *Temporal parts* are time-slices of an object, like a spatial-slice which we normally call 'part', but in time. Thus, objects have a left side and right side and also—if they persist—a present time part and a next time part.

Objects are considered *three-dimensional (3D)* if they are wholly present at the present moment, which is to imply that they have nothing which can be considered temporal parts. Objects are considered *four-dimensional (4D)* if they have temporal parts, which means that only part of the object exists in any one moment of time; the rest of it is extended in time, similar to how objects have spatial extent.

*Endurance* is the persistence—if there is such a thing--of 3D objects, and the persistence puzzles and paradoxes come from the presumption of endurance of 3D objects that are also presumed to be 3D—not 4D—and therefore wholly present at the present moment. *Perdurance* is the persistence of 4D objects, actually the existence of the object in all times without change as a single temporal worm or series of temporal stages—see below.

The *dimension of the world* refers to the dimension of the universe. In this context, it is limited to either 3D or 4D. A 3D world is the world that we experience in each present moment. If the world is actually 4D, and in particular if it is Minkowski 4D, then it is a block universe. The *block universe* is a view of the world as 'given', complete in all times, and its temporal parts appear to us in sequence, so that we experience successive time-slices of the world as it actually 'is', i.e. thoroughly existent throughout all time, without change—only our experience changes. The block universe is deterministic. Words fail to describe this.

A *4D-worm* is an object in the 4D block universe, extended in time and space. *4D-stages* are the temporal parts of an object in the 4D block universe. The stages view puts more emphasis on the temporal parts, its time-stages.

*Presentism* is the view of time such that the only time which exists is the present. The other times are conceptual constructs.

### ***B.2. Explication of the terminology***

Contemporary philosophy of time and change begins with McTaggart (1908) and his revisions and replies (1927). In the first paper he introduced the A-theory and B-theory of time, what we henceforth call the present-relational and event-relational theories, respectively. Present-relational expressions include a past, present and future using the metaphor of time that flows through the present and events that will occur, are occurring and have occurred. Hence, we must use tense to predicate events relative to the present moment. It is metaphorically said that the present-relational theory models time as flowing through the present, or the present flowing through time—the transient present. Events occurred in the past; events of the present will be past; events of the future will happen once their time becomes the present and will then become the past.

The event-relational is a theory of relational time, with temporal distances between events that are not indexed to a transient present, hence do not explicitly require attention to tense—although McTaggart (1908, 459) famously argues that it depends on the present-relational. In the event-relational theory, time is represented as a set of relations between events. The statement that a particular event *S* happened on October 11, 1982 indexes an event to a point in time. A statement about the event, if true, will be true forever, while statements that an event happens ‘now’ will not be true in the future, nor

was true in the past. If it is true that the time between event *S* and another event *A* was 20 months, then it will always be true, regardless of when it is spoken.<sup>146</sup>

Within the category of persistence through time are two types: persistence as endurance or persistence as perdurance. Endurance is persistence as a 3D object through time and perdurance is persistence as an unchanging 4D object which exists in all three times (past, present and future).

In the first subsection *B.2.a* we summarize McTaggart's arguments concerning the two theories of time. In *B.2.b* we have a brief discussion of the terminology of persistence of objects through time (eternalism, presentism, three- and four-dimensionalism, endurance and perdurance), presentism and momentariness in the context of Buddhist philosophy. In *B.3.c* we discuss some details concerning 4D-ism, especially in its stage-variant, which we conclude is relevantly similar to presentism. These brief introductions enable a more detailed look at the problem of change: staying the same, even while there is change.

*a. Present-relational and event-relational expressions: the semantics of tense.*

*b.*

In this subsection we examine aspects of McTaggart's analysis of time.

McTaggart assumes what we mentioned previously that language and intuition represent reality, hence if we arrive at logical conclusions based on that language and those intuitions, then it indicates something about the nature of reality itself. McTaggart makes three basic points in his argument about time: (1) Time is understood and measured by change in properties of objects or through the process of change during events. "But

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<sup>146</sup> Clearly this situation requires that all events occur on the same inertial plane and be proximate to each other, otherwise relativistic problems ensue, as discussed in Chapter Nine.

when we ask what we mean by saying that there were different moments of time, or a certain duration of time, through which the thing was the same, we find that we mean that it remained the same while other things were changing” (McTaggart 1908, 459). In other words, we only notice time when something changes. This seems right, and is fairly undisputed. (2) Present-relational expressions are necessary to describe change, and such expressions are background assumptions even to event-relational expressions. While McTaggart identifies this as a requirement, he then argues that it is inconsistent: “But this is impossible. An event can never cease to be an event. It can never get out of any time series in which it once is” (McTaggart 1908, 459). This point is slightly more controversial, since counter-examples have been proposed and debated. However, use of tense seems generally necessary: *E* will happen; *E* is happening; *E* has happened. (3) The highly controversial point has two components: (a) present-relational expressions are inherently contradictory, resulting in what is now called McTaggart’s Paradox; and (b) this indicates that time is unreal.

McTaggart’s arguments are detailed and provocative, and it is generally agreed that it is a mistake to dismiss them out of hand. Analysis of his arguments has at least served to clarify our understanding of how we should represent time in language and have also served to modify our philosophically sophisticated intuitions. His ‘paradox’ is that present-relational times are all times without foundation, hence resulting in vicious infinite regress. By time being all times, he means that the present moment was the future, is the present and will be the past, the future will be the present and past, and the past was the present and future. The argument proceeds as follows: First, all time involves change:

A particular thing, indeed, may exist unchanged through any amount of time. But when we ask what we mean by saying that there were different moments of time, or a certain duration of time, through which the thing was the same, we find that we mean that it remained the same while other things were changing. A universe in which nothing whatever changed (including the thoughts of the conscious beings in it) would be a timeless universe (McTaggart 1908, 459).

Hence, change in the properties of one object must be used to measure the change in properties of another. This seems right, although see Shoemaker (1969) for an interesting alternative.

Second, McTaggart argues that change can only be explained in terms of present-relational expressions. He considers the possibility of analyzing change with only event-relational expressions, that a change consisted of events ceasing or beginning without reference to past, present or future:

But this is impossible. An event can never cease to be an event. It can never get out of any time series in which it once is. If N is ever earlier than O and later than M, it will always be, and has always been, earlier than O and later than M, since the relations of earlier and later are permanent. And as, by our present hypothesis, time is constituted by [an event-relative] series alone, N will always have a position in a time series, and has always had one. That is, it will always be, and has always been, an event, and cannot begin or cease to be an event. (McTaggart 1908, 459).

As mentioned previously, statements using the event-relative series will maintain their truth value through all time. McTaggart points out that the only way to attribute change without changing the event itself is by using the present-relational, i.e., by noting the sequence of events as that which will occur in the future, do occur in the present, and did occur in the past.<sup>147</sup> Le Poidevin summarizes the argument as follows:

1. [Event-relational] relations are temporal relations.
2. There cannot be temporal relations unless there is change.

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<sup>147</sup> This argument has been disputed by Mellor (1981, 1998), who concluded that change can be expressed without the A-series, and that McTaggart has only shown the unreality of tense, not of time.

3. There cannot be change unless time in reality has [a present-relational] ordering. *Therefore:* There cannot be [event-relational] relations unless time in reality has [a present-relational] ordering. Le Poidevin (1998, 16).

4.

Third, McTaggart says that present-relational expressions involve contradiction and so cannot describe reality. The central feature of McTaggart's argument is the construction of a contradiction when using the present-relational, or as it is called: McTaggart's Paradox. He says that the definition of time using the present-relational uses time in the definition, hence this either (1) entails a vicious circle; or (2) if an iterated use of time is used to avoid the circle, then a vicious infinite regress entails. Iterated use of time is like 'in the future, something will be past'. His argument is based on the ideas that past, present and future are "incompatible determinations" (McTaggart 1908, 468), yet every event is required to be one of these three. Not only that, but every event is required to have all three characteristics of being in the future, the present and the past. "If M is past, it has been present and future", etc., with all the other possible combinations. "Thus all the three incompatible terms are predicable of each event, which is obviously inconsistent with their being incompatible and inconsistent with their producing change." But these characteristics are not properties of the event at the same time, so why is it inconsistent? McTaggart acknowledges this objection:

It is never true, the answer will run, that M *is* present, past and future. It *is* present, *will be* past, and *has been* future. Or it *is* past, and *has been* future and *present*, or again *is* future and *will be* present and past. The characteristics are only incompatible when they are simultaneous, and there is no contradiction to this in the fact that each term has all of them successively. (McTaggart 1908, 468).

He then answers the objection by showing how a vicious infinite regress follows. As Lowe explains, "...the same threat of contradiction then arises at this higher level of second order tenses" (Lowe 1987a, 63-64) as used in 'will be present' or 'has been future

and present' in order to escape from the simultaneous use of different first-order tenses referring to the same event. Lowe continues:

For instance, to say that an event *was future* is to say that it is *future in the past* (where this last 'is' may be read as tenseless). But this same event is also *past in the past*, which is again inconsistent...repeated recourse to this manoeuvre of resorting to higher-order tenses in order to evade the threatened contradiction can only serve to generate a (vicious) infinite regress, and so the manoeuvre can by no means resolve the original difficulty arising with the first-order tenses. (Lowe 1987a, 63-64).

Finally, McTaggart concludes that time is unreal.

In more than 150 articles in the recent literature, responses have included somewhat complex formal tense logic and convoluted locutions of iterated tense statements, similar to but more complex than 'in the future this event occurring now will be past'. We can only summarize here what seems to be a satisfactory resolution of the controversy arrived at in this literature.<sup>148</sup> There seems to be consensus by Lowe, Le Poidevin and Mellor—the major protagonists in the recent debate—that, first, tense semantics can result in contradictions, but those contradictions are invariably a result of failure to apply care and precision in expression. For example, 'I admire Socrates' stirs up all kinds of potentially paradoxical meanings, since it mixes the present tense about someone who does not exist presently. Yet this sentence really means that 'I admire who Socrates was' or 'I admire Socrates' philosophy'. In this way *apparent* contradictions—and McTaggart's 'Paradox' is an example—will be resolved. The clarification may require imposition of metasemantics which, as with metamathematics and metaphysics in their own contexts, imposes rules concerning the way our semantics should be used to avoid contradictions and—most importantly—to accurately represent the ontological

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<sup>148</sup> Mellor (1981, 1998), Le Poidevin (1991, 1993), Le Poidevin and Mellor (1987), Lowe (1987a, 1987b, 1992, 1993) based partly on Prior's (1967) formalization of tense logic.

character of time. An example of such analysis and care, in response to McTaggart's claim that every event is all three of past, present and future because they were, are and will be, is the following by Lowe:

Well, certainly, 'e is present', 'e is past', and 'e is future', said simultaneously, express contradictory statements. But what about the claim that what is future will become present and then past (so that every event is past, present and future)? This is simply false, or, more strictly, incoherent. What should be said is that if e is a future event, i.e. if e will occur, then *it will be possible* to express a true statement by means of the sentence 'e is present', or 'e is happening now'. If it is asked whether we can now say something which expresses now what that sentence will then express, the answer is yes: for the statement that we now express by saying, for instance, 'e will happen tomorrow' is the same as will be expressed tomorrow by saying 'e is happening today'. (Lowe 1987a, 66—my italics).

McTaggart's lack of care is to make an indexical fallacy. To say that 'e will be present' is an example of such a fallacious statement which uses an iteration of tense operators, and should instead be substituted with 'there will be a time when e is present', therefore avoiding the vicious circle or regress that McTaggart uses to conclude that time is unreal. This hair-splitting is important to remember in any analysis of temporal relations, and is an example of the importance to clearly index statements and propositions to domains of discourse, i.e. to the context of discussion and the rules of the language of that discourse.

The second conclusion—reformulated and extrapolated to support our own thesis, but still consistent with Lowe's analysis—is that tense semantics does not entail metaphysical consequences concerning the nature of time, but rather coherent tense semantics should enable accurate representation of the nature of time, an abstract linguistic model of the way time actually is. Unless we are explicitly and purposely divorced from reference to the physical world, as in pure mathematics, the modeling should go the other way: We learn how reality is through empirical investigations and

then model it in language that may be technical and may be different from our native tongue. Then we *develop* the appropriate intuitions, meaning the intuitions that match reality, rather than learning how reality is through our native language and pre-analytic intuitions. The revision of our intuitions becomes drastic once we integrate modern physics into our thinking.

*c. Persistence: setting the stage*

In this section we examine the terminology of persistence. Persistence is considered the general term for the existence of an object over time. In the categories of persistence are endurance, which is persistence if the object is considered to be three dimensional, and perdurance if the object is considered to be four dimensional. Concepts of persistence are, however, typically associated with theories of the nature of time. Our ‘normal intuitions’ of time seem captured mostly by the present-relational, although event-relational concepts are mixed in: We and objects exist in the present, but time ‘passes’ and therefore there is a past, we have a past, and things happened in the past that has occurred. The future has yet to occur, but will if we live past this moment into the next which becomes the present, and then the past. We also use an event-relational concept of time, but events are placed in the future, present or past, and perhaps will be, are and have been each of those. So it seems that McTaggart was right in this regard, that those are our intuitions. Although clearly different people may have different intuitions—the question is what the nature of time is, and we only start with our intuitions; they must be tested empirically.

An alternative theory of time is presentism: there is only the present, and the future and past are conceptual constructs. Presentism is the doctrine that what exists is now and only now: it is ‘fully present’ in the present time or not at all. Hence, presentism

could be characterized as: ‘The future hasn’t happened, may not, isn’t real, and doesn’t really exist; the past has happened, but only when it was present, hence is also not real now.’ As Zimmerman (2005, 6-7) pointed out “Many serious tenses are also presentists.” So we could revise the characterization of presentism into a more event-relational idea because describing times as present-relational implies that there are times which are not present: ‘Events happen now, and that is the only time in which events happen; We imagine a future when an event will happen, but that is only our imagination; it is fictitious; events happened in a previous now, and that is what we call past, but really there is no such thing; it is a memory, a mental event.’ Recall that not all Abhidharma schools and certainly Madhyamaka views do not include metaphysical theories of the nature of time that can be described as presentism. Theirs is mainly a view of objects through time, with either a discreteness or continuity of objects that are momentary or not even momentary, at least if we are defining existence as requiring inherent nature. Many Buddhist views, however, support an ontology of objects, of real things which says that all of those things which are real are those things wholly present now, yet they frequently define ‘real thing’ as something with inherent nature, hence Madhyamikas would deny that such things exist. We will examine in later chapters whether something with no inherent nature can be real and persist.

Some Madhyamaka scholars insist that it is the doctrine of momentariness that leads to denial of persistence, and does not lead to presentism, and that Nyāya might be construed as presentist, yet it has enduring objects. It is momentariness, not presentism, in the Buddhist perspective which entails that the object in each moment is new and ‘fresh’: there is no persistence, and only radical impermanence. Presentism in the

Western view is described in this way: What exists is ‘wholly present’ in the one present time. This is, of course, trivial since ‘exists’ is tensed and refers only to the present. But there is more to presentism than that; it means that the past and future are unreal, and only the present is real:

Analogous to actualism in modal metaphysics, it is the doctrine that all reality is confined to the present—that past and future things simply do not exist, and that all quantified statements that seem to carry commitment to past or future things are either false or susceptible of paraphrase into statements that avoid the implication. (Zimmerman, 2005b:402).

What has existed does not exist anymore and what will exist does not yet exist (if it ever will). Yet, the presentist view has been called either trivial or false. Consistent with Zimmerman, it seems that this accusation is due mainly to a faulty application of tense:

Many serious tenses are also presentists. The presentist says: The only things that exist are those that exist at present. The ‘once was’ no longer exists and the ‘will be’ doesn’t exist yet. But the proponents of presentism are also confronted with a skeptical challenge to the significance of their thesis. Is the first occurrence of “exist” in the presentist’s assertion a tensed one? Then the presentist is simply making a fuss over a pointless tautology: “The only things that exist now (i.e. at present) are those that exist at present”. Who denies this? Or is “exist” here a tenseless verb, equivalent to “existed or exists now or will exist”? But then it’s an implausible metaphysical thesis: the claim that everything exists at all times, that nothing can have a less than eternal history. So either presentism is a boring truth, or an interesting falsehood. (Zimmerman 2005, 6-7).

If presentism means, as Meyer (2005, 213-215) states it: “Nothing *exists now* that is not present”, then it is certainly trivial. If it is to mean “nothing has ever existed that does not exist now” then it is certainly false. But it doesn’t mean that. Zimmerman goes on to explain that presentism is more than either of these two options:

Presentism is neither; it is a substantive thesis, and one that is not equivalent to the claim that everything exists eternally. Just as the serious tenser thinks there is, at bottom, only one kind of truth, and that is “truth-now”; so the presentist thinks there is only one largest class of all real things, and this class contains nothing that lies wholly in the past or future. Presentism is, in fact, a thesis about the range of things to which one should be “ontologically committed”. (Zimmerman 2005, 7).

Thus presentism is not a trivial statement that whatever exists now only exists now. Rather, it is a commitment to empiricism, to what is actual in our physical experience rather than concept, memory or imaginary. And what is actual in our experience is only the present moment—at least until we include relativity. Presentism is different than McTaggart's present-relational series, which acknowledges change and a series of temporal events in the past, present and future. However, McTaggart argued that present-relationality entailed a paradox, making time unreal. Presentism rather seems consistent with that view: Time—in the sense of a real past and a real future—is unreal; only the present relates with physical reality. The rest are mental events of imagination, some of which we may call memory, which is an accurate or inaccurate representation in this present moment of what may or may not have occurred in the past.

*d. Four-dimensionalism*

Alternately, those who promote the idea that objects persist are generally not presentists, because there is some allegiance to the existence of other times: Objects persist through time, so there must be multiple times 'within' which something persists. Persistence is aligned with two types of theories of time: 3D time and 4D time, each of which refers to two corresponding types of objects. A 3D object exists through time—perhaps with changing properties—and a 4D object/worm/sequence of stages does not change (the stages change but the sequence doesn't). The 3D theory of time and persistence is endurantism: An object exists as a 3D object in each time, as time flows through the present, or as our experience flows over time (the metaphors abound and so does the imprecision). The 4D theory of time and persistence is perdurantism: An object

exists as 4D throughout all time as each ‘moment’ of time and the object’s 4D existence becomes aware to us.

The 4D object may be called a ‘4D-worm’, a temporally and spatially extended object, existent fully as it will be, is and has been through all time. 4D objects have extension in the dimension of time in a similar fashion to their extension in the three dimensions of space. While a lake may be deep in one spatial location and shallow in another, it may be liquid at one temporal location and ice at another. The 4D-worm has temporal parts corresponding to infinitesimal moment-slices of the continuous flow of time.<sup>149</sup> One cannot use the 4D-worm view to distinguish the object in one time from the object at another time except in terms of temporal parts. Our 4D-worm-lake is the mereological fusion of all temporal parts of the lake through all time in which the lake exists as this lake.<sup>150</sup> In the 4D-stage view an object is a collection-continuant of 3D stages bound together over different connected times by causal relations, and we may talk of a temporal part or stage of an object at a particular time. Each temporal part/stage is in this sense distinct from the object’s other parts/stages, while at the same time those stage-parts are causally-connected, thus the entire continuant is the 4D object with its temporal parts being its temporal stages. We therefore can say with ontological commitment that our 4D-stages-lake *is*, at this present time, the ‘now’ temporal stage = ‘now’ temporal part of the 4D-stages-lake, just as we can say that the 4D-stages-lake ten minutes ago *is*

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<sup>149</sup> There is something very wrong about this way of thinking of the continuity of time, since there is no smallest infinitesimal moment-slice, hence, in this view each ‘moment’ must have a finite duration, yet there is no such a thing ontologically. This somewhat muddies the waters for temporal parts but I assume that the sediment would settle if we applied a precise calculus to the problem and the mereological fusion which must take place (see below).

<sup>150</sup> Note the mention, but lack of focus, concerning identity over time and the implication that there must be some set of properties that make the lake the “same” from one time to another. We are not addressing these issues here, but examine them later when we look at temporary intrinsic properties.

the temporal stage=temporal part of the 4D-stages-lake then. The 4D object in the worm view is the mereological fusion of its temporal parts, while the 4D object in the stage view is the sequence of its causally-connected temporal parts.<sup>151</sup>

Four-dimensionalism has been promoted and defended in a large body of literature (see Sider 2001b for a comprehensive review and defense), and has been justified in part by special relativity, to be discussed in a later chapter. However, four-dimensionalism is frequently linked with mereological essentialism which entails some very weird conclusions. In many 4D accounts, a 4D-worm includes all the parts that it ever has had or will have, otherwise it would change—but the main idea is that the 4D object is changeless, thus solving the problem of change. Yet, this immediately entails problems with Ship of Theseus-type replacement puzzles in the identity of an object. With some reasonable justification, going backwards and forwards over all time, what parts an object will include, has included, and now includes, encompass at least an atom from billions of other objects of the geologic and cosmological time scales of ‘all time’. This composition characteristic is shared by all other medium sized dry goods also. This wide view can be expanded to consider the way the Sun is a second generation star, and how it and the accretion disk that became our solar system and planet were born from the remnants of first generation stars. As is said, ‘we are stardust’. Volcanic dust and ancient seas produced sediments which have spread over the entire planet’s surface, hence we most likely have an atom from all eruptions throughout millennia, since the dust that ‘is’ part of the 4D volcano is breathed by 4D me and integrated into my body, so there is a temporal and spatial part of me that is a temporal and spatial part of the volcano. Hence, these ‘4D-worms’ become so entwined throughout past time as to make any kind of

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<sup>151</sup> See Sider (1996, 2000, 2001) for further explication.

identity of an individual totally incomprehensible, and this is another thesis of this chapter. There does not seem to be acknowledgement in the literature of the seriousness of this situation as the obstacle that it should be to accepting a 4D-worm view.<sup>152</sup>

The 4D-stages approach is an alternative to the 4D-worm approach which—according to Sider (2001)—solves a number of these types of problems, and can be argued to solve many of the metaphysical puzzles like Sorites, collocation, Ship of Theseus and Heraclitus’ river, plus the general problem of change of temporary intrinsics. As mentioned, the 4D-worm is a mereological fusion of temporal parts, and the 4D-stages are the temporal parts that are causally connected. The distinction may not be easily understood, since the worm and stages are related. Sider does not provide much in the way of precise distinctions. What we normally call an object, like a table or a rock, when viewed through time is called a *continuant*. In the worm view, a continuant is a 4D object, and we only experience the present temporal part of it. In the stages view, what we say is an object is just the present stage. Hence, these sound similar. Here is what Sider (2001) says about them:

A four-dimensionalist is free to accept any of a number of possible views about this relationship [between temporal parts and ordinary language]. On the *worm view*, it is spacetime worms that *are continuants*—the referents of ordinary terms, members of ordinary domains of quantification, subjects of ordinary predication, and so on. This is the usual view adopted by the four-dimensionalist. On the *stage view*, on the other hand...it is instantaneous stages rather than worms that play this role. (60-61).

In response to Lewis’ analysis of temporary intrinsics and his own shape on sitting or standing, which we discuss further below:

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<sup>152</sup> Perhaps this can be viewed as a description of the interdependent arising of Madhyamaka philosophy. However, it would be as much a problem for that philosophy, since we would end up with a single, monistic entity, but see the discussion about dharmakaya footnote 83 in *Chapter Two: Madhyamaka*, Section E.1.

According to the stage view, I myself have the property *being straight*, for I am a stage, not a spacetime worm. Thus, the stage view allows both that temporary intrinsics are instantiated *simpliciter* and that they are instantiated by ordinary continuants such as persons and candles. (98).

In order to solve collocation problems, e.g. the statue and the lump of clay:.

Four-dimensionalists usually argue that the best account of the puzzles is based on the *worm view*, on which the objects of our everyday ontology are sums of temporal parts—‘space-time worms’. While we agree that the worm view gives a *good* account of the puzzles, I think that the *best account* is that of the *stage view*, according to which ordinary objects are momentary stages. (140).

In further defense of the stages view as a solution to coincidence paradoxes:.

The central claim of the stage view is supposed to be that *a speaker refers to stages of worms sliced at the time of utterance*. If we could assume that every speaker follows a one-dimensional worldline through spacetime, and that each of her utterances occur at a single point along this worldline, then the stage view’s central claim could be given a clear sense: when a speaker makes an utterance at a point *p* of spacetime, she refers to temporal stages of worms at the time that contains *p*, where ‘time’ and ‘temporal stage’ are relativized to her frame of reference when she passes through *p*. (199).

These comments serve to point out how similar the *stages view* is to presentism, where “momentary stages” are all that objects are, as noted further below. However, the *stages view* is still a variant of a four-dimensional view: In the 4D-stages view, each stage is just one temporal part of a four dimensional object. Each stage may have different properties from the next, while the 4D object itself perdures through the four dimensions as an unchanging composite object with different properties in each temporal stage, just like a spatially-extended object has different properties in one spatial part from another.

The 4D-stages view has significant similarities to presentism that are relevant to the current context of deciding if objects persist or are impermanent. For presentism, new objects appear each new moment and potentially have different properties, each object is causally connected to the next (with additional causes and conditions) and the sequence

of object-continua occurs. With 4D-stages, each stage is impermanent with potentially different properties, each stage is causally related one to the next (with additional causes and conditions) in a continua of stages, while the object persists (which we call perdurance).

### ***C. The problem of change and temporary intrinsics***

The problem of change is how something can be the same thing while changing. This immediately sends up flags warning of contradiction, so we must step back to be concerned with identity. In *Chapter Three: Metaphysics of Dependence* we discussed the identity of an object in distinction from another object; in *Chapter Four: Metaphysics of Composition* we discussed the identity of an object in distinction from its parts; in this chapter we discuss the identity of an object over time. If we define a specific river as being a specific composition of specific water molecules, then we are tying ourselves to mereological essentialism: All parts of an object belong to that object essentially. Hence, as molecules come and go—as they will—then the river in one time is never the same river as it was or will be. However, if we define a specific river as *this* body of *flowing* water, coming from up there, going down there, with new water arriving and old water leaving, within varying bounds of spatial dimensions, sometimes flooding its banks and sometimes drying up, then *the river as defined* persists while parts change. The latter is more of a structural perspective and is the more common, though quite imprecise, convention. If we define David Lewis as that person who is and must be sitting in a chair, then when he stands he is a different person according to our identity. If we define David Lewis as the philosopher who wrote *Lewis (1986)*, then he is the same person sitting or standing. The latter is the common convention, but I am certainly not proposing that any convention will do: It is of central importance to decide what Lewis is before we start the analysis of his changes, and that decision must be based on his intrinsic properties. Note, of course, that our definition of Lewis does not change Lewis. Lewis seems to think there

is something intrinsic to himself that he is sitting or that he is standing, and such a clearly non-intrinsic property entails a problem of change:

The principal and decisive objection against endurance, as an account of the persistence of ordinary things such as people and puddles, is the problem of temporary intrinsics. Persisting things change their intrinsic properties. For instance: when we sit, we have a bent shape; when we stand, we have a straightened shape. Both shapes are temporary intrinsic properties; we have them only some of the time. How is such change possible? (Lewis 1986, 203-4).

Lewis identifies his own shape (sitting or bending) as an intrinsic property, probably because it is internal to himself (I have never found shape as intrinsic reasonably justified) while internality should not—according to our conclusions of Chapter Three—be the only criterion: It may be necessary but it is not sufficient. The problem of change is discussed as the problem of temporary intrinsic properties. The problem is: How can intrinsic properties of an object change while the object persists? It is solved in Madhyamaka arguments by saying that all properties are relational and impermanent. A Western presentist who is also a believer in radical impermanence agrees that the object doesn't persist. Hence the problem of change is a problem for those who do not accept this solution, and there certainly are some good arguments against presentism and impermanence, as we see below. Our question, therefore, is whether another solution is more plausible, or if we are forced back into radical impermanence and perhaps even only relational properties, and all their consequences.

Since Lewis' personal properties are outside the scope of this dissertation, we use Lowe's (1987, 1988) example of two planks of wood joined endwise with a hinge. Employing the terminology of *Chapter Three: Metaphysics of Dependence*, the shape of this composite object called 'plank-pair' is an internal property, and with the shape is therefore independent of anything external. The shape is had in virtue of the plank-parts

alone, independent of accompaniment by any other object in the sense that whether or not there is another object, there is no difference in the shape of the plank-pair.<sup>153</sup> However, the shape is only essential and necessary to the plank-pair if the plank-pair is *classified* as a pair of planks joined with a hinge that has a specific shape, i.e. as the bent plank-pair, or the straight plank-pair, for some *ontological* reason. For instance, that it cannot change shape without being destroyed. With this specificity to the classification of what the object is—and somehow that classification has to be more than merely semantic and conventional to have metaphysical consequences—if the shape is changed by straightening or bending respectively, then we must say that it is a different object.

In the conclusion of that Chapter Three, I promoted the view that *internal, in virtue of, independent of other objects, necessary and essential* are all required in the definition of what is intrinsic. In different domains of discourse or scientific domains of validity we may classify the kind or object in different ways, i.e. by emphasizing the essential and necessary nature of certain properties but not others, or possibly even emphasizing its pragmatic use for us.<sup>154</sup> How we initially view the identity of a kind or thing must be specified, or at least be clearly understood, before we can consider if or how it persists in time. This is an example of relationality of the identity of an object over time. Briefly, defining the object in a certain way will have consequences to our identification of it if there is some physical structure, function or behavior which

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<sup>153</sup> I must add the caveat ‘in a wide range of physical contexts’ since we can picture a number of physical contexts in which the shape is quite dependent on other objects, e.g. that there is an appropriately placed mass sufficient to un-bend the plank-pair due to gravitational attraction. Also, in moving frames or gravitational fields the shape may vary. But for now those contexts are not directly relevant.

<sup>154</sup> I therefore take issue with Garfield’s characterization of a table as conventional simply because it could be defined as something else, mentioned in Chapter Two. If a child sits on a kitchen table that does not make it a chair; rather she is using the table as a chair. So I would de-emphasize the pragmatics and emphasize the ontological. With human utility of objects, there is vagueness, but less so with natural objects.

supervenes necessarily on the particulars of the definition. The ‘same’ item may have different functions depending on its shape and/or simply on its relationship with other structures—how it is used, interacts with other things, what is intended for it, etc.

Different intrinsic properties of the item may be relevant to its different roles, and also there will be different relationships and interdependencies with other entities. Whether such properties are of necessity intrinsic or relational is the main question, but also whether they change, or whether the changing relationships entail that it is a ‘different’ item. The key distinction between intrinsic and not intrinsic should, however, depend only on the metaphysical or ontological character of the object, not on our classification schemes, identity classes, semantic relationship to it, or concepts of it. To establish this, I argue that it is necessary to establish the identity of the object as being in an ontic domain in order to be sure of its ontological character, as determined by physics theories which are true in their ontic domain. Otherwise, if we only can identify the object and the phenomena of concern within a merely pragmatic domain, there will be vagueness in our understanding of what it is. However, I do not mean to suggest that this implies that the object itself necessarily would have any vague character. These issues are yet to be addressed fully, and while the succeeding analysis in this chapter will assist us in clarifying some concepts, much of the work must await the physics chapters. There we see that differences arise simply from the ‘same’ item being looked at from different energy-scale domains or in terms of different phenomenal interactions with which it is involved. The semantic and epistemic relationality in our discourse and categories should be consistent with the ontic relationality of the actual being of the entity, and that

requirement should be built into our physics epistemic framework. Our discourse and categories should accurately model what the entity actually is.

We find here another example of one of the major theses of this dissertation, contextualization: In order to avoid metaphysical puzzles, and realize how at least some of them are solely word games with no ontological consequences, we must be precise in specifying the context, domain of discourse of philosophical analysis, and/or the domain of applicability of our scientific theories. If we want to avoid metaphysical puzzles of change, we must carefully define the properties of the object under discussion *prior* to the analysis. If we define either this kind—the plank-pair kind of object—or this particular plank-pair as ‘these [types of] two pieces of wood bound with a hinge, which can be either bent or straight’, and indeed that accurately (ontologically) categorizes the object, then its particular bent or straight shape is an accidental, secondary and contingent property, not necessary, essential and therefore not intrinsic—even though internal and independent of other objects and independent of accompaniment—because a particular choice between the two shapes is not essential to its identity. Therefore, in this case there is no problem of change: Accidental or relational properties may change without entailing a contradiction, while the plank-pair persists. If we add to the definition that the plank-pair must be bent, and justify it ontologically, and then if it is bent at time  $t_1$ , but at time  $t_2$  it is straight (perhaps it was broken and re-set straight), the idea that we then have a new plank-pair could be justified.

The above analysis contradicts Haslanger’s (1989) suggestion that there is a significant obstacle to thinking that we can consider that the plank-pair’s shape is not intrinsic: According to her shape of some sort is intrinsic. Indeed, I agree that there is no

such thing as a shapeless plank-pair blob; every solid must have some fairly well defined shape or other, hence some shape is necessary and essential to it being a plank-pair. Hence, shape in general is intrinsic, although which particular shape may not be: Specific shape for many objects certainly may change over time. Hence specific shape is called a ‘temporary intrinsic’: The object “is intrinsically bent at one time and intrinsically straight at another” (Haslanger 1989, 123). This view that shape is intrinsic, hence change in shape is an example of the problem of change, is a major focus of the literature, and is largely based on the point raised by Haslanger that shape *of some kind* is intrinsic. She concluded that *the particular current* shape is therefore intrinsic. I view this as a fallacious use of the idea of intrinsicity and understanding of physical shape. The fact that the object has shape does not change; it still has a shape.<sup>155</sup> Yet it is only the particular shape that changes. The particular shape is only intrinsic if we are confined to a context in which the object has an essential and necessary particular shape, for example if it is fixed in that shape. The original idea of our plank-pair, with a flexible hinge, with the shape easily changed without breaking it, is certainly not that sort of thing. Another example of the ontological nature of shape is chemical isomers, molecules with the same composition but different structural arrangements which typically entail different physical and/or chemical properties. On the basis of the findings in *Chapter Three: Metaphysics of Dependence*, within a domain the very notion of ‘intrinsic property’ *requires* that they be permanent within a domain as long as the entity exists at all, because an intrinsic property is necessary and essential to what a thing is: its very identity.

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<sup>155</sup> This is the problem of determinate and determinable. See [comp.uark.edu/~efunkho/determinable.pdf](http://comp.uark.edu/~efunkho/determinable.pdf) for an introduction and bibliography.

Note that we want very surely to know that the object doesn't really change when we change how we define it: The latter involves semantic, epistemic, and conceptual issues of how we understand things, rather than how things are. Yet those issues may have metaphysical consequences: Instead of simply a semantic problem it seems that we also have a metaphysical problem: what it is, not just what we call it. Lowe (1988) suggests that Lewis (1986) conflates these two, thus providing a bad solution to both, and therefore Lowe distinguishes them and deals with them separately. The semantic problem of change relates to how we define the property of an object in relation to time. However, Lowe's metaphysical problem of change relates directly to the semantic problem. The problem is "how there can *be* objects for the description of which the semantic problem arises—that is, how there can exist objects such that we need to be able to say, without fear of contradicting ourselves, that one and the same such object may undergo a change from possessing one intrinsic property to possessing another incompatible one?" (Lowe 1988, 76). Two properties are incompatible if an object may not have both properties at the same time, e.g. bent and straight. We must deal with the semantic problem before the metaphysical one. Starting with our "common-sense talk of persistence through change" and seeking solution which revises that talk the least, Lowe offers three possible ways to define the object and its property in relation to time:

We may parse '*a is F at t*' either as (i) '*a is F-at-t*' (so that what is really being ascribed to *a* is, say, a shape-at-a-time—a kind of relational property), or as (ii) '*a is-at-t F*' (so that the ascription of a shape to *a* is temporally qualified, i.e., the property-exemplification relation between *a* and a shape is relativized to a time), or finally as (iii) '*a-at-t is F*' (so that a shape is ascribed to a temporal part of *a*—Lewis's favoured solution). (Lowe 1988, 73, my italics).

The first *solution i* is rejected because in this solution the predicated property is identified as being relational to time, and therefore revises our talk about properties—they are

supposed to be properties, not relations. There is no problem considering some *generic shape* as being a relation to time—sitting now, standing then; this is just a statement of the time evolution of the system. However, the specific property of a specific object cannot be a relation to time—it is rather a property *of the object* that is had at a time, which is *solution ii*. Lewis (1988, 74) says *solution ii* is a variation of the first but Lowe finds it unique. The first solution is strongly rejected by Lewis, Haslanger and Lowe due to hypostatization of time apparent in this solution, thus supposedly entailing a relation to time. Relation to time is considered relation to some other object, hence it is concluded that the property is relational and not a proper property, and cannot be intrinsic. Yet we are told that sitting shape is intrinsic, so it must not be relational to time. This analysis is understandable only when we realize that all parties are considering each particular shape to be intrinsic, even though each shape is clearly not necessary and essential, while I argue that for a property to be intrinsic it must be necessary, essential, had in virtue of the object itself, and independent of other phenomena. Therefore, it seems that their assumption is incorrect. If we consider the shape of our plank-pair, considered in the context of physics descriptions of dynamic time evolution of properties, the shape must be a function of physical conditions which must be functions of time, and will also be a function of time directly, but that doesn't entail that there is an object called 'time' to which all properties are therefore relational. It's just that non-essential properties change as functions of time without changing the object *per se*. A drop of water that changes shape as it drips off a pipette is still the same drop, because its shape is not an essential part of its identity—and actually its ability to change shape, and the conditions which determine the shapes that it takes on, are essential to its being.

Actually, once we confine analysis of the functional relationships of physics equations to the context of only non-living physical phenomena, I would argue that *solution i* should be seen as the main solution, and this idea is in significant contrast to much of the rest of the literature, perhaps due to the lack of confinement, i.e. distinction between living and non-living objects (and perhaps some confusion about personal identity). It becomes clear that this is the best solution once we deny use of two factors: what we identified as the *misuse of intrinsicity* and also what we previously identified as the *living object fallacy*. The first is that intrinsic properties must at least be necessary and essential, hence cannot change within the same entity. Recall that the living object fallacy has two parts: (a) the *similarity assumption* is the certainly unjustified and most probably fallacious assumption that non-living objects must be characterized in the same way as living objects; and (b) the *unitarity assumption* that living objects are, by their nature, unitary and with various unspecified intrinsic properties. Regardless of the validity of the unitarity assumption—which is most likely false anyway—the former is not justified. Once we purge the analysis of those two factors, *solution i* can be seen as the correct one—although full justification and explication must await future chapters. This solution—which we name *the dynamic solution*—is simply an application of the functional approach common to physics dynamics.

Lowe's favored solution, based on Haslinger (1989) is solution *ii*, hence we can define plank-pair as being-at- $t_1$  bent or being-at- $t_2$  straight. Hence, according to this solution, shape is intrinsic and specific shape is temporarily intrinsic and indexed to time. Temporary intrinsics may change, while the plank-pair persists with shape of some sort. Haslinger's and Lowe's solution is called the 'adverbial solution' to the semantic

problem of change and temporary intrinsics. We see that these first two solutions collapse into the first in the non-living context, consistent with Lewis' suggestion that they are variations of each other, even though he rejects both.

The third solution *iii* is Lewis' favorite, the temporal parts solution, also defended by Sider (1999, 2001). In this view, the object is four-dimensional and therefore is said to perdure through time. The object as a whole actually exists entirely without change, yet has temporal parts just as it has spatial parts, and properties of different temporal parts may be different. The 4D-stages view promoted by Sider makes this situation explicit, in that each temporal part is said to be a stage of the object, a temporal segment of the whole with particular intrinsic properties. A later stage may have different intrinsic properties. Therefore, according to this view, there is no real change in the properties of the object as a whole—it just has different properties at different temporal stages. The object as a whole is complete, existing in different times. The most significant problem with this solution is the entwining of the identity of all objects throughout the universe once it is combined with mereological essentialism, which it typically is, as previously mentioned. If this view is divorced from mereological essentialism and combined instead with a different view of identity, and then divorced from the *living object fallacy*, then it could perhaps be a coherent solution, if one can accept 4D objects into our ontology.

The main reason to adopt a 4D ontology, of course, is special relativity, which blurs the difference between 'now' and 'then' when in different frames of reference or at different locations. We then add temporal parts in order to make it consistent with our experience of the present in a present-relational (A-series) intuition about time. We then can offer a solution to the problem of change as change of properties of temporal parts of

a 4D object. The determinism of the block-universe view of the 4D world is tempered, however, with systemic uncertainties of decoherence of entangled states, and we therefore must modify that view with something like George Ellis' crystallizing universe, to be discussed in *Chapter Nine: Physics of Change*.

Without the relativity reason to adopt a 4D ontology, an alternate is the structuralist one promoted by Lowe, which does not require temporal parts and four dimensionalist thinking. Lowe's metaphysical problem is expressed in terms of the composition and structure of the object. First, he asks the question: How "one and the same such object may undergo a change from possessing one intrinsic property to possessing another incompatible one" (Lowe 1988, 76). Again, he assumes that there can possibly be such a change to incompatible *intrinsic* properties, while I am proposing that there is no problem with change to incompatible *relational* properties and there is no change to *intrinsic* properties: The only changes are to non-intrinsic properties. Now, our solution is forming: We consider only the necessary, essential and independent properties of an object that form its structural, causal relationships in particular contexts as intrinsic (if they exist) and those do not necessarily change with change of relational properties.

Lowe's expresses it this way:

...that the identity of time of certain objects consists in the preservation of certain relationships between their constituents at any given time: thus the identity of a ship consists (roughly speaking) in the maintenance of certain structural relationships between the objects that constitute its component planks and spars at any given time...[this] explains how...being numerically *one and the same*...at times *t* and *t'*, [the object] may nonetheless differ in *some* of its properties at the two times—differ because *its* diachronic identity is consistent with a degree of replacement and/or rearrangement *amongst its components*...(Lowe 1988, 76).

Our characterization of the kind of properties which form the structure is embodied in

Lowe's "certain structural relationships...that constitute its component[s]..." The

replacement or rearrangement may occur without loss of identity as long as the object's fundamental nature is preserved, or what we call its essential and necessary properties. This is a structuralist interpretation. Since it refers to components and their arrangement which is its structure as a whole object, Lowe's solution is called 'reductive Humean supervenience'. Therefore, Lowe's interpretation is consistent with ours, in that *any* properties—even internal ones, even complete replacement of all the parts, even change of shape, may still accompany persistence of the object as long as the necessary structural arrangement of its fundamental nature is maintained. Hence, the river persists, even while parts that are not essential to its identity change. Also, the fundamental, metaphysical 'nature' of an object is at least influenced by how we define its identity, which is its semantic nature. These two 'natures' of an object are each interrelated with how we explain and understand the function, structure and components, bringing in the epistemic nature and problem all together within a particular domain of philosophical discourse and domain of applicability of scientific theories.

Those who believe that objects are 3D and persist by enduring through time favor the adverbial solution; those who believe that objects are 4D and persist by perduring through time favor the temporal parts solution. By and large, it seems that the 4D solution is rejected by those who just cannot find the intuition to consider objects to be 4D, and the 4D solution is highly favored by those who invoke special relativity.

Those who support the presentist doctrine approach things differently. Instead of trying to explain *how* things persist yet change, and how to avoid the semantic-metaphysical puzzles which persistence in the face of change seems to entail, the presentist either denies the existence of a past and a future, or at least promotes the idea

that the object only exists in the present. Hence, the presentist may insist on radical impermanence, as do Bishop Butler, Reid, Hume and Chisholm, as a strict application of Leibniz' Laws. Thus, a presentist-impermanentist (or Buddhist) may say that the plank-pair is bent now, and then in a new moment a new plank-pair is straight now.

Alternatively, the presentist-endurantist may simply say that objects persist by enduring as time flows through the present, which is really a simple endurantist position which does not deny the past and future, but is supplemented with a view that places more epistemic priority on the present. The presentist-endurantist, like her multiple time-endurantist cousin, must be a very strict tense-logician by clearly specifying the times and tenses of the domain of discourse. The plank-pair is straight; in a previous moment of the present it was bent; and in a next moment of the present it may be bent again.

As previously pointed out, the presentist position is quite similar to the 4D-stages view, as noted by Sider. The 4D and 3D descriptions have been compared and found formally inter-translatable by McCall and Lowe (2006, 2009), although their bias towards 3D comes out quite clearly when they try to show how 3D descriptions can more accurately model motion than 4D talk:

...the [3D] endurantist can now say that the explanation of the change in distance is that the 3D particles are *moving* relative to one another. A prerequisite for motion is *continuous endurance*: two particles that were not continuants over the period  $t1$  to  $t2$  could not be said to be in motion during that period...Motion implies something moving. If there were not something that persisted throughout the period of movement, what would it be that moves? (McCall and Lowe 2006, 376)<sup>156</sup>.

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<sup>156</sup> The last two sentences sound a memorable echo from Nāgārjuna:

What has been moved is not moving.  
What has not been moved is not moving.  
Apart from what has been moved and what has not been moved,  
Movement cannot be conceived.

Where there is change, there is motion.

McCall and Lowe go on to say that a 4D view cannot account for motion, since the object is simply a sequence of temporal parts.

...its apparent motion is an illusion. Rapid replacement of one state by another closely similar state mimics motion, but it is not motion. This also applies to replacement of one instantaneous 4D temporal part by another. What motion requires is a moving 3D object which endures, or so it would seem. (McCall and Lowe 2006, 376).

The temporal parts or 4D-stages are parts, like spatial parts in a 3D object: One temporal part is not the same as the next temporal part, even though together they make a 4D whole, and even though they are causally connected in a 4D continua. So McCall and Lowe say that this analysis does not allow for a persistent thing, and motion requires something that persists while it moves from place to place. The 4D object just *is*, and one temporal part is *now*, while the next part is *then* (which becomes *now*), but there is no one thing that moves: It is more like a slide show. Likewise, there is no one thing to be the subject of change. Their analysis has some plausibility, but there is a major flaw: It considers temporal parts as discrete, not continuous—as does at least much of the explication of other temporal parts and 4D-stages views. Hence, McCall and Lowe's analysis suffers from the same fallacy as Zeno's and Nāgārjuna's (MMK chapter 2) analysis of motion, and has the same solution, based on Aristotle's solution combined with calculus:

So there can be no primary part of the time: and the reason is that rest and motion are always in a period of time, and a period of time has no primary part any more

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Since there is change in the moving,  
And not in the moved or not-moved,  
Motion is in that which is moving. (II:1-2, Garfield 1995:6)

Nāgārjuna is examining what motion is in order to deny that there is any inherent nature to motion itself separate from that which composes it. McCall and Lowe are examining motion in terms of what composes it.

than a magnitude or in fact anything continuous: for everything continuous is divisible into an infinite number of parts. (Aristotle, *Physics* 239a:20).

Zeno's reasoning, however, is fallacious, when he says that if everything when it occupies an equal space is at rest, and if that which is in locomotion is always occupying such a space at any moment, the flying arrow is therefore motionless. This is false, for time is not composed of indivisible moments any more than any other magnitude is composed of indivisibles. (Aristotle, *Physics* 239b:5).

When the arrow is analyzed using differential calculus with a model of space and time that are continuous, we can model the motion, regardless of how we interpret whether the object is 3D through time or 4D—they are merely different metaphors of the model.<sup>157</sup>

We see in this analysis of motion a typical case of metaphysical confusion: Motion clearly exists, hence the task is to devise a coherent philosophy to account for it and change our intuitions and models accordingly, rather than to apply some unjustified *a priori* rationalist metaphysics and unsophisticated intuitions that uncover a puzzle which supposedly entails ontological paradoxes.

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<sup>157</sup> See Salmon (1970) and Grünbaum (1963, 1967 and 1969, which is in Salomon's 1970) for solutions to Zeno's paradox, which actually waited for 19<sup>th</sup> Century differential calculus to be perfected. See Siderets and O'Brian (1976) for comparison of Zeno and Nāgārjuna's

## ***D. Conclusion***

We are generally discussing the nature of dependence of objects on time, and specifically whether objects are persistent or impermanent. No resolution obtains from this chapter, since we lack physics knowledge of intrinsic properties necessary to determine the identity of what it is that might persist or not persist. However, we have discussed certain concepts and approaches to time, and have now some conceptual tools to approach such a resolution.

Our main conclusion in this chapter is that there is no problem of change of temporary intrinsic properties. That problem was that an object stays the same while some of its intrinsic properties change over time, and this entails ‘paradoxes’, ‘problems’ or ‘puzzles’. Recall that the only reason the plank-pair’s bent or straight shape was considered intrinsic was because some shape is intrinsic to an object: there is no such thing as a shapeless plank-pair blob. However, it is not necessarily intrinsic to a plank-pair to have only one of the choice of bent or straight shapes; having shape as a generic property does not change when the object changes from bent to straight. It is only the temporary bent-ness or straight-ness property which has changed. This temporary property is not intrinsic to the plank-pair when the plank-pair is ‘a pair of wooden planks hinged together, thus allowing it to be either bent or straight as needed’. The particular shape only becomes necessary and essential, thus intrinsic, when we are confined to contexts in which the object must necessarily be, for example, a bent plank-pair but not a straight plank-pair, and this must be due to some ontologically justifiable intrinsic characteristic.

In this chapter we have discussed several approaches to the problem of change. First, quagmires of seemingly metaphysical puzzles are mostly avoided when we are seriously attentive about tense. Those puzzles are therefore understood not as paradoxes of our metaphysical reality. Rather—as we realized in the previous two chapters—we need to use more accurate models, intuitions and theories of actual physics in the context of whatever problem we are dealing with and with more reliance on them instead of *a priori* reasoning. In terms of the problem of this chapter, serious attention to tense must be combined with the realization that many properties are relational—either internally relational to parts or externally relational to other objects—or merely unnecessary to its being, hence are not intrinsic. By ‘being’ we refer to the essential structural nature within a specific domain. Once we realize this, we must then combine it with further views: (1) Change of relational properties does not entail puzzles of persistence; (2) non-living objects do not necessarily function like or should be considered similar to living objects; (3) we must have an understanding of the intrinsic properties of an entity which are determined without regard to convention in order to understand how it changes over time. Hence, we must distinguish the necessary intrinsic properties from the inessential relational properties; (4) Therefore, taking a structuralist view of the identity of objects in terms of their necessary intrinsic properties demonstrates that there is no problem of persistence: Intrinsic properties (if they exist) may indeed persist, hence the object may persist.

Second, presentism is not trivial, and is plausible, under certain restrictions. The often repeated claim that presentism is either trivial or obviously false uses fallacious arguments that are not serious about tense. When one is serious about tense, it is found

that presentism has significant plausibility if one is confining oneself to concern with the present alone. Many arguments against presentism are based on analyses which involve different times and hence use assumptions that the presentist rejects at the outset. Thus, ‘evidence’ about other times is not considered evidence by the presentist. Since the presentist does not conclude anything about the present when shown ‘evidence’ that is concerned with other times, the presentist may be satisfied with her confinement to the present. Non-presentists, however, will not be, since they would like to talk about the past and future.

Third, Lowe’s reductive Humean supervenience and structuralist solution is promising but requires that we work out the details of how objects are constituted consistent with modern quantum field theory and condensed matter physics, and must include entangled states and actual bonding mechanics, plus how objects evolve over time within the context of relativistic spacetime. Actually, as we shall see, structure has significant holistic aspects since—as is well known and has been mentioned previously—there are severe limitations to the applicability of reductionism in quantum domains, which includes many entities of even macroscopic sizes.

Fourth, there is significant similarity between the 4D-stages and 3D-presentist expressions for the nature of objects existing in the present. Presentists may be insistent in their defense of how past and future are mental constructs with no ontological consequences, and four-dimensionalists may be as equally insistent about how their solution avoids all those nasty metaphysical puzzles (which are mostly word play anyway, hence, while not necessarily trivial may be solved by purely semantic modifications by understanding the proper context of discourse, rather than entailing a

different ontology). It is only if we consider the time slices of 4D objects as truly existent in the past and the future that these diverge. It is one of the major theses of this dissertation that rational analysis of our intuitions and the logical consequences of them are not sufficient to achieve knowledge of the way the world is—we must additionally ground our metaphysics with empirical and theoretical results of modern science. Hence, in *Chapter Nine: Physics of Change* we look at the physics of this problem and try to decide if objects are four dimensional and if there is reality to the past and/or future. If there is, then the presentist view is severely hampered. George Ellis (2006, 2009) conclusions are that there are local bubbles of spacetime during the local collapse of entangled states in which the local present decoheres from the unknown future to the known past; that bubble is of finite spatio-temporal extent; and it is that decoherence which defines the present, thus the ‘global now’ has a finite duration as the ‘sum’ of local presents defined by local decoherence processes. Yet, that duration during which the entangled states of the past collapse to the present is generally quite small. Therefore, even if we adhere to this decoherence conclusion and technically must admit that ‘the present’ has a duration, that duration is so small that the distinctions between the 4D-stages and presentist views are irrelevant to most problems of common discourse.

We have yet to determine if there are any truly intrinsic properties that satisfy our full understanding of inherent nature. We will find that this relates to the natural kinds, and I argue that there are at least domain-specific natural kinds, categorized by their state-independent properties such as mass, charge, and spin for the elementary particles in some domains, or number of protons in the atom for chemistry. We still also have yet to determine if it is possible for an object to remain unchanged for more than a moment, or

even for large finite times, as Madhyamaka arguments deny. That issue is for physics to examine, and it is to physics that we finally turn.

## CHAPTER SIX. PHYSICS PLURALISM

### A. *Introduction*

In this chapter I outline a plausible pluralist epistemic framework called *Physics Pluralism*—capitalized to distinguish it from other versions of pluralism—which we can use to understand and apply physics to determine the basic physical nature of non-living phenomena. The motivation for synthesizing Physics Pluralism is to establish a framework from which we may interpret the results of physics theorizing and empirical research in order to determine whether or not that nature is inherent or relational, both or neither. As described in *Chapter Two*, Madhyamaka philosophers argue that there is no inherent nature. Those arguments were interpreted as promoting the positive thesis that there are relational natures. In turn, those two kinds of natures were broken down into three dichotomies: causal independence or interdependence on other phenomena; mereological independence or interdependence; and persistence or impermanence through time. The three dichotomies are summarized as independence or interdependence (or mutual dependence); singular or composite; and persistence or impermanence, respectively.

One option is to take an instrumentalist stance and say that our physics theories have terms and sentences which should be interpreted (in the context of those theories) as saying nothing about the nature of phenomena other than what should result from measurement procedures. Thus, there is nothing known about such phenomena; rather, we have interactivity that results in a measurement, but nothing confirmed about the actual nature of entities. According to the instrumentalist stance, there are no adequate

grounds for believing that theoretical terms refer to actual entities, at least if the entities described are not directly perceivable by unaided human senses. Instead, a generic instrumentalist would understand the terms as merely theoretical constructs that only facilitate calculations and predictions. To ‘refer’ entails reference of the terms *as described by the theory*, hence it is not just the terms in isolation that we say do or do not refer, but the terms within the particular theoretical context.<sup>158</sup> Without referring terms, even though calculations may be accurate, in the instrumentalist stance this does not indicate that the referents of the constructs necessarily exist as spatio-temporal entities. Indeed, some interpretations of Madhyamaka match the instrumentalist stance, and expand upon it. Instrumentalists generally take the evidence of direct perception to indicate that at least those entities are ‘real’ or ‘exist’.<sup>159</sup> Van Fraassen takes this stance, and distinguishes such entities from those that cannot ever be directly seen (such as electrons, in contrast to the moons of Jupiter which, if we were there, we could directly

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<sup>158</sup> Throughout this chapter I use ‘reference’, or that theoretical terms ‘refer’, as a shorthand for what Laudan (1981) identifies as the second claim of *convergent epistemic realism* as promoted by Putnam, Boyd and Newton-Smith: “R2) The observational and theoretical terms within the theories of a mature science genuinely refer (roughly, there are substances in the world that correspond to the ontologies presumed by our best theories);” (Laudan, 1981, 20) Hence, by ‘reference’ I mean R2, which entails that the descriptions of those entities in the context of the relevant theory correspond to reality. The question remains if those elements of our ontology have inherent nature or are purely relational. The other claims of convergent epistemic realism as characterized by Laudan are discussed briefly in the section below on the instrumentalist objection to realism. They are: “R1) Scientific theories (at least in the ‘mature’ sciences) are typically approximately true and more recent theories are closer to the truth than older theories in the same domain; ... R3) Successive theories in any mature science will be such that they ‘preserve’ the theoretical relations and the apparent referents of earlier theories (i.e., earlier theories will be ‘limiting cases’ of later theories).’ R4) Acceptable new theories do and should explain why their predecessors were successful insofar as they were successful.” (Laudan, 1981, 20-21)

<sup>159</sup> One may be tempted to take these words, ‘real’ and ‘exist’, as synonyms to ‘inherent nature’. However, according to our interpretation of Madhyamaka, real and existent things can have no inherent nature, but have relational nature. However, then we must be concerned with what those ‘things’ might be, because ‘things’ or ‘entities’ usually indicates a possessor of intrinsic properties, as we have discussed previously (Chapter Three). Hence, there is correspondence with structural realism which says that ‘real’ indicated the existence of structural relations.

see, hence do exist as “observables”).<sup>160</sup> Madhyamaka philosophers go further and say that even objects that we can directly perceive have no inherent nature, hence do not ‘truly exist’: From a conventional view, of course those objects such as our chariot exist, yet if we examine closer, through *sevenfold reasoning* or *neither-one-nor-many* we find that such entities have no ultimate inherent nature. Rather, according to Madhyamaka, references to the inherent nature of entities should be interpreted as pragmatic conventions that are ultimately mistaken. It may be that instrumentalism would be more hospitable to Madhyamaka views. However, I agree with Wallace who identifies instrumentalism as a “thinly veiled form of solipsism” (1996, 104),<sup>161</sup> and that is not the Madhyamaka intention. The interpretation of Madhyamaka that we use here acknowledges that we know more than our senses—due to what is called *inferential valid cognition* in Buddhist epistemology (Dreyfus, 1997), or inference to the best explanation in a world of uncertainty even about direct perception in Western epistemology.

We may rather take a realist stance as an intuitive starting point (rather than a thesis to be demonstrated in this dissertation) and say that if there is ‘sufficient’ evidence (and perhaps other criteria, like a reliable explanation) then we may make an epistemic commitment to believe in the existence of entities which are described by some

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<sup>160</sup> Van Fraassen (1980, 16-17). Even though we can see them only through a telescope, someday astronauts would be there to see them directly, hence they are observables. However, a cloud chamber track does not indicated observation of a charged particle, we may say that the particle is detected, yet the only thing that is observed is the condensation track.

<sup>161</sup> One of the major issues with van Fraassen’s analysis is his distinction between what can be seen without the aid of theory, which he insists should be limited to direct sensory perception, and what requires theory to interpret. This insistence ignores the requirement to apply theory to direct sensory perception, since what we see may simply be an hallucination. Since all perception then should be interpreted through theory (which we may call habit, training or psychological propensities), by his account everything must be understood instrumentally, and thus nothing real may be established, except my own mind, which is what I and Wallace identify as solipsism. There is a huge literature about this issue which we will not examine here.

theories—even if too small to directly see. In this case we may then say with confidence that those entities do indeed ‘exist’. Realists argue that the evidence would be miraculous if there were no world as described by the theories (the *no-miracle* argument), and they say that our best knowledge of the world results from our best theories (the *inference to the best explanation* argument).<sup>162</sup> There are also shades of gray in realist stances, such as varieties of structural realism which either are agnostic about the existence of such entities or deny them altogether, while allowing that structural relationships and causal properties exist independent of entities—or perhaps the entities are derivative of the structures. Thus, the ‘existence’ of entities in these views is at least in doubt, hence certainly their inherent nature must be at least in doubt if not denied altogether. Structural realist stances—in their emphasis on relational properties and doubt in inherent nature—perhaps hold promise to have a favorable comparison with Madhyamaka. However, as mentioned in Chapter Two’s analysis of what is called the *śūnyatā* of *śūnyatā*—the relationality of relationality—even relational properties cannot have inherent nature according to Madhyamaka. Thus adaptation of such stances to each other must be carefully executed.

Just as was the case in *Part II: Western Metaphysics* we are more concerned with finding philosophically plausible understanding of metaphysical meanings of inherent nature and relationality in its three components than with finding meanings that match Madhyamaka. While I do offer comparisons between the approaches, arguments and conclusions of physics and Madhyamaka, in this *Part III: Physics*, we will be more concerned with finding a philosophical framework for understanding the place that

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<sup>162</sup> For the classic paper on the no-miracles argument, see Putnam (1975, 75). For a discussion of inference to the best explanation and further references see Psillos (1996).

physics has in figuring out what the world is like than with creating an epistemic framework that matches Madhyamaka. Rather, we will seek a plausible epistemic framework that we can justifiably apply to physics theories and empirical results to give us knowledge about the inherent and/or relational nature of physical phenomena. I offer comparisons with Madhyamaka, but that will not be a criterion for plausibility of such a framework. That framework should stand or fall based on empirical physics and sound philosophical analysis, not because it corresponds to a preconceived idea.

In this chapter we define such an epistemic framework, with scant argument or examples for it; those must await the next three chapters. Physics Pluralism is a synthesis of different views that acknowledges the wisdom in many different stances, yet notes that the conversation has been muddled by a lack of contextualization and insistence on universal application of any one stance. Physics Pluralism, rather, accommodates different stances in different domains of applicability. If we take an instrumentalist stance, our knowledge is severely limited because we do not know the *nature* of what instrumentalists interpret as the references of theoretical constructs which cannot be interpreted realistically, unless we take ‘nature’ to indicate merely the result of measurements. Indeed, some quantum physicists take this as all that we can know; hence they should be considered instrumentalists. However, our question here is if we can justify a framework that has room for one or more realist stances. We address that question in this chapter, and provide some argument for inclusion of realist interpretations. However, we also acknowledge the necessity for instrumentalist interpretations in some domains.

There are two main objections to using physics to answer basic metaphysical questions about the character of non-living phenomena. The *instrumentalist objection* (Laudan, 1981) is motivated largely by the fact that we cannot directly perceive those entities which many theories describe. An anti-realist stance is found in historically and philosophically motivated mistrust of the idea that we can *extrapolate* from the empirical adequacy, success or acceptance of physics theories to adoption of the truth of what may simply be instrumental explanations of the nature of reality that are provided by such theories. Truth of a theory is here defined in this objection partly as the reference to actual features of the physical world by the central terms of the theory that have been utilized in its success, as one element of what has been called *convergent epistemic realism* (CER), which we discuss in this chapter. CER is likened to progress in science that gets us closer to understanding the true way the world is. Some realists respond to the objections by saying that instrumentalism should be restricted to *developing* theories, and respond to the anti-realist by saying that theories which satisfy certain criteria in a *credibility scale* should be interpreted realistically.

We must keep in mind the distinction between the *truth of answers* to specific questions posed to the theory, which is essentially due to its success or empirical adequacy, and *truth of the theory*, which requires an additional factor, that the central terms used in that success as interpreted by the theory refer to actual features of the physical world in a domain. Both kinds of truth—if indeed the theory has such truth values—will be relevant to our current context of determining the nature of phenomena.

The *fundamentalist objection* to realism is that there must someday be a single, *grand unified theory of everything*, and therefore all other theories must either be

considered approximations or models of it, or as simply false, while the former is (or rather, will be) the only true theory. This objection acknowledges the inconsistencies between our two best clusters of fundamental theories: quantum physics and relativity.<sup>163</sup> Pluralist-oriented physicists segment physics into domains in which certain theories apply, leaving a ‘final’ microphysics (if there is to be one) of what may be the ultimately smallest in the Planck scale for that most micro of domains, but not considering it the theory of everything. Fundamentalists rather envision that the theory of the smallest (of the highest energy) will be able to fill in all the gaps in our intertheoretic reductions in even larger (hence, lower energy) phenomena and unify all of physics based on that microphysics. However, from what we already know of the extremely small, that knowledge is limited in its ability to explain the less small, and the limits are not of missing data or missing theory, but rather are part and parcel of the nature of our world, just as Heisenberg’s Uncertainty Principle cannot be overcome with more information.<sup>164</sup> I argue that knowledge within the many ontic domains of the less micro must stand on its own to a significant degree. This conclusion is only partly justified here, leaving more complete justification for the next three chapters, and especially in *Chapter Eight: Physics of Composition* where the more precise definition and requirements for domains to be ontic is presented.

Physics Pluralism exhibits three kinds of pluralism. It exhibits *epistemic pluralism* in allowing the terms of some theories to be instrumentally interpreted in some domains in which that seems to be the proper interpretation, and perhaps those same terms (but

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<sup>163</sup> This issue is discussed in Chapter Nine, Section D, especially D.4.

<sup>164</sup> Unless we take a hidden variables approach, which we will not due to the many impediments to it—they don’t call it ‘hidden’ for nothing. However, that approach is briefly discussed later.

certainly other terms of other theories) to be properly realistically interpreted in other domains. This epistemic view has ontic consequences, in that the realistic features in one domain may have contrasting or inconsistent properties compared with those in other domains. Physics Pluralism exhibits *ontic pluralism* in allowing different properties in different domains of what seem to be the same entity. However, entities must be defined in relation to a domain, hence if we are examining what seems to be the same entity, yet examining it with different domains and theories, we may not be able to justify the view that there is just one entity.<sup>165</sup> Another feature of the framework's ontic pluralism is the way it addresses the debate in structural realism concerning allowed elements in our ontology. Promoters of varieties of structural realism argue that we do have knowledge of structural (causal) relations, yet we either know nothing about entities and their properties (Worrall), there are no entities (Ladyman), or entities are derivative of relations (Chakravartty).<sup>166</sup> Physics Pluralism acknowledges the possibility that each of these views may be true *in their own domains*, thus some domains will have an ontology with only structural relations, events and processes with different kinds of structures in different domains. However, this framework admits domains where entities and their properties are known quite well, thus suggesting an entity realism, and other domains

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<sup>165</sup> For example, Physics Pluralism would explain that a proton in domains of quantum chemistry is a singular entity, but in domains of chromodynamics it is composite of three quarks. The fundamentalist view is that the proton is *really* composite. However, the quarks are entangled, and this entangled system is *essentially* a unity in domains of quantum chemistry, hence Physics Pluralism explains why it is *really* a unity in those domains. It is essentially a unity because it is more than just that we can treat it 'as if' it were a unity—an entangled system *is* a unity while entangled. It is essentially a unity rather than a unity simpliciter because it can be broken apart into components. The point is that in different domains the entity *is different*, not just that it acts differently. Note that when we deal with classical objects, like a rock, the different domains which are defined by different phenomena will refer to the same rock. This relates with Physics Pluralism's response to structural realism, allowing different ontological elements in different domains—entities in some, but no entities in others. See below.

<sup>166</sup> Worrall, 1989; Ladyman and French, 1999; and Chakravartty, 2003, epistemic, ontic and semi-realism, respectively. See Ainsworth (2010) for a summary review of many varieties.

where our ontology is entirely unknown, thus leaving us with instrumentalist interpretation of those terms.

Physics Pluralism generally denies that we will be able to find a fundamental theory of everything that will be used to derive all characteristics of every physical situation, regardless of domain. Thus, Physics Pluralism denies the extremes of physics fundamentalism, which can be characterized (or caricatured) as the hope that there is a Grand Unified Theory of Everything that will answer all questions. Physics Pluralism shows that there are ontic domains in which independent theories obtain, describing different kinds of entities with different properties from the properties of what seem to be those same entities in different domains. However, there are *general principles* that seem to apply everywhere, such as conservation of energy. Hence, in a third kind of pluralism, Physics Pluralism is *fundamentally pluralist*, which may sound like a contradiction, but is a way of pointing out that Physics Pluralism acknowledges not only a pluralist view concerning many characteristics of entities and processes, but also that there are general principles which apply throughout most if not all domains of physics. These general principles are fundamental ontological features of the universe that incorporate the basic provisions of a scientific perspective which cannot be lightly denied. We certainly can't make universal statements about the truth of such principles, since we are in the context of empirical science which can and does integrate some degree of doubt in everything.<sup>167</sup>

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<sup>167</sup> As previously mentioned, the question before us is one of plausibility, not certainty. I agree with Quine that no interesting and non-trivial certain knowledge is possible. Knowing that 'all bachelors are unmarried men' gives us no knowledge beyond the definitions of those terms, just as with all 'quartz are minerals' and '1+1=2'. Similarly, we apply a model-theoretic semantics to understand that each of those statements must be understood to be within a context of a system of language which is natural, scientific and/or mathematical, hence may have meaningful truth values only within the context of their respective system. We are here in search for a system which will provide us knowledge within the context of physical non-organic phenomena, hence physics that examines whether any phenomena have inherent nature or only relational nature.

However, if we are to take a pluralist stance we must also accommodate those principles and understand how their generality relates to pluralism.

A note about what this chapter does not provide is called for. Extensive and detailed examples will be required in order to justify use of Physics Pluralism, yet those examples will await the next three chapters. The reader should understand that we are not interested in answering all philosophical questions here, but only three: Can we reasonably believe that there is inherent nature as opposed to only relationality in physical phenomena, with the components of that dichotomy understood as independence or interdependence, singularity or composition, and persistence or impermanence, respectively. Consistent with the pluralist view, the answer to all three is a resounding *it depends on the context*, which could be interpreted as relational: Since in some domains there is inherent nature and in other domains there is only relationality in a sense that is local to their respective domains, we must conclude that globally there is only relationality and no inherent nature. However, when considering the general principles, we need to consider if they describe cross-domain inherent nature that violates the idea of ontic relationality. If the general principles are shown to be concerned with relationships and interactions then they should not entail inherent nature, yet if they demonstrate cross-domain intrinsic properties then they would describe universal inherent nature. My analysis here is necessarily brief, but I would speculate that the general principles involve significant relational characteristics, but there may be some that demonstrate inherent nature in a purely non-relational way. The ones that I examine in this dissertation are what I consider the main ones, like conservation and symmetry principles and the action principle. Though general principles, they are applied differently in different domains and

with different characteristics. These certainly seem to be domain dependent and ultimately relational. I examine conservation of mass-energy in some detail, and this property is the sum of relational and inherent characteristics. Charge is only relational if we consider interaction with the vacuum, the so-called vacuum polarization. Spin is only a microscopic domain property. However, much of the argument and examples for these conclusions must await the following chapters.

This chapter begins with an examination of the elements of physics theories according to the *semantic conception of theories*, which is the foundation of Physics Pluralism. By using the concept of *partial isomorphism* from da Costa and French (2003), it is possible for the empirical truth of a theory in some domains to be established. The partial isomorphism does not provide simply *partial truth*, although that term and similar ones like *quasi-truth*, are typically used. Rather, as pointed out by da Costa and French and emphasized by Physics Pluralism, we can see that we need not be shy about the level of truth that is involved as long as we recognize that the domain of a theory is not the entire physical universe, but rather a subset of it—the domain which is defined by the partial isomorphism. Hence, what is important is knowing how to restrict the domain.

Since Physics Pluralism allows for a realist interpretation of some terms of some theories, i.e. allowing for the terms to refer to actual entities of our world even if we cannot observe them directly, we first discuss some justification for realist perspectives by providing a brief summary of the well-known instrumentalist and other anti-realist objections and responses by realists. We then describe domains in more detail, followed by itemization of the credibility scale to rate theories in a way that gives us sufficient confidence to counter anti-realists in some domains and, with the mechanism of the

partial isomorphism in the semantic conception of theories, will enable us to determine *which* theories are empirically true in their domains. A preliminary justification for anti-fundamentalism closes this chapter, setting the stage for further justification that will follow in later chapters.

The following gathers disparate footnotes together for the reader's convenience. I base the ontological aspect of Physics Pluralism on Fritz Rohrlich and Larry Hardin's (1983) response to Larry Laudan's (1981) attempt to refute a version of scientific realism that he characterized as 'convergent epistemic realism', plus a fair amount of associated literature. Rohrlich (1988, 1996, 1997, 2001, 2002) further developed the response by Rohrlich and Hardin (1983) and that by Hardin and Rosenberg (1982) into what Rohrlich called 'cognitive pluralism'. Batterman (1995) contributed significantly to this discussion, and he effectively fleshed out physics justification for the philosophic view with his various papers and book (2000, 2002, 2005a, 2005b, 2006, 2009), with constructive responses by Redhead (2003) and Belot (2005). The pluralist ontology has significant roots in the renormalization programme which began to be widely known and widely used in various domains in the 1970s and 1980s. Cao and Schweber (1993) added significant insights about renormalization in quantum field theory, or rather the effective field theories programme, which was enhanced by Cao (1997). That comprehensive survey of 20<sup>th</sup> C. field theories, plus the introduction and essays in Cao (1999), especially that by Fisher, provided understanding of the role played by renormalization group transformations and the effective field theory programme in both the standard model and also in condensed matter physics. Today, pluralist ontology is represented even in introductory textbooks such as Feng Guan and Jin Guojun (2005), noted as Feng and Jin

(2005), *Introduction to Condensed Matter Physics*. The epistemological aspect of Physics Pluralism is based on development especially of the model-theoretic variety but also other interpretations of the semantic conception of theories, with roots in Tarski (1935), Suppes (1957/1999, 1960, 1961, 1967), Suppe (1974, 1989), van Fraassen (1980, 2008), Giere (1985, 1988), French and Ladyman (1999), plus numerous works by da Costa, Bueno, French and collaborations summarized and elaborated in da Costa and French (2003). Physics Pluralism has some similarities yet significant differences with a form of scientific pluralism promoted by Cartwright (1999:Chapter 1) and Kellert, Longino and Waters (2006:Introduction). Cartwright did not see any particular organizing principles or relationships between the ‘dappled’ world of theories, and Kellert et al. are more focused on consequential arguments concerning social issues.

## ***B. The Semantic Conception of Theories***

### ***B.1 Introduction***

The central difference between the older ‘syntactic’ conception of theories and the newer ‘semantic’ conception is the recognition that theories *should* be *extralinguistic entities* such that slight modifications of the language do not entail completely different theories. The latter situation was recognized as one of the failings of the former conception. The purpose of this section is to explain the meaning of the identification of theories in the semantic conception as extralinguistic entities, and along the way to generally explicate the semantic conception of theories which is the conception that is currently used by instrumentalists and realists alike, and could be called the new ‘received view’. This requires, however, some background.

I view the identification of theories as extralinguistic entities in a similar fashion to what we discussed concerning the idea of intrinsic properties discussed in *Chapter Three: Metaphysics of Dependence*, where we found that many philosophers ‘knew intuitively’ what it was for a property to be intrinsic, but the formalization in a precise definition got in the way of clarity. Just so with scientific theories: they must be extralinguistic, that is, they must be the same regardless of language or formalization which may be varied with pragmatics, as long as they refer to the same domain. Hence, any chosen theory such as thermodynamics, the special theory of relativity, or classical non-relativistic mechanics, will not change even if expressed in different natural languages, e.g., French, or German. Similarly, even if expressed in different mathematical formalisms, such as Hamiltonian vs. Lagrangian expressions of classical mechanics, or Heisenberg’s matrix mechanics vs. Schrödinger’s wave equation

formalism for quantum mechanics, a requirement of the different formalisms must be that the theory does not change—otherwise one of the formalisms would be of a different theory. Physics theories generally have multiple formalisms as different expressions of the theories that are pragmatically different but still describe the same domain. This is the ground of what we know must be the case for a consistent conception of scientific theories.

Then the process of determining a formal conception of theories is to come up with a theory of theories that preserves this requirement. The version of the semantic conception that we use here is also called the model-theoretic view which is essentially an application of the same model-theoretic semantics on which the key concept of contextualization is based that we applied throughout the previous chapters. The semantic conception of scientific theories grew as a reaction to several flaws in the syntactic “Received View”<sup>168</sup> of theories as promoted by logical positivists (Suppe 1974). Specifically, in their syntactic formulation a theory became dependent on its language. Without a theory having independence from language, i.e. as an extralinguistic entity, a slight change in ‘observation’ or ‘theory’ language, including experimental procedures, mathematical formalism, or even empirical results, would change the entire theory. Yet, it is a desirable characteristic of theories to maintain some core of the theory in the face of minor changes. In this section we summarize the relevant features of the semantic view and how it is based on a set-theoretic, model-theoretic formalization of mathematical logic. Our main purpose in this section will be to show how one can consider structures, theories and models to be independent of the language within which it is expressed,

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<sup>168</sup> It is odd that it is called received, since it is half a century old now. I capitalized it, just as Suppe did, but now to distinguish it from the newer semantic conception of theories which I previously identified as the contemporary ‘received view’.

which is something that many analysts tout as one of the significant improvements that the semantic view has over the syntactic. On the outset, this seems to be a difficult task. We need to plow through some formal concepts in order to come to the conclusion.

One of the main findings of the semantic conception is that a theory is a collection of models, rather than an interpreted set of sentences. However, a model is a collection of sentences, hence what has been gained? Consider a physical model, e.g. of a molecule, and equate the balls that are meant to represent atoms with sentences in a formal model. Whether the model is made of wood or Styrofoam balls should not be relevant to the significance of the model. What the model represents is the structure of the molecule, and that is independent of the composition of the physical representation, but only pertains to the relationships between composita. Of course, other models will address the nature of the composita, but the metaphor still holds: it is the representation of the model itself that is relevant to the theory, and different sentences may combine in different ways to form another model that will be equivalent with the first model in the original language.

The semantic view was developed by Patrick Suppes, Ronald Giere, Frederick Suppe and others.<sup>169</sup> Notably, the view is used explicitly within either formal or informal frameworks in justification of Putnam and Boyd's convergent epistemic realism (CER), Ladyman's ontic structural realism (OSR), Chakravartty's semi-realism and even Psillos' 'standard' realism. It is also used as the context for van Fraassen's structural empiricism version of instrumentalism. Even though there is frequent explicit invocation of the

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<sup>169</sup> The major modern sources are Suppes (1957, 1960), Giere (1988) and Suppe (1989). The latter has a comprehensive treatment that includes a preface with an interesting autobiographical history of the development of the view. For a brief introduction see van Fraassen (1980:Chapter 3) (which is mostly a reprint of his 1976 famous article "To save the phenomena" which is also reprinted in Leplin's (1984) excellent collection that also has Laudan's (1981)). See also da Costa and French (2003) and van Fraassen (2008). For the point of view of the modern discussion of ontic structural realism start with French and Ladyman (1999) and Chakravartty (2001).

semantic view in the debate, there is infrequent application of the full technicalities of that view because it was thought that a theory under investigation must be expressible in axiomatic formalism in order to be amenable to the full power of the model-theoretic toolbox of mathematical logic. Not many robust theories in physics have been formulated in that fashion. Fred Suppe states the issue:

According to the Semantic Conception of Theories, scientific theories are not linguistic entities, but rather are set-theoretic entities. This is in sharp contrast to many versions of the positivistic Received View on Theories, which construes theories as partially interpreted axiomatic systems, hence as linguistic entities. To say that something is a linguistic entity is to imply that changes in its linguistic features, including the formulation of its axiom system, produce a new entity. Thus on the Received View, change in the formulation of a theory is a change in theory. However, scientific theories have different individuation properties, and a given theory admits of a variety of different full and partial formalizations. The Semantic Conception of Theories construes theories as extralinguistic entities which admit of different full and partial formulations. In this respect, theories are individuated on the Semantic Conception the same way science individuates them. (Suppe 1989, 3-4).

## ***B.2 Formalities***

This section has some technicalities and may be viewed as an appendix for those who wish to skip it. The point of the section is to identify the technical meanings of terms such as model, structure and theory, as used within formal mathematical logic, and especially to indicate at least intuitively how a theory may be considered extralinguistic. The correlation of these concepts with the semantic conception of theories is sometimes tenuous, depending on the author, yet it is generally acknowledged that some grounding in formal logic informs the concepts of that semantic conception.

The formalities of the semantic view of scientific theories used in this dissertation are based on the model-theoretic view of the mathematical logic of first-order predicate

languages<sup>170</sup> (see, e.g., Enderton 1972, especially 79-81). Sentential or propositional logic involves simple declarative propositions and includes a formal language, semantic rules and rules of proof. The semantic rules provide the conditions which determine the truth values of sentences in the language, thus providing a formal semantic interpretation of the language. First-order logic adds quantification and predicates and substantially expands the application domain compared with sentential logic. A predicate is a function to the domain of truth values. The syntax of first-order logic has rules for generating well-formed formulae (wff) and sentences (wff with no free variables) of the language, while the semantics determines the meanings or interpretation of those expressions.

The *structures* of a first-order language are the core of its interpretive semantics, determining the domain of the universal quantifier  $\forall$ , and what the other parameters (predicate and functional symbols) denote within the formalism of the language (i.e., not in terms of any physical representation). Hence, a structure  $S$  for a given first-order language is a function with domain that is a set of parameters such that  $S$  assigns (1) to the universal quantifier, a nonempty set  $|S|$  called the *universe* of  $S$ ; (2) to each *n-place* predicate  $P$  in the language, a relation defined on the universe; (3) to each constant  $c$ , a member of the universe; and (4) to each *n-place* function, an operation from the domain of the universe to the range of the universe.

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<sup>170</sup> There are many informal instantiations of a semantic view that revolve around ideas of models that are not based on the full technicalities of mathematical logic. While models may be spoken of in terms of mathematical logic—as it is in this section—or in terms of tinker toys as representations of architectural structures or DNA, as one proceeds from the use of logic to that of tinker toys there is what I believe to be a degradation in the precision of the language concerning the meaning of the model and its interpretation. Yet, in empirical sciences, which are of necessity non-formal (such as physics) this imprecision seems to be part and parcel. Much philosophical work revolves around trying to understand the meaning of the models of a theory (think of the Bohr model of the atom) that is called the interpretation of the theory, which, together with the formalities and empirical content of the theory comprise, I think, the theory in totality.

For example, consider the simple theory comprised of the following two sentences: 1. Everybody loves somebody; and 2. Somebody loves everybody. The universe is 3 people,  $\{a, b, c\}$ . The set of relations ‘x loves y’  $\{(a,b), (a,c), (a,a), (b,a), (b,b), (b,c), (c,a), (c,b), (c,c)\}$  satisfies this theory.

A structure  $S$  assigns meaning to the elements and sentences of the theory, and truth of sentences is defined within the context of the structure. Consider the following example from Enderton (80). We are given the language of set theory with universal operator  $\forall$  (‘for all’), existential operator  $\exists$  (‘there exists’), membership  $\varepsilon$ , negation  $\neg$ , binary relation  $<$  (‘less than’) and standard conventions of well-formed formulae. Note that translations indicated by the quotes are informal for understanding purposes but those phrases are not part of formal structures: The elements of the structures are simply scratches on the page and intuitive understanding of them may give false impressions (although they frequently do not). Now take structure  $S$  with set  $\{S\}$  as the set of natural numbers, and  $<$  as a relation between the set of pairs  $\{m, n\}$  with  $m, n \in \{S\}$ , such that ‘ $m < n$ ’ is defined and well-formed, translated as ‘ $m$  is less than  $n$ ’. The sentence  $\sigma: [\exists x \forall y \neg(y < x)]$  in this language can be translated under  $S$  as “there is a natural (non-negative) number such that no natural number is smaller”, which happens to be true in the language. Hence we can say that this sentence  $\sigma$  is true in  $S$ , or that  $S$  is a *model* of the sentence.<sup>171</sup> Note that this indicates why *model* and *structure* are frequently used interchangeably when the truth of  $\sigma$  is assumed.

A *theory* is the set of sentences of a language that is closed under logical implication. Define  $Mod \Sigma$  to be the class of all models of sentences  $\Sigma$  in our language,

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<sup>171</sup> My use of truth here is intuitive, not formal. See Enderton:81-82 for an explication of relevant formal truth.

i.e., the class of all structures such that all of its sentences are true. Define the consequences of  $\Sigma$ , symbolized as  $Cn \Sigma$ , to be all sentences logically implied by  $\Sigma$ . Define the set of all sentences which are true in all models of  $\Sigma$  as the theory of  $Mod \Sigma$ , symbolized as  $Th Mod \Sigma$ , which is just the closed set of all sentences logically implied by  $\Sigma$ . Theory  $T$  is *axiomatizable* iff there is a decidable set  $\Sigma$  of sentences such that  $T = Cn \Sigma$ . (Enderton, 144-5) “When a theory is axiomatized by defining a set-theoretical predicate, by a *model* for the theory we mean simply an entity which satisfies the predicate [makes it true]” (Suppes 1957, 253). Here ‘satisfaction’ is used in the Tarski (1935) sense.

### ***B.3 Extralinguistic theories***

As mentioned, in order to apply the formal semantic conception one must formalize a theory and its models by generating a language and decidable sets of sentences that are closed under logical implication and that are true in all models of those sets, within the defined domains. Additionally, this formalism must be sufficiently robust for the scientific tasks at hand, e.g. providing novel confirmed predictions and explanation of phenomena while not being *ad hoc*. While within mathematical logic the concepts of language, sentences, structures, models, theories and truth are given precise meanings, the adaptation of those concepts to empirical sciences (including physics), which include non-formal elements, becomes less precise. However, the non-precision is formalized and the extralinguistic character of theories is indicated and made more precise in the semantic conception through the use of hierarchical sets of models linked by partial isomorphisms as we see when we discuss da Costa and French (2003) below. Suppes (1957, 253-254) states that the use of models and theories in empirical sciences are generally “non-mathematical, relatively inexact statements about the fundamental

ideas of a given domain of science.” While axiomatizations in the syntactic sense are found less often, precise mathematical expressions of theories in domains of physics are probably necessary for a theory to deserve the label—and we will use that requirement to judge the maturity of a theory. Even without axiomatic formalities, models are still not linguistic entities, and physics theories—which are classes of models—are still extralinguistic entities. The point is that a model of a physics theory is not a logical model.

Finally and relatedly, within scientific practice itself we simply do not find axiomatizations in this logico-linguistic sense. As van Fraassen has emphasized, what are called “axioms” in a textbook on quantum mechanics, say, do not look anything like the kind of thing we expect from our logic courses, nor do they play the same role (1980, p. 65)...Suppe (and van Fraassen) conclude that ‘theories are not collections of propositions or statements, but rather are extralinguistic entities which may be described or characterized by a number of different linguistic formulations’ (Suppe 1977, 221)” (da Costa and French 2003, 25)..

Hence, the classic mathematical notions of axiomatization do not apply to such theories. Such theories are the same regardless of language, natural or technical, and will generally admit different equivalent expressions. Note here that the conclusion is that theories are not collections of propositions or statements, yet I mentioned previously that a structure or model is a collection of sentences closed under logical implication. How is this apparent contradiction resolved? The way is through the partial isomorphisms, or what might be called interpretations of the language in the older syntactic terminology. Partial isomorphisms isolate relevant features of one model and relate it to relevant features of another model. In our physical model of a molecule mentioned previously as an example, the partial isomorphism will identify the relationships between balls (wood or Styrofoam) with the information in a data model from experiments on real molecules, thus distances and arrangements of the balls will represent physical distances and arrangements between

and of real atoms. In a semantic but non-physical model the distance units (meters, feet) or angle units (degrees or radians) will not be relevant to the significance of the model as a whole.

It is at least significantly due to the fact that we (the community of philosophers of science) knew that theories *should* be extralinguistic (yet our philosophy of theories was not sufficient to the task) that the syntactic ‘Received View’ of scientific theories, with its dependence on Carnapian distinctions between theoretical and object languages, foundered. We know that a theory must be extralinguistic, so the only (!) issue is how to formally describe a theory such that this is true, and that is how the semantic conception of theories was developed.<sup>172</sup>

Redhead’s (2001a) review of Psillos’ (1999) defense of realism may assist in understanding how both concrete and abstract structures are used in the semantic view of scientific theories and Physics Pluralism. First, Redhead notes that Psillos fails to clearly define *structure*. This is not atypical in the literature. Many provide some vague reference to the mathematical equations of a theory, which is what Worrall (1989) originally meant by structure, but that is not sufficient to a clear and comprehensive understanding—equations do not stand alone. “Informally a structure is a system of related elements, and structuralism is a point of view which focuses attention on the relations between the elements as distinct from the elements themselves” (Redhead 2001a, 345). Concrete

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<sup>172</sup> See the preface to Fred Suppe (1989) for an enlightening introspective account of the history. Patrick Suppes (1960) makes the point in comparing the “constancy of meaning and difference of use” of the term ‘model’ and analyses several uses compared with the definition in logic. However, he also suggests that one can interpret many of these uses in the set-theoretic way, and shows the many ways models can be used to assist understanding theories and making them more precise. While Suppes’ ideas are quite optimistic, and certain theories of certain well-defined and idealized domains of physics have been axiomatized, most of physics and certainly most of other empirical science continue to resist extensive axiomatization in the logico-linguistic sense, even though they are extensively and precisely mathematical, which is why we can and should rely on the semantic conception.

structures might be exemplified by specific constituents of an entity, e.g. bricks, brush strokes or words and their arrangements e.g. in a house, picture or sentence. An example of an abstract structure, as second-order properties of those relations, might be ‘fit together next to each other’, etc. or similar characterization appropriate to encompass an abstraction of the common features of all of the above examples. Thus abstract structures provide abstract characterizations of concrete structures.<sup>173</sup> According to Redhead, the former can be thought of as *ante rem* second-order Platonic Forms “shared by all the concrete relational structures in a given isomorphism class” or the class itself, represented by any arbitrary member.

The claim of the structural realist is that this abstract structure associated with physical reality is what science aims, and to some extent succeeds, to uncover, rather than the true physical relations of that reality. The abstract structure can be thought of then as a second-order property of the true physical relations, rather than these physical relations themselves.

The mathematical representation of this abstract structure is what Psillos and Worrall mean when they talk about the 'equations of a theory'. Psillos seems to assume that the structural realist is committed ontologically only to the reality of abstract structure. (Redhead 2001a, 345)<sup>174</sup>.

I certainly do not adopt the Platonic view here, yet abstract structures are idealizations compared with the more concrete models closer to the data.<sup>175</sup>

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<sup>173</sup> There may be some confusion here. Abstract structures in this sense are not formal structures, even though both are abstract. Formal structures are not abstractions *of* classes of concrete structures, which is what Redhead is talking about here. Formal structures are structures of formal systems, with nothing concrete about them. For different presentations of abstract and concrete structures, theories and models see Cartwright (1999), especially chapters 3 and 8, and Morgan and Morrison (1999).

<sup>174</sup> Note that Redhead’s essay is a critique of Psillos’ (2001) book. Redhead is characterizing Psillos’ characterization of Worrall’s views. Redhead then goes on to criticize Psillos’ characterization by pointing out that Psillos’ characterization is ontological, while Worrall’s is epistemological. This seems correct, and much of the literature (e.g., Ladyman, Ross, French) seems to agree. Redhead’s point is not that the ontological view is wrong, but that it does not characterize Worrall’s version of SR, which is called ESR for that reason.

<sup>175</sup> Examples of axiomatized systems may assist understanding. One early example of a physics theory that has been axiomatized, and to which the semantic view could be applied, is classical particle mechanics (Suppes 1960, 291; see also Suppes 1957, 291-305). Five primitive notions are required: (1) a set *P* of

Van Fraassen (1980, Ch. 3) explains the semantic view with four simple axioms producing a geometric structure called the Seven Point Geometry, also called the Fano Plane, which is the finite projective plane that contains the smallest number of lines and points.<sup>176</sup> The Fano Plane is *isomorphic* to a substructure of the infinite Euclidean plane structure, and the Fano Plane is therefore *embedded* within the latter. The concept of embedding one theory in another is, according to van Fraassen, particular to the semantic view. This concept greatly assists evaluation and comparison between theories, and is not available to the syntactic view.

The syntactic picture of a theory identifies it with a body of theorems, stated in one particular language chosen for the expression of that theory. This should be contrasted with the alternative of presenting a theory in the first instance by identifying a class of structures of its models. In this second, semantic approach the language used to express the theory is neither basic nor unique; the same class of structures could well be described in radically different ways, each with its own limitations. The models occupy centre stage. (44).

Van Fraassen illustrates some of these concepts within the context of his constructive empiricism by examining the Newtonian theory of mechanics and gravitation  $TN(v)$ , which is the theory with the solar system's centre of gravity having constant absolute

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particles; (2) an interval  $T$  of real numbers interpreted as elapsed times; (3) the position function  $s$  defined on the Cartesian product of  $P$  and  $T$ ; (4) a mass function  $m$  defined on  $P$ ; and (5) a force function  $f$  defined on  $P$ ,  $T$  and the set of positive numbers used to name the forces. A realization of the axioms (i.e. a model of the theory) might be the ordered quintuple  $CPM = \langle P, T, s, m, f \rangle$ .

It is simple enough to see how an actual physical model in the physicist's sense of classical particle mechanics is related to this set-theoretical sense of models. "We simply can take the set of particles to be in the case of the solar system the set of planetary bodies... The abstract set-theoretical model of a theory will have among its parts a basic set which will consist of the objects ordinarily thought to constitute the physical model" (Suppes 1960, 291).

<sup>176</sup> See [http://en.wikipedia.org/wiki/Fano\\_plane](http://en.wikipedia.org/wiki/Fano_plane) for a graphic example. The axioms are: (A1) for any two lines, there is at most one point that lies on both; (A2) for any two points, there is exactly one line that lies on both; (A3) On every line there lie at least two points; (A4) There are only finitely many points. In that structure are seven 'points', seven 'lines', three perpendiculars and an inscribed circle. The axioms are seen to be true in this structure of the theory and language of Euclidian geometry, and "Any structure which satisfies the axioms of a theory in this way is called a model of that theory" (43). Note that 'point' and 'line' are two of the three primitives ('plane' is the third) in the Euclidian geometry theory generated from Hilbert's axioms of geometry. 'Perpendiculars' and 'circle' are derivative. The picture and even imagery of interpretation of the primitive terms are merely intuitively helpful representations of the abstract structure but the terms are entirely abstract symbols.

velocity  $v$ . Newton claims empirical adequacy for  $TN(0)$  and all  $TN(v)$ . Hence, “all the theories  $TN(v)$  are empirically equivalent exactly *if all the motions in a model of  $TN(v)$  are isomorphic to motions in a model  $TN(v+w)$ , for all constant velocities  $v$  and  $w$* ” (46).

Van Fraassen’s preliminary explication of empirical adequacy is that “a theory is empirically adequate exactly if what it says about the observable things and events in this world, is true” and the more precise formulation is that “such a theory has at least one model that all the actual phenomena fit inside” (12), i.e., the sentences expressing the empirical content are true in that model.

French and Ladyman (1999) examine the semantic view in support of their form of ontic structural realism. They confirm Suppe’s (1974, 221) comment that “theories are not collections of propositions or statements, but are ‘extralinguistic entities which may be described or characterized by a number of different linguistic formulations’” (French and Ladyman 1999, 105). Hence, while the set-theoretic formulation of a structure (that which tells us to what the terms of a language refer), a theory (the set of all sentences of the language closed under logical implication) and its models (the class of all structures  $S$  for the language in which every sentence of  $S$  is true) are based in language, since they are idealized as autonomous so that they can be extralinguistic. One of the major issues for logical positivism was that if the language changes, e.g. if another term is needed due to empirical advances, the theory must change also. In the semantic formulation it is proposed that the structure and model might not change even if the language changes, thus preserving the continuity of science through theory change—yet the language, which expresses the ontology of the theory, does change over time. It is hard to see how change

in structures and models would not occur, considering how intimately connected and dependent the structures, theory and models are to the language.

French and Ladyman attempt to solve the two problems of (1) the limited capability for many theories of empirical science to be axiomatized; and (2) the need for the theory (as the class of all of its models) to be independent of the specifics of its language. They develop further the notion of *partial truth* and *partial isomorphisms* (the different partial formalizations mentioned by Fred Suppe in a previous quote earlier in this section, his 1989, 3-4). Da Costa and French (2003) utilize this notion, alternatively calling it also simply *true*, what Suppe calls *empirically true*. A relation is part of the definition of a structure: it relates a function of the *n-tuples* of the language's elements. The latter are interpreted, e.g., as the causal, mathematical and/or relational structure of a theory. A relation becomes partial by limiting it to a particular domain of elements (French and Ladyman 1999, 105-106): It is not the relation that is partial, but it is the domain that is only a subset of the universal set of the theory. Hence, with a change in the language, one may simply adjust the domain to include only what the relation relates to. Hence, the structures and their models are also constrained to the new domain. This adjustment of the domain means that the theory is true in that revised domain, and the truth is not partial—the relation is simply true—because it is the isomorphism that is partial. Hence, the partial isomorphism only picks out those relata which satisfy the relation. Hence, the truth relates only to a confined domain, which is simply what the theory is describing, rather than being approximately true if we think of the domain with a wider scope that includes things that do not pertain to the theory. Theories are, of course, idealizations: the only complete description of the world is the world. Hence, to

describe some portion of the world we abstract and idealize the connections with other parts and the characteristics of the selected part of the world that we are describing. However, the theory should clearly specify the limits of the idealizations and abstractions, and will provide for parameterization of those situations outside its scope. For instance, a theory of inclined planes will describe frictionless systems, yet specify parameters for the friction coefficient to allow for extensions that will enable the theory to encompass real systems. Thus, we are not dealing with idealizations that can be discarded as merely approximate, but rather idealizations with features that are pertinent to the context of investigation. I argue that such idealizations do not necessarily entail falsity, but may just entail limitation of domains, i.e. restrictions of the domains to those phenomena in which the idealizations refer to existent entities and processes. In being an idealization and abstraction a theory is not so much false as incomplete—it only applies to what it applies and no more. Hence, we must know to what it applies before we make conclusions on its basis, i.e. we must know its domain, or the context of discussion.

This summary was intended to capture the essence of the way in which it is generally interpreted that the semantic view of theories becomes extralinguistic, thus being an improvement from the ‘failed’<sup>177</sup> syntactic view, which is the intended conclusion of this section: Structures (hence theories) in the semantic view are extralinguistic, hence do not change with slight changes in elements of the domain. Rather, the models, partial isomorphisms and/or domains change. Hence, the theory may survive the next experiment even if something different is found, hence a new conception of convergent epistemic realism has a chance to be true, that there is an evolution of theories—not that they become closer to the truth, but that they truly reflect actualities in

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<sup>177</sup> This is in scare quotes because not everyone considers the syntactic view dead.

more and more domains. Here, truth of a theory is defined as follows: the theoretical terms that are supposed by the theory to have physical realization accurately refer to things in the world as described by the entire content of the theory. Many questions remain, some of which are explored below.

#### ***B.4. Objections and Replies***

Chakravartty (2000) takes issue with the conclusion that the semantic conception of theories in the model-theoretic formulation allows for a scientific realist interpretation without reliance on use of language that would then entail the same issue with language that was problematic for the logico-syntactic ‘Received View’ conception. Issues revolve around the idea that theories are ‘identified’ with collections of models, or ‘are’ collections of models, and also distinctions between ‘abstract’ and ‘idealistic’ models. Chakravartty’s main point is that in the process of explaining a phenomenon, we will still need to rely on reference and correspondence between what the theory says and what is observed, and this will require use of language in the same way as reference and correspondence between theories in the logico-syntactic conception. Because of that situation, we will be forced to interpret the nature of ‘unobservable’ entities instrumentally, rather than realistically.

French and Saatsi (2006) and French (2009) respond to Chakravartty by acknowledging that, indeed, language is required, and promoters of the semantic conception do not deny that this is necessary, nor that there will be reliance on reference and correspondence. In the semantic conception, especially as described by da Costa and French (2003), partial isomorphisms provide such a service, and what the a model of the theory refers and corresponds to is, finally, the data model of the empirical data (more about this below). Therefore, it is not that language is not used, as it certainly will be

when we wish to *interpret, explain* and *believe* what the theory says is going on, but rather that it will be easier to *reduce* or reliance on slight and irrelevant changes in language by use of the semantic conception.

I add further responses, more specific to my own context. First, Physics Pluralism is not designed as a framework that can be used in all situations, but rather only to address the main issues discussed here, which is whether phenomena are causally independent, mereologically unitary and/or persistent through time. Hence, the question is whether we can determine enough from our theories to address these issues, rather than answer all questions about all the nature of all entities, properties and relations. One of the main reasons why we can address our issues—as I argue throughout the rest of this dissertation—that is due to what I call the epistemic pluralism of Physics Pluralism, which is my second reply: In some domains we will be forced to use only instrumental interpretations, but in other domains we will be able to use more scientifically realist interpretations. For example, following Hacking and Dharmakirti, if we can use something to build other things, i.e. if it has a function, then it is real.

Additionally, in partial consequence of the above point, and as I argue in more detail elsewhere, the distinction between observable and non-observable in this debate—which is drastically different than its use in physics—is spurious, for the following reasons. First, if we take this objection seriously then we must acknowledge the theory-laden quality of our own perceptual psychology and hard-wired neurology, and without further analysis we would end up in an untenable position of not being able to believe anything we think we see. Second, we need not rest here, due to the amazing advances in science and especially the scientific method and understanding of the relevance of

evidence. This will be reflected below in our discussion of the credibility scale of Physics Pluralism.

## C. Theory systems

### C.1. The elements

As previously explicated, Physics Pluralism is informed by a Tarski-Suppes model-theoretic version of the contemporary semantic conception of theories.<sup>178</sup> Physics Pluralism defines a theory-system—or simply a theory—as an interrelated collection of components: *general principles*; the *formal theory* which has the formal statements of the theory; *informal models*; *domains of applicability*; and *data models*. Empirical data which form the basis of data models are technically outside of the theory system itself, and are the ultimate ground and arbiter of validity, utility, and possible truth of a theory.<sup>179</sup> Additionally, Physics Pluralism utilizes a *credibility scale* to score theories, and *partial isomorphisms* are relations between elements of different models of the theory.

Briefly, general principles<sup>180</sup> include symmetry and conservation principles connected by Noether's theorem<sup>181</sup> and such basic ideas such as the principle of least

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<sup>178</sup> As based on Tarski (1935, 1944) and Suppes (1957/1999, 1960, 1961, 1967) as developed further by Suppe (1974, 1989), van Fraassen (1980, 2008), Giere (1988), French and Ladyman (1999), da Costa and French (2003) and numerous other individual and collaborative works by da Costa, Bueno, Ladyman, van Fraassen and French. The epistemological form of the framework is what constitutes a scientific theory, and is essentially that itemized by da Costa and French (2003) and French and Ladyman (1999) and Rohrlich (1988, 1996, 1997, 2001, 2002) with variations and explications of my own.

<sup>179</sup> This is not to deny a relationship between theory and the data that is collected, the experiment that is chosen to be conducted, nor for that matter the collective agencies that select experiments to fund. That situation is embodied in the first criterion of the credibility scale, acceptance, and thus we do have societal and psychological influences that should not be discounted, but rather must be addressed, yet are outside the scope of this chapter.

<sup>180</sup> Including general principles in the theory-system is in my view not given substantial enough emphasis in the literature, hence including them as a separate component of a theory in the formal definition should be considered one of my innovations.

<sup>181</sup> Indeed different theories and domains will have different symmetry and conservation principles, and seeking the symmetries are much of the work of physics, just as determining *how* Hamilton's Principle is applied in different domains is central to physics investigations. Nonetheless, the principle that there are

action embodied in Hamilton's Principle, which essentially embodies principles of causality.<sup>182</sup> These general principles are applied at least nearly everywhere in all theories and domains, if not everywhere, and are as near to fundamentally and universally applicable formal structures as exist in physics. Much—though not all—of physics can be accomplished by simply applying these notions, and much of physics concerns how they are applied in the particular domain of concern. Hence, some of the pluralism manifests as different implementations of these general principles in different domains, and more pluralism is demonstrated in particular characteristics of particular domains.

The formal theory<sup>183</sup> includes the language of the theory—the terms and relations between terms that embody the formal, structural, generally highly abstract, and

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symmetries is, apparently, universal, and once we find the symmetries much of the hard work is done. See Finkelstein's (2003) essay on symmetry unifications based on Madhyamaka principles in Wallace's (2003) collection of relevant essays seeking correspondence between Madhyamaka and science, both physical and cognitive.

<sup>182</sup> The principle of least action, which is associated with the calculus of variations, has an extensive history. See [Goldstine \(1980\)](#) for a comprehensive treatment. The principle of least action and its application in Hamilton's formulation is fundamental to physics, and is taught and used throughout the subject. See for example Landau and Lifshitz (1951, 1958, 1960, 1971), and especially their (1960) for a classic mechanics introduction to the concepts. For beginners I also recommend Brun (2007) for an elementary introduction, or numerous Google sources. For example, as described in [http://www.scholarpedia.org/article/Principle\\_of\\_least\\_action](http://www.scholarpedia.org/article/Principle_of_least_action) "The principle of least action is the basic variational principle of particle and continuum systems. The true dynamical trajectories of a system are found by imagining all possible trajectories that the system could conceivably take, computing the action (a functional of the trajectory) for each of these trajectories, and selecting the one (or more) that makes the action 'least' (actually stationary). The true trajectories are those that have least action." Hamilton's method—which has different implementations—may start with describing the Lagrangian  $L$  of the system, which is an function of position, velocity and time that is the sum of all kinetic energies minus the sum of all potential energies from all sources. The task is to predict the evolution of the system. The action is defined as the integral of the Lagrangian over time from some beginning time to some ending time, yet to be determined. From the starting point, all possible variations are tried through the integration process and the derivative of the action over position is set to zero. The latter means that the action of the system will be a minimum, and that is the true trajectory that the system will take. This principle is essentially the same as causality because it directly expresses how a different trajectory requires a different energy.

<sup>183</sup> Taken from French and Ladyman (1999) and da Costa and French (2003). The reader is directed to the former for a review of the relationship between the syntactic and semantic conceptions, and the nature of structures, models and partial isomorphisms which hold between the structures (hence between the models), as well as the criticisms and responses provided in current literature. Further works by French, Ladyman, da Costa and Bueno as listed in the bibliography here provide further refinements which have been incorporated within this chapter and synthesized with my own extensions.

mathematical expression of the theory. In some interpretations (Worrall 1989) the formal structures of a theory are simply its differential equations which express the time evolution of the system. If the theory admits axioms, these are included.<sup>184</sup> An additional part of the formal theory is a collection of generally hierarchically organized formal models connected by partial isomorphisms which relate the abstract models to more concrete ones.<sup>185</sup>

Generally, many, and perhaps an infinite number<sup>186</sup> of *informal models*<sup>187</sup>—what da Costa and French and others, in particular Cartwright (1999), call *phenomenological models*—may be included in the theory-system, represented by different classes of models, each describing different types of interaction or particular instantiations of experimental and/or real-world situations that are explained by a theory-system. These models are called informal because they include details of experimental or real world systems which admit variations and details of equipment type and procedure, environmental and initial conditions, as well as inputs from more than one theory, as

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<sup>184</sup> For example, Kinsey, Sugar and Suppes (1959) formulate the axioms of classical non-relativistic mechanics and those would qualify as part of a formal theory.

<sup>185</sup> The abstract models may be more comprehensively true in an abstract sense, with wider scope, yet not implementable in experiment or in examination of the non-laboratory world because they abstract only the features of the lab or world which are relevant to the particular factors being discussed. Hence, more concrete yet still formal theory-bound models that may be ‘less true’ in having simplifying assumptions that do not refer to actual states of affairs of the world may be required to develop the formal structural and mathematical expression of a theory into one that can be applied.

<sup>186</sup> The class of informal models in any one theory contains models with the relevant features of all the *possible* experimental situations that could examine phenomena described by the theory. Thus, all pendulum experiments ever conducted or that could be conducted (under reasonable assumptions) in any high school would be in the class of informal models of classical mechanics. This is potentially an infinite set, but I need not push this point since nothing important rides on it.

<sup>187</sup> There has been much work done on developing our understanding of the role that informal models have in the theory system, including Morgan and Morrison (1999), Kellert, Longino and Waters (2006), and Cartwright (1999, 2007).

needed. They are less idealized, less abstract, and are practical to implement in experiment. However, they are informal also because not everything in the world or lab can be modeled, so the experimenter must select which factors to include, hence are more grounded in the ‘nitty-gritty’ of a real experimental procedure.

Empirical data is gathered during an experiment, and data models are developed which identify features of the data that are relevant to the theory. Isomorphic relations—generally partial—are established between those data models and the informal models of the experiment, which in turn have isomorphisms with the formal models.<sup>188</sup>

Central to understanding Physics Pluralism is the set of *domains*<sup>189</sup> that define the context of phenomena which are explained by the theory-system. The phenomena to be explained are generally the starting point for theoretical development—we ask ‘what is *that* all about?’ and then build elaborate abstract systems and concrete equipment to try to find an answer.<sup>190</sup> The problems and processes of identification of phenomena and domains are a central part of research utilizing Physics Pluralism.

A theory may have terms that are interpreted realistically. To reiterate what this means, and to be more technically correct, we say that the sentences of the theory which describe the properties of those terms are true in a correspondence sense, in that there are

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<sup>188</sup> Since they involve direct attention to the nature of the world they of necessity have subjective elements including notably the choices made by the scientific team for inclusion in, or exclusion from, the description. Therefore, descriptions in informal models are of necessity not inclusive of everything that is part of the experimental or real world situation.

<sup>189</sup> The terms ‘domains of applicability’ and simply ‘domains’ is used frequently in the literature, but rarely given serious attention, yielding more to the formal theory or informal modeling. Therefore, my focus on it is also somewhat of an innovation of Physics Pluralism. My treatment of it is largely based on the work of Rohrlich and Hardin (1983) and further work by Rohrlich (1988, 1996, 1997, 2001, 2002)

<sup>190</sup> I say that specifying the phenomena defines the domain in the context of a theory system because our initial identification of what to investigate and how to describe it is part of a semantic and epistemic system of personal and social culture. However, while acknowledging these influences, I also acknowledge the efficacy of physics in objectifying this experience.

actual physical entities which exist, and the description in the theory—which is of course an idealization—captures the relevant features of those entities under the conditions described, such that a partial isomorphism (or hierarchical series of them) may be established between the models of the theory and the data model(s) of measurements conducted on those entities. This technical description is summarized by saying ‘the terms of a theory refer’, or ‘the theory is interpreted realistically’. A realistically interpreted theory should technically only be true, but many technically false theories are generally interpreted in seemingly realist fashion, such as classical non-relativistic mechanics, hence those theories are called ‘approximately true’, and ‘technically false’. Recall that the truth of a theory is defined in relation to a domain, hence to say that ‘the theory is true’ indicates that there is a particular domain in which it is true, since no theory has yet been found to be universally true in all domains (while there may be general principles that are true in all domains), hence we say a theory is ‘true in a domain’ rather than simply true. Domains of a true theory, if there are any, are called *ontic* because they must have ontologically and objectively rather than epistemologically or pragmatically defined boundaries. As Fred Suppe (1989, 98) states, domains of empirically true theories are natural kinds, although I would predicate this by confining the true theory to the domain in which it is true, hence limit the natural kind to that domain, as we shall see in succeeding chapters.<sup>191</sup>

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<sup>191</sup> Although in my interpretation ontic domains are rather representations of natural kinds. Suppe, in my judgment, incorrectly identified the domain of classical non-relativistic mechanics as an example. The key to realizing his error is the implied use of fuzzy domain boundaries (such as described in the next paragraph of mine) to define the domain of this theory, while in a later section of his text he denies such use. Natural kinds do not have fuzzy domain boundaries.

To a degree, we will be concerned with natural kinds throughout the physics chapters, just as we were concerned with them in Chapter Three, since a natural kind is typically understood in terms of what we have been calling its inherent nature, the intrinsic, permanent, essential and necessary features of the entities in that kind. Hence, it is of concern to determine—at least intuitively if not definitively—if there are such entities. As it turns out, we will find that natural kinds frequently—if not always—are domain-sensitive; that is, the characteristics or properties which determine the kinds with inherent nature have such nature only within particular domains, and are found to be relational in other domains, hence are globally relational and only locally inherent.

To explicate further concerning domains, classical non-relativistic Newtonian dynamics is used when the velocity is low in relation to that of light, and gravity and acceleration are low.<sup>192</sup> However, this theory describes a world with no limit to any relative velocity, hence with simultaneity, mass that stays constant independent of velocity, and no equivalence relationship between mass and energy or gravity and acceleration. That world does not exist, so by our definition this theory is false, in that there are no even partially isomorphic models which are true of the theory. In the original realist responses to Laudan that inspired development of Physics Pluralism,<sup>193</sup> Rohrlich and Hardin define a domain boundary between the Newtonian and special relativity with the commonly used dimensionless parameter  $\beta^2 = (v/c)^2$  such that if  $\beta^2 \ll 1$  the Newtonian theory could be considered approximately true. However, by Physics Pluralism (and standard fundamentalist reasoning as well) it is understood as being false

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<sup>192</sup> Such that the Schwarzschild radius divided by the distance to a large mass is much less than 1. See Rohrlich (2002).

<sup>193</sup> Hardin and Rosenberg (1982), Rohrlich and Hardin (1983)

everywhere because the terms do not refer; additionally it gives false answers in every domain.<sup>194</sup> We call *merely pragmatic* any domain which is described by such approximately true yet literally false theories.

Physics Pluralism requires that the boundaries of ontic domains within which true theories have terms that refer must be objectively defined by parameters that have no such inequalities in their definition. Such objectively defined boundaries are termed asymptotic by Rohrlich and Hardin (1983, 605), but Batterman (1995, 174) distinguishes a regular from a singular perturbation problem in the asymptotic approach (e.g., as  $v \rightarrow c$ ) to domain boundaries. The boundary between non-relativistic and relativistic domain is regular in values of calculations based on  $\beta^2$  for the following reason: We apply epistemic or pragmatic values to determine a domain and which of these two theories to use, depending on the errors that result from using the easier Newtonian theory. The error between the Newtonian theory and special relativity grows smoothly as  $v \rightarrow c$ . However, the reference of terms is singular: The relativistic world is the way the world is, and it is drastically different than the ‘imaginary’ classical world. Hence, Newtonian theory is false, but useful. For a domain of a theory understood within the epistemological framework of Physics Pluralism to be ontic, thus allowing for a true theory in that domain, the theoretical terms that are intended to have physical realization must refer to actual features of the physical world. Additionally, the domain boundary must be singular (in Batterman’s sense) in values of calculations and we must know for ontological

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<sup>194</sup> Regardless of the fact that classical non-relativistic dynamics is used in innumerable instances in many real-world applications without consideration of relativity and still gives accurate *enough* predictions with errors well below the noise level of other factors, it has been found to require a relativistic correction for velocities as low as 10 m/sec, and gravitational differences due to differential distances above Earth’s surface of only 1 m (Chou 2010). But more importantly in our context, the terms do not refer, hence the theory is false and *also* gives false but nearly true answers if  $p \ll 0$ , plus other considerations of gravity and acceleration.

reasons alone—not mere convenience—where the domain ends. Such a theory may well be singular in reference of terms, thus two ‘neighboring’ domains may have true theories with very different terms describing relevantly different worlds. To be singular is another way of saying that there are clear demarcation criteria to distinguish one domain from another, which is perhaps why Suppe called them natural kinds, the definition of which commonly requires such criteria (see Bird, 2008). For example, Newton’s dynamics and the special theory of relativity are singular in terms of simultaneity, i.e., there is no asymptotic approach from simultaneity to no simultaneity, it is a binary state of affairs: In the former there is simultaneity and in the latter there is not. There are no gradations between these factors of the theories. However, they are not singular in terms of calculations, which are dependent on a factor which smoothly varies with speed from zero to the speed of light. Hence, at least one domain—in this case the Newtonian one—must be merely pragmatic. With different referential terms applying in different domains, it may be difficult to justify a statement that the world has a global nature purely one way or another, rather than—as Physics Pluralism describes—having multiple natures, different in different domains.<sup>195</sup> The latter feature of this framework is ontic pluralism, and there is therefore an *ontic relationality* when we compare the world of one domain to that of another, which is a central finding of Physics Pluralism.

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<sup>195</sup> Recall that the *neither one nor many* Madhyamaka argument, e.g. in Śāntarakṣita’s (MAL) is mostly about there being no singularity (MAL spends 60 of 90 verses on this) and then if there is no single then there cannot be any multiple, since the latter comes from the sum of the former (MAL has only the 61<sup>st</sup> verse on this). However, this application of classical extensional mereology is not valid now that we know calculus and quantum anti-reductionism, although more on the latter in further chapters. Hence, we may have multiples without singles, or rather those terms lose meaning. Thus something may come from adding an infinite number of nothings, so to speak. This situation was not expressed in Madhyamaka writings, to no one’s surprise since it was not comprehensively described until Leibniz and Newton and not completed until Dedekind in the 19<sup>th</sup> century.

We now will discuss the credibility scale of a theory-system. I do not consider the credibility scale an element of a theory *per se*. Rather, I consider it part of the Physics Pluralism epistemic framework, part of our judgment and interpretation of the theory. While an argument could be made that it should be considered part of the theory, a discussion of the issues would bring in unnecessary complications. The credibility scale is used to score theories and provide us with epistemic warrant to believe that the theories can give us knowledge about the nature of phenomena. The credibility scale—to be explicated in more detail below—grades theories to judge the level of confidence that we have in the following characterizations: (1) *acceptance*, similar to *empirical adequacy* or *success*; (2) *horizontal coherence*, which pertains to its use in relation to other physics theories and perhaps other sciences; (3) *maturity*, which usually has formal, mathematical components; (4) *domains of applicability*, or simply *domains*, which are the representations of physical phenomena for which the theory provides an explanation, including characterization of the domains as *merely pragmatic* or *ontic* and how well phenomena are understood within their domain. For instance, classical non-relativistic mechanics is a very well understood yet false theory for the merely pragmatic domain of trajectories of non-quantum entities with velocities ‘well under’ the speed of light, and classical relativistic mechanics is a very well understood true theory for the ontic domain of all trajectories of non-quantum entities with all physically realizable velocities. (5) *Vertical coherence* pertains to the theory’s relationship with the theories of ‘bordering’ domains, and its level of integration in comparison to other theories, perhaps in terms of intertheoretic reduction **where** that is possible, though it is not always possible; and finally (6) *truth in its domain*. If a theory is not accepted, i.e. it is not empirically

adequate, then it is a developing theory, and its terms are generally more instrumentally rather than realistically interpreted.<sup>196</sup>

Physics Pluralism allows for realist interpretations, hence a brief summary of the fairly well-known instrumentalist and other anti-realist objections and responses by defenders of the generic form of realism which became the focus of recent debate—*convergent epistemic realism* (CER)—is appropriate. By CER science progresses closer and closer to the truth, a theory is approximately true in its domain, and successor theories get less approximate and more true: Truth admits gradations. (By contrast, for Physics Pluralism more domains are added to the corpus of domains with theories that are true in their domains.) Yet, we really have to know how approximate and in what way the theory is approximately true in its merely pragmatic domain or if it is true in its ontic domain in order to understand the nature of phenomena. To do so we must begin by looking at instrumentalist objections.

### ***C.2. Anti-realist objections and responses: epistemic pluralism***

I argue that at least one type of anti-realist objection—pessimistic meta-induction, as described below—can be summarized as ‘throwing the baby out with the bath water’. This is because in that view entire theories are dismissed *tout court*, including many mature theories of our past which are actually currently used and integrated with their successors. It is true that most of those have been significantly modified, yet in the new

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<sup>196</sup> The credibility scale has been expanded from work by Hardin and Rosenberg and Rohrlich and Hardin, who responded to Laudan’s explication of the instrumentalist objection, plus notably work by Rohrlich (1988, 2001).

form they become part of modern science.<sup>197</sup> A traditional realist who also supports a fundamentalist perspective may also react to older theories by discarding them.

Physics Pluralism is not a purely realist framework, but does admit theoretical terms which are interpreted realistically in certain contexts (which we call domains). The framework is epistemically plural, meaning that there are domains within which we don't have enough justification for a realistic interpretation, hence must have utilize an instrumental interpretation. In those domains the central theoretical terms of the theory are interpreted as merely theoretical constructs solely for the purpose of prediction, without ontological consequences. However, there is sufficient justification to believe that some central theory terms for some theories in some domains are—with a high level of confidence—accurate descriptions of reality sufficient to identify the terms as referring to 'real entities', even if they are not visible to the naked eye.<sup>198</sup> Some of those theories are discussed more fully in the following three chapters. Yet, as da Costa and French (2003, Chapter 8)<sup>199</sup> assert, in order to justify a realist interpretation two main instrumentalist objections must be addressed: *pessimistic meta-induction* and *underdetermination of theories by data*.

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<sup>197</sup> The modified forms generally make them models of a more complete theory.

<sup>198</sup> There are no perfect descriptions of reality—reality is too complex and probably infinite in characteristics. The only complete representation of the world is the world itself. We can, however, identify classes of characteristics, and create *good enough* descriptions to enable comparison with experience (experiment) which might provide *sufficient justification* to believe that those entities which are describe exist as described. In that case, our interpretation is called realist. This applies even to those things we cannot directly perceive. Additionally, we should even doubt the accuracy of direct perception, which certainly is influenced by preconceived notions, or even mood. Also, we can say 'the teacup exists as a real entity', as we label 'this thing' the teacup that is holding my tea. The question is: What is the teacup other than 'this thing'? Then we start describing, and no description can be complete other than the thing itself.

<sup>199</sup> See also Psillos (1999) which da Costa and French summarize, analyze and expand upon.

Pessimistic meta-induction (e.g., in Laudan, 1981) occurs from examination of the historical record of theories showing that older successful theories which were thought to be true were subsequently found to be false; hence by induction we have good reason to believe our current ones are false also. Responses and counter-objections in the anti-realist/realist debate continue.

One of the first of many realist responses to Laudan<sup>200</sup> was that many of the false theories were merely hypotheses or conjectures, immature developing theories or even successful and partially accepted theories, but with explicitly instrumental terms in the first place, or terms that were not fully accepted as having physical referents.<sup>201</sup> Second, many ‘succeeded’ theories were not discarded, but were rather refined by constraining their domains and adjusting the interpretations and perhaps operational definitions of some of their concepts and theoretical terms, thus strengthening their utility and perhaps even making them true in their new domains. The extralinguistic feature of theories under the semantic conception saves the theories from being discarded if adjustments to models can instead be made. Third, some non-referring terms were not central to the success of

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<sup>200</sup> Hardin and Rosenberg (1982), Rohrlich and Hardin (1983), Psillos (1999), da Costa and French (2003).

<sup>201</sup> Caloric is a case in point. See Hardin and Rosenberg (1982, 611-615, especially 614), and Psillos (1999, Chapter 6) for an extended analysis summarized and echoed by da Costa and French (2003:Chapter 8), including their analysis of work and conversations by and between Laplace and Rumford. Caloric has an extended and fascinating history which has been used as a case in point for both the instrumentalist and the convergent realist. There were, however, conflicting views since some interpreted the entity realistically, thus the theory was not even thoroughly accepted by the community at the time, even though it had some significant successes. The investigation of the concept resulted, at least in part, in the principle of conservation of energy. Additionally, the idea of a fluid medium for energy in solid states re-arises in the quantum mechanics of condensed matter physics. Hence, the concept was not entirely discarded, and, like the ether discussed below, has utility and perhaps true reference in new clothes, as discussed in the fourth point, below. Indeed, some physicists are instrumentalist about some theoretical terms in some current theories. However, the instrumentalist is, I would argue, restricted to domains which are on the boundaries of our knowledge, hence making those developing theories in those domains, while in domains of confirmed evidence, even concerning what is generally considered the ‘same’ theory, those same physicists would interpret terms realistically. For a survey of what readers of *Physics Review* think is real, see Crease (2001, 2002). I think that this survey, however is too limited in scope to be relevant, although it is thought provoking.

the theories, hence did not refer to actual features that were necessary to the empirical success of the theory, and should not be used to judge its truth. Fourth, the features to which some terms supposedly referred actually were confirmed by the successor theories and associated experimental evidence to exist as actual entities, but their properties as described by the successor were different from the properties described by the predecessor.<sup>202</sup> Thus, for example, a realist interpretation of the *entity* ether as described in each of the many progressive iterations of theories of light transmission may not have been justified, but many of the *structural (causal) properties* of such an entity were retained and enhanced, and they are actual features of our physical world.<sup>203</sup> This is the

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<sup>202</sup> See Hardin and Rosenberg (1982) and Rohrlich and Hardin (1983) for detailed examples. For instance, the *ether* is another case in point for both sides of the argument. From the CER point of view, the *ether* as a medium for the transmission of light in the early mechanical theories was not rejected entirely, but was replaced by the electromagnetic field in mature classical electrodynamics. Also, significantly, the older ether was replaced precisely because the consequences of its properties were not confirmed by experiment, and its existence did not play a central role in the success of ether theories in general and Maxwell's theory in particular. The latter only 'required' a medium for reasons consistent with mechanical conceptions in older theories of electromagnetism which his theory replaced; Maxwell's was not a mechanical theory and use of the ether was an anachronism in its philosophical interpretation or inspiration during development, but was not used in its application. Since it was not used in the theory's success, its lack of referent is not relevant to analysis designed to cut the link from success to truth. Further, the ether was revived (or rather never fully dropped) to become the quantum vacuum in quantum field theories, and retains a role in current theory.

<sup>203</sup> Note that background vacuum quantum field is used to explain phenomena that we otherwise do not understand, but this does not entail a realist interpretation of it. While we know much about it, there is a lack of substantial evidence about some of their properties; hence perhaps we should interpret the term instrumentally in some domains. Yet, we know that there is *something* that is causally relevant to the effects that we identify as being caused by that field, even while unsure of all its properties. When the autumn leaves on the lawn start swirling above the ground at the same time that I feel a cool pressure against my face (and with no dog or other alternate cause in sight), along with leaves moving in the trees, I validly infer with near certainty that there is something atmospheric causing the swirling. We call this feature of the world 'wind', yet we may not know all its precise properties. It is important to realize that some of the domains which include the vacuum field are used by certain theories (e.g. quantum electrodynamics) with great precision and the term is central to their success. The difference between the instrumentalist and the realist is that the former would stop here, while the realist would say that there is therefore substantial evidence that the term refers, hence that field belongs in our ontology, although the question remains (see *Chapter Eight: Physics of Composition*) whether that field has inherent nature or is purely relational. Yet other effective field theories use this term in domains at the forefront of modern research designed to determine its incompletely known properties.

response by advocates of structural realism. It has been argued by many authors<sup>204</sup> that the convergent epistemic realism which this progression demonstrates contradicts Laudan's major thesis, thus indicating rather that science does progress closer to the truth, building on the previous work rather than tossing accepted and mature theories out *tout court*. We do not have the space to present those arguments here since they involve detailed examination of the history and particulars of physics theories which the reader can obtain through the references in the bibliography and footnotes of this chapter. If we accept this for now for the sake of presenting Physics Pluralism, we have one of its major ingredients, *epistemic pluralism*, allowing for both instrumental and realist domains.

Several objections arise against the convergent epistemic realist (CER) interpretation. The accusation of 'Whiggish' reconstruction of history<sup>205</sup> might be laid against this analysis, and other reconstructions may demonstrate opposite conclusions. Yet the point is that now our standards are much higher and we are always testing the limits of our theories to confirm their veracity. Those standards are defined in our previously outlined credibility scale that is described in more detail below. Another objection is that, even if we agree to convergent realism without yet accepting Physics Pluralism, then we only know that we are not at the truth yet, and all theories so far, even those high in the credibility scale, are just what has been called *pragmatically true*,

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<sup>204</sup> See Hardin and Rosenberg (1982) Rohrlich and Hardin (1983), Rohrlich (1988, 1996), Worrall (1989), Ladyman (1998), and Psillos (1999) to start.

<sup>205</sup> Ernst Mayr, "When Is Historiography Whiggish?" *Journal of the History of Ideas*, April 1990, Vol. 51 Issue 2, pp 301–309

*effectively true, approximately true, quasi-true, relevantly true or true enough.*<sup>206</sup> Physics Pluralism, however, distinguishes merely pragmatic from ontic domains and utilizes the perspective of completing the isomorphism which will enable us to state with confidence whether or not a theory is in an ontic domain and is *true in its domain* (within the limits of extreme skepticism) by focusing on restriction of the domain to those classes of phenomena for which the theory is true. One could further object that this method could be in danger of trivializing the entire process by restricting the domain only to those things that are real in order to make the terms refer. But this is the point: We only accept as ‘real’ those things that have sufficient evidence to support their reference as described in the theory.<sup>207</sup> No theory (so far) describes all of reality, and it is unreasonable to suppose that it could. A theory describes one set of characteristics of the complete reality, and it is only in relation to that set which we must hold the theory accountable. Thus, if a classical relativistic mechanics describes the dynamic (time) evolution of a system under influences of energy fields and constraints, then it is only those characteristics described by the theory which must refer to actual features of the world in order for the theory to be true in a domain.

As our final objection to the CER interpretation, if the continuity of science is justified—meaning that science progresses by integrating what has been theorized

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<sup>206</sup> These are indeed the terms currently in use by those who apply the semantic conception of theories, even those in the realist camps. Da Costa and French (2003) mention the predicates pragmatic, partial and quasi and note that the formalizing of those notions through their development of a non-classical paraconsistent logic enables their use in a non-ambiguous way. ‘Approximate’ is rarely used with any precision and without a metric of proximity it is fairly useless. ‘Relevant’ is similar to ‘effective’, discussed below, and they are made precise in physics contexts. ‘True enough’ is from Elgin (2004).

<sup>207</sup> Surely, there always will be doubt, but there is even doubt about the existence of teacups by any definition of teacups other than ‘those things which hold tea’, in other words without any detailed descriptions. Once we get into detailed descriptions of physical things, we must use physics theories, and we always have doubts.

previously into restricted domains rather than tossing past partially true theories out entirely—then we might have several theories which each at least seem to point to the same object and describe different properties: How can we say that both theories are true?<sup>208</sup> This brings us to the next instrumentalist objection against CER. We are told that empirical observations may provide evidence to support more than one theory, because any theory is underdetermined by the evidence due to fact that evidence never densely spans the entire physical reality and a theory must select only from the evidence, leaving the rest to speculation. Therefore, “there are always empirically equivalent rivals to any successful theory” and therefore “theory choice was radically underdetermined by any conceivable evidence” (Laudan and Leplin, 1991). I rather view the evidence as determining the domain that the theory explains, and the confusion concerning underdetermination is confusion about what it is that the theory is trying to explain. There is, of course, a class inclusion problem: we test a baseball and form a theory that covers all baseballs. This is where we can make a mistake: Maybe one made in Cincinnati requires a different theory. This is where we must apply mature judgment and science methodology. One response to this underdetermination objection in the literature is that even when empirically equivalent alternatives are produced, “. . .it is often not at all clear that they are genuinely incompatible rival theories that deserve to be taken seriously as scientific theories” (Earman and Roberts 2005b, 255).<sup>209</sup> They may be logical alternatives

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<sup>208</sup> Within Physics Pluralism what may seem to be different theories may actually be the same formal theory applied through different models into different domains. The seemingly ‘same’ object may actually be different entities. The difference is justifiable in quantum domains where objects get entangled and lose their identity, and are generally indistinguishable, hence what seem to be the same particle may exhibit drastically different properties in different domains. However, in classical physics domains, entities maintain their identity in different domains.

<sup>209</sup> Objections to invalidating underdetermination also arise, as, e.g., mentioned in Rohrlich (1996, 449). These include the Copenhagen vs. Bohm versions of QM; Riemannian vs. rubber geometry of GR; and

with notational variations, but without physical realization of actual differences in reference; they may be “cheap instrumental rip-offs, i.e. theories that cannot even be formulated without piggybacking on the theory to which they are supposed to provide alternatives...” (255). An alternate may even instantiate extreme skepticism. However, such theories should be discounted unless there is explicit physical evidence to support it.<sup>210</sup>

It is important for us to be able to at least discount, if not deny the underdetermination objection against a theory in order to have confidence in what it says about the nature of particular phenomena in a domain. In other words, we should be confident that there are no equivalently mature, accepted and true (in its same domain) alternative theories that provide information about the nature of those phenomena which contradicts our original theory. Another complaint of Earman and Roberts against the underdetermination objection attempts to address this situation by stating that it is simply not that easy to produce empirically equivalent alternatives. The basis for this view is that once a theory has become mature and accepted the alternatives have been weeded out, so a new alternative is not typically developed within the domains of such theories in which we have a high level of confidence in the reference of its terms. It should be part of our formulation of mature and accepted theories that only certain physical conditions should

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operator vs. functional (path) integrals formalism of QFT. Each of these must explain the same empirical observations, yet have significantly different ontologies. If we were to interpret these realistically, we would have an underdetermination problem. Rohrlich argues that the ontological issues are in domains of the boundaries of our knowledge, where these theories should be considered developing, hence future empirical evidence may provide the evidence to choose between them. I add that each of these should be considered different models of a core formal theory, and the core formal theory may indeed be merely developing for the time being in those border domains.

<sup>210</sup> The question of how much evidence is enough should be addressed, which is a huge topic in philosophy of science. We approach that topic in further chapters.

be included in the domain of such a theory. Those physical conditions to be included must have been significantly tested according to our credibility scale, thus providing sufficient evidence to support the contention that the theory applies to those conditions. This underdetermination objection is that other theories could be produced as alternatives, that rival theories must provide different explanations for the same empirical evidence.<sup>211</sup> Yet, as Earman and Roberts state:

When empirically equivalent alternatives can be found, it is often not at all clear that they are genuinely incompatible rival theories that deserve to be taken seriously as scientific theories. In some cases, they **are** mere notational variants on the original theory. In some cases, they **are** “cheap instrumental rip-offs,” i.e. theories that cannot even be formulated without piggybacking on the theory to which they are supposed to provide alternatives. (Example: “The world contains some unobservable structure or other that conspires to cause the observable structures all to be exactly as if the general theory of relativity were true.” This is perhaps an alternative to general relativity, but it is not a rival **theory**; no **theory** has been specified here.) In some cases, they are philosophers’ skeptical-nightmare scenarios, involving Cartesian demons, brains in vats and the like, which are not serious contenders as scientific theories. (Earman and Roberts, 2005b, 255).

One common counterexample proposed against positions similar to that expressed by Earman and Roberts, and therefore in support of the underdetermination objection to scientific realism, hence in support of instrumentalism, are hidden variables theories in quantum mechanics. Since the interpretation of quantum mechanics results is a central issue in philosophy of physics, and consideration of hidden variables theories will provide elaboration of the way in which pluralism may be applied as a response to the instrumentalist-realist debate, we will take a look at this case study in some detail,

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<sup>211</sup> We can interpret the search for the next decimal place in universal constants or other parameters as attempting to discover unknown structures, just as Tycho Brahe’s extra decimals in his observations of planetary movements served to confirm heliocentrism and discrepancies with Newtonian theory were discovered from the tiny variation in the perihelion of Mercury, thus providing incentives and confirming evidence for the general theory of relativity.

beginning with the historical background. Einstein provided a simple suggestion at the 1933 Solvay Conference (later published as Einstein, Podolsky and Rosen, 1935 and known as the EPR paradox) to counteract Heisenberg and Bohr's proposal that uncertainty and indeterminance was not just epistemic, but rather were ontic. He outlined a *gedanken* experiment demonstrating that both position and momentum should be features of physical reality and quantum mechanics as proposed by supporters of quantum indeterminacy predicted action-at-a-distance, thus violating local realism. EPR concluded that (1) either quantum mechanics as proposed was incomplete or non-commuting quantities (such as momentum and position) cannot have simultaneous reality, and by their thought experiment (2) such quantities do have simultaneous reality. They concluded that quantum mechanics is incomplete. They left open the option that measurements of each variable should be simultaneous, but rejected this option as entailing the objectionable requirement that ontological reality depended on the process of measurement.

Einstein's proposal provoked Rosenfeld (1967) to respond that: "This onslaught came down upon us as a bolt from the blue..." (quoted in Wheeler and Zurek, 137). Bohr's (1935) response was generally considered (and I agree) less than satisfactory. Later the EPR *gedanken* experiment was reformulated by Bohm (1951, 1952) in terms of spin, and Bell (1966) spelled out the difference between counting classical entities with precise values and quantum entities without them (and Bell, as a supporter of Bohm's hidden variable view was sure that the latter would be found to actually be classical). Hence, classical entities must follow what is now called Bell's Inequality. Bell's Inequality and further formulations like the Kochen-Specker theorem (Kochen and

Specker, 1967) are called ‘no-go theorems’ which set limits on hidden variable theories. With suggestions by Clauser et. al. (1969), for example, plus improvement of technology, experiments could begin in earnest (the famous Aspect experiments, starting with Aspect, 1976). Yet, it was found that quantum particles violated Bell’s Inequality. Thus it was concluded that quantum particles are not classical, and do not have precise values, at least in the domains of measurement. While some concluded that local realism was denied, many pointed out that these experiments conflated several principles which were not easily separable. See Home (1997) and especially Affriat and Seleri (1999) for detailed technical support for the idea that the matter had not yet been settled, plus Santos (2004) and Genovese (2007) for more recent reviews. Thus, what became known as ‘detector loopholes’ were identified, and various versions of hidden variable theories ( ) were proposed that would be empirically adequate by satisfying the measurement results, yet preserve the precise, classical values which intuition required.

These HVT must be explicitly equivalent to the formalism of quantum mechanics and must provide empirical predictions which match current data that verify indeterminate values. , propose classical values as the ‘ultimate’ nature of quantum entities Thus, HVT posit precise values underlying the measurements, while the standard interpretations do not, even while anything measurable must produce the familiar quantum indeterminacy. This counterexample demonstrates the degree to which Earman and Roberts’ position is an overstatement, since HVT in modern form are certainly not “instrumental rip-offs”, and some versions of those theories are accepted by a subset of the quantum physics community. Yet, those theories pertain to different domains: even HVT state that measurable quantities must exhibit imprecise values, and they are only

positing some ‘underlying’ or ‘ultimate’ nature beyond the scope of currently available empirical evidence. Thus, those HVT must be considered developing theories, just as new effective quantum field theories in those domains beyond the reach of experiment must also be considered developing, until such time as evidence provides verification one way or another.

Coming back to a general analysis of realist responses to instrumentalist objections, Worrall (1989) highlighted a continuity of structural properties referred to by the terms such as the ‘ether’ mentioned previously as an important factor in convergent epistemic realism. Those structures describe relational and causal properties of entities to which the terms refer, rather than referring to entities themselves or their intrinsic properties. Since Worrall’s formulations of this view, different varieties of structural realism have been proposed.<sup>212</sup> The Physics Pluralism view is that there are different domains in which each of these alternatives may be the more appropriate interpretation, and none applies universally. Recall that *epistemic pluralism* is the aspect of Physics Pluralism allowing it to accept both merely pragmatic and ontic domains. Thus we can have ontological commitments that reflect both instrumentally or realistically accepted theory terms in different domains, respectively. This results in allowance of use of both false theories and also admitting theories which are true in their domains. Physics Pluralism also exhibits *ontic pluralism*. Thus, different ontological elements may be

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<sup>212</sup> See Ainsworth (2010) for the structure of different structural realist views Worrall’s version (called now *epistemic structural realism*) identified the structures with the differential equations of the theory. He also suggested that no knowledge of the entities could be obtained. Alternatives by Ladyman (1998) and French and Ladyman (1999) were provided which generalized the structures in a model-theoretic framework which has become part of Physics Pluralism. These alternatives and those of Chakravartty (2003) also offered arguments concerning the existence or nature of those entities. French and Ladyman argued that the entities do not exist (ontic structural realism), thus producing the *problem of relations without relata*, responded to by Chakravartty’s synthesis which found the relata implicit in the structural relations.

included or excluded from our ontologies in different domains.<sup>213</sup> Therefore, we need not continue bickering about the universal advantages and disadvantages of the various kinds of realisms: the content and entities described by a generic or ‘standard’ realism (Psillos 1999) or entity realism (Hacking 1983) which further requires engineering applications in addition to ‘standard’ realism may be quite appropriate in some domains—there is a very high level of justification for the reality of teacups and molecules from satisfaction of many criteria—while a structural realism of some sort may be called for in other domains where the existence of independent entities is in question and we know of only structural relations. Examples of the latter would be in quantum domains where ‘entities’ are indistinguishable, frequently entangled, and, as Teller states, are “intrinsically relational”, hence ‘entities’ may not even exist, at least not in a commonplace intuitive sense.

To review, in this section we have discussed various instrumentalist objections and responses to realism which support the realist stance. Instrumentalists identify several problems: pessimistic meta-induction and underdetermination of theory by the sparse evidence. These objections suggest that we must instrumentally interpret the entities and relations of our theories referred to by the theoretical terms that were central to their empirical success, especially if they concern entities that are not directly perceptible. Physics Pluralism is epistemically plural, and thus allows both instrumentally-interpreted and realistically-interpreted theories, yet relegates the former to domains of developing

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<sup>213</sup> For instance, in classical domains—relativistic and non-relativistic—we have an ontology of objects and precisely-defined properties. Yet, in domains of quantum mechanics ensembles of particles with the same state-independent properties and relational structures are indistinguishable and are frequently entangled, so it is not always possible to identify particular objects and properties. Thus, in quantum domains we may be restricted to structural relations, events and processes as the sole ontological elements. Of course, the indistinguishability of quantum particles is highly controversial, but if we are only concerned with physically realizable situations, rather than simply logical possibilities, and for the former quantum particles are indistinguishable. See Redhead and Teller (1991, 1992), Teller and Redhead (2000), and Teller (1995).

theories. The demarcation between the two is found in our credibility scale, discussed below. Physics Pluralism is also ontically plural, allowing different ontological elements in its different realistically-interpreted theories, depending on the nature of their domains. Thus, we should further discuss domains, since they are central to the pluralist perspective, after which we can examine the credibility scale.

### ***C.3. Domains of applicability***

According to the notion of conceptualization based on model-theoretic semantics that I am using in this dissertation, conversations occur in *context*, while I call the contexts of philosophical conversations *domains of discourse*. I do so, rather than calling them simply ‘contexts’ in order to identify the need to restrict the conversations to a well defined domain, while the term ‘context’ may involve fuzzy demarcation criteria. In physics, context becomes even more precisely defined, as *domains of validity* or *domains of applicability* (or simply, domains) that distinguish the type of phenomena for which particular physics theories provide good explanations that may be empirically adequate and possibly true. Thus, there are two features to which domains are intimately tied: phenomena and explanations, thus weaving ontological with epistemological aspects of theories together.<sup>214</sup> A domain is part of a theory system, and it is important to note that the system as a whole defines and describes a domain and a theory, including all its

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<sup>214</sup> There is also a semantic component, in that we have to identify the phenomena of concern using descriptions and categories, thus defining the domain of discourse. How a categorization entails different epistemic and ontic characteristics must be understood carefully, so that we do not confuse our categories with the nature of entities. Some say that the physicist’s natural kinds are merely the physicist’s categories, conventionally chosen for pragmatic reasons. The (generic) physicist, however, is quite aware of this, and this is what distinguishes state-dependent properties which are explicitly relational from state-independent properties which are explicitly intrinsic and independent of relationality. However, my point is that the explicit independence of relationality is still domain-specific, as discussed throughout this Part III. Thus intrinsic properties of natural kinds may also be intrinsically relational when we examine the kind throughout different domains.

elements.<sup>215</sup> However, empirical data—which actually are separate from the theory system—is the final arbiter of the utility and any potential truth of the theory system, and description of the domain.

Shapere (in Suppe 1977) defined ‘domains’ as bodies of related informational items, subject matters such as those concerning electricity, magnetism, light or chemistry. Rohrlich and Hardin, and further works by Rohrlich (see footnotes 178, 204 and 209 and the bibliography), further identified domains of applicability as the topics of physics theories (sometimes called domains of validity by Rohrlich and others), which I identify as an extension of contextualization and domains of discourse in philosophical discussion. Domains of applicability are representations of the physical domain of the context of phenomena under examination. I define two basic types of domains of applicability of scientific theories: *merely pragmatic* and *ontic*. When the reader sees a domain classified as ‘pragmatic’ it is not meant to suggest that ontic domains have no pragmatic function, hence we predicate pragmatic domains as ‘merely’ so. Merely pragmatic domains have fuzzy boundaries defined by the problem at hand, and typically utilize false theories which provide *approximately true* or *true enough* answers to our questions. Ontic domains have clear and objectively defined boundaries defined by symmetry breaking and clearly defined physical structures. Symmetry and symmetry breaking is discussed in detail in *Chapter Seven: Physics of Composition*. In general,

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<sup>215</sup> Thus a ‘natural law’ cannot be isolated from the entirety of the system and validly examined out of context. For instance, Cartwright (1999) examines Newton’s Law  $F=ma$  and the universal gravitation force function  $F=GmM/r^2$  out of context, and then identifies cases where they are not true because there is no acceleration while the ‘law’ determines that when there is a force an acceleration should also be present. Yet the entirety of the system, which in this case is classical non-relativistic mechanics in, e.g. Hamilton’s formulation, includes the additional ‘law’ that the force in  $F=ma$  is the total of all forces of the physical system, not just one part in isolation. Cartwright acknowledges something like this in her insistence that laws are only true *ceteris paribus*.

symmetry may be defined as a structural unification of several properties that are indistinguishable in one domain, yet through the breaking of that symmetry those properties become distinguishable in another domain. Because of the phenomena of symmetry breaking—of which quantum entanglement may be considered an example—some phenomena in a lower energy-more macroscopic physical scale ontic domain are *decoupled* from phenomena in other ontic domains at higher energy levels at the more microscopic level. This observation is contrary to a common assumption that a change in the detailed configuration and composition of microscopic phenomena necessarily entails a change in macroscopic properties. Many empirical results conflict with that assumption.

As a case in point, an interpretation of the nature of certain quantum phenomena has no necessary relevance to an interpretation of the nature of classical phenomena just because the former is presumed to be the more ‘fundamental’ or ‘basic’ in a reductionist sense, without two further factors: (1) independent empirical and theoretical justification to show how the theory of the more basic domain applies to other domains; and (2) complete and coherent intertheoretic reduction, which is derivation of the less basic from the more basic. For many theories it is typical that both requirements are not satisfied, although there are notable exceptions. This distinction between the quantum and classical world is an example of what is called ‘Bohr’s cut’, and it has been justified recently within variations of the decoherence programme which attempts to show how the classical emerges from the quantum. ‘Emergence’ in this context might be interpreted in the context of intertheoretic reduction (see Howard, 2007), but our use integrates acknowledgement that qualitatively different properties are exhibited in classical domains compared with quantum domains, and therefore the two still must be analyzed

independently. (The emergence of classical domains from the quantum is discussed briefly in *Chapters Eight and Nine*.) Our understanding of the nature of physical phenomena must have a context as indicated by a theory system and its domain of applicability, and conclusions in one domain may not be valid in different contexts. According to Physics Pluralism we must include contextualization in our understanding rather than requiring a universal, fundamental or ultimate understanding based in one domain. This central finding is called *epistemic relationality*. However, we also acknowledge the existence of universally applicable general principles, such as conservation principles, and these will also be addressed in further chapters.

The domain specifies phenomena to be investigated—or alternatively phenomena define the domain, depending on how we are using the theory. The point is that the domain is specified by the phenomena of interest, and the domain is then a description or representation of that phenomena. A theory and its models are then used to explain the phenomena. Empirical data (which result from interaction in the domain within an experiment that is designed to examine a particular class of phenomena) are modeled and explained by a theory's formal theory. In an important positivistic sense our description of phenomena cannot be accurate without a full description of the equipment and procedures used to examine it. Thus at the outset interactivity is acknowledged between phenomena and experiment, and any isolation of the nature of phenomena without a context of experiment is generally not justifiable. In one way or another, implicitly or explicitly, some physics theory, epistemology and theory of scientific methodology must be used to guide development of the experiment and interpretation of the data. In Physics Pluralism this is called epistemological relationality.

Entities, such as molecules and teacups, are physical, but domains in a theory system of Physics Pluralism include physical objects considered in interaction with experimental procedures in the context of formal and informal models, and since the procedures and theories isolate only a certain kind of phenomenal interaction which involves abstraction of the physical space, then it becomes more obvious that domains are representational. They are the map of the phenomenal territory. For instance, if we want to use classical mechanics to predict the trajectory of a baseball, then that is the definition of the class of phenomena in our domain, or more generally the class of similar phenomena. We can define the location in space and time of the baseball in terms of the familiar Euclidean three dimensions and time and then consider its motion within that space and time. However, modern physics theories use 'phase space', which is a six dimensional space composed of the three dimensions of Euclidean space plus three dimensions of momentum, plus time. Modern classical dynamics plots the movement of an object in representational phase space over time, and that is the complete description of that object in that theory system. The domain of this type of trajectory phenomena is that complete, abstract description within the context of that classical mechanics theory system. If our objects are quantum particles, quantum mechanics models them in Hilbert space, which is non-physical, and is an abstract representation. As an additional example, phenomena for which the teacup may be described accurately by classical dynamics under standard conditions of temperature and pressure may define one domain, while the teacup at extreme values of very high or very low temperatures or very high pressure will be in separate domains and require different physics. Therefore, the same physical

object—or again more generally the class of such objects which may be identified as a natural kind— may be represented differently in different domains.<sup>216</sup>

A highly credible theory system is a representation of physical reality in its domain: It is a description and explanation of phenomena. Our current issue relates to the adequacy of one particular representation in describing and explaining a particular class of physical phenomena, and whether the theory system may additionally be true in its domain. These determinations will enable us to have trust that the theory system can accurately answer our questions concerning the inherent and/or relational nature of phenomena.

#### ***C.4. Realism and inherent nature***

Before we discuss the credibility scale of Physics Pluralism, a word is appropriate about the relevance to the project of determining inherent nature or relational nature that is implied by the realism that this framework allows in certain domains. If a theoretical construct is interpreted as ‘real’, i.e. as referring to “substances in the world that correspond to the ontologies presumed by our best theories” (Laudan (1981, 20), we might infer that those substances have inherent nature. If the “substance” is an entity, such as a teacup, and the ontology specifies its properties as independent, singular and persistent (which may or may not apply to the teacup, but let us accept for the moment that there is such an entity), then this suggestion would be justified—the teacup in the

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<sup>216</sup> In some sense it is the same teacup, physically, in each domain, yet because we must represent it as different since it has very different characteristics it is not always useful or even justifiable to think of it as the same teacup. Rather, it is useful to think of it as a completely different physical object because it has significantly different properties. However, one could also say that the teacup has different properties under different environmental conditions yet it is the same teacup. These different approaches embody semantic and epistemic relationality differences, and the ontological consequences—if any—must be investigated in the physics context. These are examples of global relationality, that is relationality between domains, even while there may be inherent nature of the teacup within particular domains.

domain of phenomena involved in it sitting on the table seems to have inherent nature. However, ontologies also include relations which are inherent to an entity, as suggested in previous chapters and further detailed in future ones, such as the electromagnetic field due to the inherent charge of an elementary particle in domains of classical or quantum electromagnetism, or mass in effective field theories of the standard model that is the result of interactions with the Higgs field of the background vacuum quantum field. These are what Teller calls “inherently relational” substances. Consistent with a form of structural realism (which is the appropriate realist framework to apply in at least quantum domains) the quantum entities should not be considered ‘real’ (as discussed in *Chapter Eight: Physics of Composition*), while the structures, i.e. the causal relations, should be. Thus, relationality inherent in the nature, rather than inherent nature independent of relationality, is exhibited in those domains.

Thus, as a reflection of the ontological pluralism of Physics Pluralism, there are different elements of our ontology in different domains—there is no single, universal ontology. Similarly, there is no universal nature to elements of our ontology—there are (we shall see) independent, singular and persistent properties in certain domains, and dependent, multiple and impermanent properties in other domains, even when we are addressing properties of what we conventionally label as the same entity. For example, the river (as appropriately defined in a domain of when it just keeps rolling along) is persistent, while its components are not, but the river and its components are in different domains—the river is a classical entity and its components are in quantum domains. Hence, universally, or globally, there is relationality that is exhibited in comparison between domains, even though there may be inherent nature (by the tripartite definition)

within particular domains. This is called ontological relationality, and I argue that it is—along with semantic and epistemic relationality—both a valid interpretation of the meaning of *śūnyatā*, and incidentally also a valid way of interpreting physics.

### **C.5. The credibility scale**

Physics Pluralism is based on the semantic conception of scientific theories,<sup>217</sup> which is consistent with both instrumentalism and realism. However, Physics Pluralism allows some terms of some theory systems to be interpreted more realistically if the theory follows all the criteria in the *theory credibility scale*.<sup>218</sup> It may be argued that the credibility scale should be considered part of each theory, yet I take the stance that the credibility scale provides an interface with a more generic methodology and sociology of science (although I will not pursue that argument here), hence is a meta-theory, part of epistemology rather than a particular theory. Additionally, all references to domains in these criteria provide the interface with the semantic conception of theories, in that the domain must be defined through isomorphisms relating the elements of each theory to the empirically-informed data models. I do not reiterate these isomorphism links in this description of the credibility scale.

If a theory does not satisfy the first criterion it is a developing theory, hence more instrumentally interpreted. The criteria of the scale are progressive, so a theory satisfying cumulatively more successive ones is more credible. A true theory must satisfy all six criteria. All developed theories satisfy the first criterion:

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<sup>217</sup> Suppe (1974, 1989), Suppes (1957/1999, 1960, 1961, 1967), van Fraassen (1980, 2008), with roots in Tarski (1935), yet perhaps in contrast perhaps to some aspects of Giere (1985, 1988),

<sup>218</sup> See the footnotes 178 and 209 for references. The credibility scale is based on Rohrlich and Hardin (1983) enhanced with further synthesis.

1. The theory must be *accepted* by the relevant scientific community, and this acceptance is given because the theory is *empirically adequate*: the theory explains the data and ‘saves the phenomenon’.<sup>219</sup> The theory is justified and supported by extensive testing and use throughout the community; it is successful; it produces novel, confirmed predictions beyond its Humean base of empirical data.<sup>220</sup>

Note that van Fraassen’s (1980, 12) preliminary explication of empirical adequacy is that “a theory is empirically adequate exactly if what it says about the observable things and events in this world, is true”. Thus, if we take his description, and confine ourselves to only observables (commonly defined, not as per quantum mechanics observables), then empirical adequacy of a theory in the domain of phenomena described by the theory is equivalent to the truth of a theory in that domain. Hence, the concept of a theory being true in a domain should not be foreign even to instrumentalists of van Fraassen’s sort. Here is the difference between realism and anti-realism in this debate: What about phenomena that are not directly observable (and how do we define observability anyway)? The topic of defining observability has been discussed at length in the literature, and we shall not pursue it further here, hence we do not distinguish between observable and non-observable in that common parlance. We retain empirical adequacy as less than truth since we are concerned with all phenomena, directly

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<sup>219</sup> “... a theory is empirically adequate exactly if what it says about the observable things and events in this world, is true-exactly, if it ‘saves the phenomena’” (Bas van Fraassen 1980, 12). The issue about ‘observability’ mired van Fraassen in what I would judge to be a morass of unnecessary restrictions which he attempted to get out of over the following decades, and, again in my judgment, failed. As physicists, we ‘see’ electrons from their spectra with our instruments just as those with good eyesight ‘see’ teacups from their spectra. However, full justification would entail an extended discussion which is unnecessary at this time.

<sup>220</sup> For a discussion of novel predictions see Campbell and Vinci (1983)

observable or not. We use the quantum mechanical meaning of observable even for other theories as something which has physical realizability, hence should be measurable.

2. The theory has *horizontal coherence*: the theory is used in different physics domains, with different physics theories, since multiple theories are typically used in application to any real-world or real-experimental situation, and this we call ‘inter-domain analysis’. Theories with horizontal coherence, have mutually supporting results, and are even often used in different sciences altogether, e.g. biology as biophysics.<sup>221</sup> They are used in engineering applications to make things (Hacking, 1983). They have useful models.
3. The theory is *mature*: its formal expression (as opposed perhaps to its philosophical interpretation)<sup>222</sup> is well-understood and well-articulated, and for physics this usually means a conceptually and predictively powerful formal mathematical expression that allows for little or no vagueness in application of the mathematical concepts. The mathematical expression is generally derivable from first principles, such as the general principles which are elements of our theory-system. Maturity also entails “an extended history, theories shaped by many hands, having become a permanent part of science and not merely a part of its history” (Rohrlich and Hardin 1983, 603). A mature theory doesn’t come and go, although it may get absorbed as a model of a successor.

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<sup>221</sup> To conclude that horizontal coherence yields improvement in credibility has been disputed because all the interlocking branches of science may be simply a house of cards or fragile Quinean web.

<sup>222</sup> Quantum physics as a cluster of many quantum theories is popularly considered to be poorly understood because of issues in the interpretation of the measurement problem (see Wheeler and Zurek, 1983). However, we must remember to separate the *formalism* from the *interpretation*. Maturity in a theory system relates to the formalism, and the formalism of many quantum theories is well-understood and well-articulated, and satisfies all the other criteria for mature theories, and many also are true. In a sense, the formalism describes quantum domains and the interpretation attempts to put that formalism in terms familiar to us in classical domains, which frequently simply cannot be accomplished.

4. The theory has at least one *well-defined domain of applicability*. Such a domain would be a well-understood abstract representation of a class of phenomena that the theory explains with high confidence. The boundaries of the domain, beyond which phenomena are not understood as well, are also clearly defined, although the domain may be merely pragmatic and may have fuzzy boundaries such as with classical non-relativistic mechanics compared to its relativistic cousin, which are still well-defined, yet with inequalities indicating its merely pragmatic characteristic. We know the errors of such a theory in a domain, and we still frequently use it, even though we know it is false everywhere, because the errors are known to be smaller than we need worry about for the task at hand.
5. The theory is *established with a vertical coherence*. This criterion typically involves an attempt at relating one theory in a domain to the theory in a ‘neighboring’ domain, and may involve an attempt at intertheoretic reduction, which is the ability to derive or reduce one theory that describes phenomena in one domain from another theory which describes phenomena in a neighboring domain.<sup>223</sup> A common example is deriving classical non-relativistic mechanics from classical relativistic mechanics by making the speed of light infinite. However, many ‘neighboring’ theories are not amenable to complete intertheoretic derivation, yet still may have a degree of vertical coherence due to some degree of coherent relationship between them. The ‘establishment’ of a theory derives from its relationship to a ‘successive’ theory which has established the limits of the domain of the ‘predecessor’ theory. In regards to this criterion of

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<sup>223</sup> Neighborhoods must be defined. Typically a neighboring domain of a theory is distinguished from its neighbor by its energy scale, such as QED and QCD, but other criteria may prevail. We examine this further in later chapters.

the credibility scale, sensitivity to change in many parameters or extreme conditions within the domain of applicability has been investigated and the limits or boundaries of the domain have been established, with new physics being used beyond those limits. The theory is ‘established’ because there is further and substantial confirmation not only of the domains where the theory does not apply, but the domain where it does. Note the well-known limits of applicability of classical physics by relativity. Most of the theories that are considered part of the corpus of physics are mature and accepted with horizontal coherence, and many also are established. This criterion is still consistent with an anti-fundamentalist view described below in Section C.6 because the theory is confined to a domain. It is also consistent with the semantic conception of theories in that a theory, confined to a domain, may still have relationships with other theories in other domains. These relationships are called intertheoretic reductions when one theory may be derivable from another by adjustment of domain boundary criteria, as mentioned above in Section C.1.

A theory may satisfy all of the first four criteria and not be *established* by another theory, which is criteria #5. The latter is as far as Rohrlich and Hardin’s scale went, and they tried to associate truth in a domain with the ‘establishment’ of a theory, making classical non-relativistic mechanics true in its established domains, what I have called its merely pragmatic domains with low velocities. However, Batterman took issue with this, as discussed earlier in this chapter. Classical non-relativistic mechanics existed having satisfied criteria #1-4 for quite a while until ‘established’ by relativity and quantum

mechanics, even though it was slowly eroded before it was officially superseded.<sup>224</sup>

Indeed, it was thought to be true, which is the next criterion, and that we now realize it is false is a prime motivation for instrumentalist views, but that situation is also a prime justification for Physics Pluralism. We acknowledge that a theory satisfying just criteria 1-5 is not secured as being true, and therefore we now attend to the limits of domains where we do not have full knowledge, and confine the domains of true theories to those with established evidence indicating its truth. Here is how I express this criterion:

6. A theory is *true in a domain* if the central terms of the theory—the ones actually used in satisfying the previous criteria—refer to actual features of the physical world that exist as described by the theory and interpreted within the context of the theory. This is an analog to a typical view in standard semantics, e.g. the statement that ‘It is snowing.’ is true if it is snowing. Note that ‘reference’ alone is not sufficient for truth, but reference here entails reference within the theory, and if the terms refer to actual entities *described by the theory* that are found to exist as described, then this indicates that the theory is true in its domain. Thus,

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<sup>224</sup> One may think that classical non-relativistic mechanics reigned supreme unchanged for more than 200 years from Newton until Einstein. However, while there was hope that a mechanical explanation of all domains could be achieved, the history of physics shows that there was a steady erosion of the viability of the mechanistic explanation of many kinds of phenomena: other types of theories were required in those other domains, thus establishing limits to the mechanical view. Indeed, the mechanistic model for atoms died completely in physics with development of Feynman diagrams, although it lingers in analytic metaphysics. Additionally, while the initial statements of its ‘laws’ were used and are even now retained in popular awareness, the theory’s maturity was not realized until Lagrange’s formulation in 1788 and even more so with Hamilton’s formulation in 1833. Further maturity—note that maturity admits gradations—was achieved over the following decades even to recent times, and with each addition new insights were obtained. Additionally, two new theories—relativity and quantum mechanics—suggested that classical non-relativistic mechanics is false in all domains, that its terms simply do not refer to true features of our physical world, even while those newer mechanics *established* the enormous depth and breadth of empirical adequacy of the older mechanics in a more restricted epistemic domain. Indeed, the erosion of the older mechanics is complete in one sense, since we now know that it is always false. However, that is the next criterion, and further limits in the utility of classical non-relativistic mechanics will only appear beyond the edges of its well-known, well-understood, well-articulated, etc. domains, within which the first five criteria are satisfied, it is used, understood, and is true enough for many purposes, government and private.

‘electrons have a positive charge’ is not a true sentence of classical electrodynamics, hence is not meaningful in the theory, hence has no relevance to the theory’s truth value. When we use ‘refer’ we mean this context of reference. Hence, terms which do not refer and also are not utilized in that domain would not modify the truth value of a theory. The domain in which a theory is true must be ontic.

As mentioned, ontic domains have singular limits in calculations of values predicted by a theory that is true in its domain, yet the true theory-system must also be able to demonstrate a completed isomorphism (discussed in the section C.7 below) from a model which truly represents physical features of the world to data models of our Humean knowledge base, i.e. we have to know that there are actual physical features of the world being described in order to know that the theory is true. The completion of the partial isomorphism is discussed below, after a word about fundamentalism.

As mentioned, the horizontal and vertical coherence of theories—which improves its credibility—requires ‘associations’ between theories (sometimes called intertheoretic reduction) involving derivation of one theory to another. Therefore, we should be concerned with how to determine such coherence and define such associations with theories interpreted by the semantic conception of theories in the model-theoretic variety, and in the context of the credibility scale. We will consider two types of pairs of theories and consider their associations. First, both theories apply in merely pragmatic domains and the differences are merely pragmatic. Hence, each are considered false, but instrumentally useful, and adjustments of parameters will allow derivation of one to the other. These two theories may indeed be subsets of a different theory, or variants of the

same one—selections of different models from the same theory-model collection. They will share general principles and the theory core, along with many of the models, to the level where their pragmatic differences become important and different models are required. This case pertains, e.g., to theories that are locally pragmatic variations of a Newtonian non-relativistic classical mechanics customized for particular physics or engineering problems.

Second, each theory applies in their own unique and neighboring ontic domain, thus in some sense at the opposite end of the spectrum from the first case, in that both theories are true in their respective and ‘neighboring’ energy-scale determined domains. Derivation of one to the other has to do with matching parameters at the domain border between them and adjusting the energy scales for the domain of each. There may be notable conceptual differences, and intertheoretic reduction may not be possible. This example pertains, e.g., to different effective field theories. The theories may not share models, but they will share general principles and a theory core of (in this example) relativistic quantum mechanics, yet many of their models will be drastically different.

The central relevant idea of the semantic conception is that theories are collections of models (structures) connected by partial isomorphisms, hence are extralinguistic entities that may not be drastically modified with minor changes in the theory language. When there are minor variations, such as the first case above, then we are using the same core theory with different choices of models. In the second case, there may be major variations, and while the same general principles and at least some of the theory core may be shared, many of the models will differ, and we may have an entirely different theory without shared models. Since we have not promoted the idea that there is

one theory of everything and all other ‘theories’ are minor variations of model collections from that one theory, but that we rather have a pluralistic situation where different theories apply in different domains, there does not seem to be a problem here. The views of convergent epistemic realism, or any kind of realist interpretation of theories, are not threatened by the drastic paradigm shifts like non-relativistic to relativistic, or classical to quantum. CER occurs within a flux of such major changes, and we can track how to work with and characterize examples from one and then the other of each of these pairs of theory clusters categories.

### ***C.6. Anti-fundamentalism: ontic pluralism***

The major alternative to pluralism generally and Physics Pluralism in particular is fundamentalism, the idea that we require a single true unified field theory of everything—an elusive quantum gravity, perhaps—although we don’t have it yet.<sup>225</sup> However, it is now realized by many that even if there were a good theory at the Planck scale we would still need independent theories at intermediate energy scales down to the lower energy of the several current effective quantum field theories, and further theories down to the energy of our own macro-sized world. That realization is a major

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<sup>225</sup> For example: “Our present theories are of only limited validity, still tentative and incomplete. But behind them now and then we catch glimpses of a final theory, one that would be of unlimited validity and entirely satisfying in its completeness and consistency. We search for universal truths about nature, and, when we find them, we attempt to explain them by showing how they can be deduced from deeper truths. Think of the space of scientific principles as being filled with arrows, pointing toward each principle and away from the others by which it is explained. These arrows of explanation have already revealed a remarkable pattern: they do not form separate disconnected clumps, representing independent sciences, and they do not wander aimlessly—rather they are all connected, and if followed backward they all seem to flow from a common starting point. This starting point, to which all explanations may be traced, is what we mean by a final theory” (Weinberg 1992, 6). See also the comments and discussion that follow Weinberg’s essay in Cao (1999), where his fundamentalism is challenged, as it is generally by the effective field theory programme which was the topic of that conference.

justification for many pluralist views, including Physics Pluralism.<sup>226</sup> The problem in our context is *not* just that we do not have that fundamental theory of everything *yet*, but even if we did then we would still *require* use of many other theories in their own domains. I have associated this interpretation (or perhaps this state of affairs if my interpretation is correct) with an interpretation of the two truths of Madhyamaka: there may be local domains with inherent nature, and we call that nature relative, because globally when we compare this situation with that in other domains we find relationality. We then interpret that global relationality as the ultimate truth.

This stance in physics theories is described by Cao and Schweber (1993), Cao (1997) and the several essays in Cao (1999), especially those of Fisher (1999) and Nelson (1999). It is based on insights gained from renormalization research in the effective field theories programme of quantum field theory, plus work in condensed matter physics including work on *critical phenomena* such as at the boundaries where all three phases of matter (solid, liquid and gas) occur at the same time. Additional insights inform the pluralist approach from work by Rohrlich and Batterman who provide examples from other physics theories, including those of classical physics, such as rainbows and water droplets generally.<sup>227</sup> Some of the phenomena described by those research programmes

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<sup>226</sup> A fundamentalist may assume that all physical parameters of materials, such as the melting point of water, must be derivable from fundamental quantum chemistry. However, as much as water has been studied, its basic physical parameters must be measured because they cannot be derived directly from Schrodinger's equation, and it is not a matter of CPU capacity. See especially Hassan and Mehler (2004), and also VandeWall (2007) and Cabane and Vuilleumier (2006).

<sup>227</sup> Rohrlich (1988, 1996, 1997, 2001, 2002) and Batterman (1995, 2000, 2002, 2005a, 2005b, 2006, 2009). I call this a 'pluralist turn' in the epistemology of physics, which has had vocal and sophisticated expression in the philosophy of physics. In addition to those mentioned previously, we should not ignore the work of Cartwright (1983, 1999) and Kellert, Longino and Waters (2006). However, while Physics Pluralism has some similarities with those views, it also has significant differences with them. For instance, Cartwright did not see any particular organizing principles or relationships between the 'dappled' world of theories, while Physics Pluralism includes the fundamental general principles which are true everywhere,

are examples of what is called ‘emergent’ phenomena, the existence of which continues to be controversial even in light of important examples. The relevant concept is

*decoupling*:

What have we learned from renormalization theory? We learned that the detailed physics of matter at microscopic length scales and high energies is *irrelevant* for critical phenomena. Many different microscopic theories lead to exactly the same physical laws at a critical point. As Michael Fisher explained [in this same volume] one can even make precise quantitative predictions about certain ‘universal’ critical exponents without getting the microphysics right in detail. What is important is symmetry, conservation laws, the range of interactions, and the dimensionality of space [our general principles]....Fundamental physics is *not* necessarily the physics of smaller and smaller length scales, to the extent that these length scales decouple from the physics that we’re interested in at the moment. (Nelson 1999, 264).

Or, as expressed by Wallace:

In nucleon physics at very short ranges, the approximately-free particles are *quarks* (this is referred to as *asymptotic freedom*); at longer ranges, the interactions between quarks become far stronger and it becomes more useful to treat *nucleons*—neutrons and protons—as the approximately-free particles. (There is of course a sense in which a neutron is ‘made from’ three quarks, but the matter is a good deal more subtle than popular-science treatments might suggest!) (Wallace, 2008:82).

Note that it is not simply a matter of utility as Wallace suggests here, but there is also an ontological aspect of decoupling, which for the nucleon is due to entanglement of the quarks as a single nucleonic entity. The fact that the separate quarks can be somewhat distinguished at higher energies is not relevant, and in fact free quarks do not exist in nature. Decoupling of phenomena at a lower energy from phenomena at a higher energy is an indication that we have ontic domains. In the Madhyamaka interpretation we might say that the inherent nature of one domain is decoupled from the relationality in other domains. Phenomena in the lower energy must require their own physics, even if we have

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and acknowledges more about the organized relationships between theories. Kellert et al are more focused on consequential arguments concerning social issues in which Physics Pluralism does not delve.

the complete theory of the more microphysics domains, because there are factors that cannot be derived from the more fundamental theory. We call such decoupled phenomena *emergent*. The decoupling theorem and the effective field theory framework “...endorse the existence of objective emergent properties, which entails a pluralist view of possible theoretical ontologies. This in turn has set an intrinsic limit to the reductionist [fundamentalist] methodology” (Cao 1997:350).

What rides on the anti-fundamentalism of Physics Pluralism? If many of the theories in many domains that we now have are semi-autonomous in the way described (there are still general principles, and both vertical and horizontal coherence, if not intertheoretic reduction) and true in their domains, then we do not have to think that all our knowledge is contingent and will probably be revised with the next big discovery. However, even if there is what some—for example Weinberg—think is a string theory that will fill in the missing links between different effective field theories, allowing intertheoretic reduction, then what we then have is *explanation* for *why* the now less autonomous theories are still true within those domains.<sup>228</sup> Hence the details at the boundaries between different domains will be explained, but the nature of entities and relations within the ontic domains should not change. In the context of our current problem, we must be careful that our conclusions about inherent or relational nature—to be discussed in further chapters—do not rest on one view but not the other if we are to have more complete confidence in them.

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<sup>228</sup> The comments and discussion that follow Weinberg’s essay in Cao (1999) are relevant here, where his fundamentalism is challenged by effective field theory. It would be interesting to see if his thoughts have changed in the last decade.

### ***C.7. Completion of the isomorphism***

Ontic domains must have singular, not regular perturbation limits in the values of variables calculated within the theory, which is to say that there is a binary condition without continuous, asymptotic approach—rather, it is on or off, one value or another. Regular perturbation limits are what we have called fuzzy boundaries, such as the continuous comparison of the velocity of an object compared with the speed of light, thus making classical non-relativistic mechanics described in a merely pragmatic domain. An ontic domain, however, has non-continuous borders to relevant parameters, enabling distinctions based solely on ontological considerations rather than merely pragmatic ones. Thus, there will be no fuzzy, continuous and pragmatically-determined boundaries to ontic domains. This is one necessary feature of the domains of a true theory, since that theory may not be true if mere pragmatics are used in defining the domain. We will see how ontic boundaries are not fuzzy (i.e., not regular with gradual changes, but rather singular with drastic changes) when we discuss symmetry breaking in Chapter Eight. The second central relevant feature of Physics Pluralism which provides us with confidence in a theory's truth in an ontic domain is use of partial isomorphisms, as described in French and Ladyman (1999) and da Costa and French (2003). We must determine that the terms of the theory actually refer to features of the physical world not in approximations, but as accurate representations. Note again, that when I say “terms of the theory actually refer”, I indicate that there are actual entities which exist in the world as described by the theory and referred to by such terms, such as ‘electron’, that must be interpreted in the entire context of the specified theory. This is accomplished through the partial isomorphisms between the models which are partially isomorphic to each other and to the data model(s). We know that the reference is realistic through the accumulation of evidence

that tips the balance into our judgment that indeed there are such features which exist as represented. We can then judge such theories true in their domain rather than being merely empirically adequate.

A theory's models can frequently be ordered as a hierarchical set from more abstract to more concrete. The final partial isomorphism is to a data model of the empirical data.<sup>229</sup> The isomorphisms are generally considered partial because the models in a particular hierarchical set from the formal theory to the experimental setup to the empirical data (as described in Section B) designed to apply to a particular phenomenon are not identical, but rather are similar, and the partial isomorphisms select the relevantly similar features of each. A model is not a complete description of the state of affairs of a phenomenon: The model abstracts from the state of affairs, ignoring what have been determined to be irrelevant conditions. French and Ladyman argue that partial isomorphisms give us partial truth of the theory, and such partial truth is similar to the more popular notion of 'approximate truth' of convergent epistemic realism, yet within the semantic conception of theories we find it more clearly spelled out what is meant by that predicate. Indeed, in the hands of da Costa and French (2003) it becomes quite precise. Both pairs of authors label the isomorphism as partial to emphasize the idea that the domains within which the isomorphism holds are actually subdomains of our entire knowledge base.<sup>230</sup> If we confine the domain properly, and restrict ourselves to theories

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<sup>229</sup> Developing the best data model of the empirical data is a matter of statistical analysis and evidence theory which is beyond the scope of this dissertation. See, for example, Bury (1975). There may be multiple isomorphisms to multiple data models.

<sup>230</sup> Given a first order structure  $m = \langle A, R_i, f_i, a_k \rangle$  where the indices range over the integers,  $A$  is a non-empty set,  $R$  is a family of partial relations,  $f$  is a family of functions and  $a$  is a family of distinguished individual elements of  $A$ , "...the aspect of 'partiality' in the above account is represented by the introduction of families of partial relations, which are *partial* in the sense that any relation  $R_i$ ,  $i \in I$ , of

that satisfy all six criteria of the credibility scale, including notably an ontic domain, the isomorphism becomes complete, not partial, and the truth therefore is also complete, not partial, i.e. the theory is true in the domain. In this way, da Costa and French demonstrate how the ‘partial’, ‘pseudo’, ‘approximate’ predicates of truth become simply true, which I call true in a domain in order to highlight the salient point. Note that this is nothing mathematically or physically new, but rather is a different philosophic way of looking at the partial isomorphism and partial truth. We do not need to use the ‘approximate’, etc. predicates to the veracity of a theory because we understand what it is the theory is intending to describe or represent, and then understand what is described or represented, without thinking that the many other parts of our world that are outside the intended scope and are unexplained by our theory therefore indicate a lack of veracity of the theory because what it did not intend to describe was not described.

In order for the sequence of partial isomorphisms from a theory’s formal structural model to the data model of a domain to become a complete isomorphism from the same theory’s structural model to the data model of a restricted subdomain enabling the theory to be *true in its subdomain*, more will be needed. We find these additional requirements demonstrated and more precisely defined in *Chapter Eight* where we discuss symmetry principles, effective field theories and condensed matter theories, and in *Chapter Nine* when we look at relativity. Next, we look at causality as the physics understanding of dependence and independence.

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[number of arguments]  $n_i$  is not necessarily defined for all  $n_i$ -tuples of elements of  $A_i$ ” (French and Ladyman 1999, 106).

## ***D. Conclusion***

There is little that is new in the components of Physics Pluralism that has not been proposed, discussed and utilized in various areas of philosophy of science generally, philosophy of physics and various physics research and interpretations. However, it is a synthesis that I argue is unique, significant and relevant to a project of determining the nature of physical phenomena and the way in which that nature—or rather those natures—should not be considered singular and universal, but rather must be considered multiple. Additionally, I think that my interpretation of the Madhyamaka two truths and the association of that with Physics Pluralism is also unique.

We first clarified the important difference between the syntactic and the semantic conception of theories, which is that theories in the latter may be understood as extralinguistic entities, thus freeing theories from drastic modification when there is a minor change in the theory language, experimental setup, data, etc. This allows us to perceive a continuity of theories even in the face of modifications, thus allowing realist interpretations of theories, as has been argued against Laudan's anti-realist arguments reviewed above. The central point is that the theory might not change, yet modifications in the language, etc. manifest in different isomorphisms and restrictions of the domains to which the theory now applies. Thus the theory once thought true in a domain, and then found false in that domain, may still be considered true, yet in a restricted domain. However, if the restricted domain is not ontic, and is merely pragmatic, then we must say that the theory is false, although useful.

The elements of a theory have been outlined: general principles, the formal theory, informal models, domains and data models. These elements are connected

through partial isomorphisms, described in Section B in the context of the semantic conception. With clear understanding of the nature of those isomorphisms comes clear understanding of the possibility of truth of a theory in a domain, which is the final criterion of a credibility scale that allows us to have confidence in assessments by the theory of the nature of phenomena. A theory that is true in a domain must have a domain that is ontic, not merely pragmatic, and we discussed the requirements for a domain to be ontic. Further specification of those requirements awaits Chapter Eight's elaboration of the concepts of symmetry and symmetry breaking.

As mentioned, detailed examples await the next three chapters, where we discuss the three dichotomies of inherent nature and relational nature in turn.

## CHAPTER SEVEN.      PHYSICS OF DEPENDENCE

### A.    *Introduction*

In this chapter we discuss features of Physics Pluralism while examining the first component of the question regarding inherent and relational natures: whether there are phenomena that are causally independent from each other. For physics, the question of independence or dependence is discussed in terms of causality, as it is for Madhyamaka and also as we developed it for Western metaphysics.

Recall from *Chapter Two* the *Madhyamaka causality arguments* which—in the interpretation offered there—did not reject the idea that there was causality, yet argued that causal relations are between entities which have no inherent nature, and the relation itself has no inherent nature. This argument has been interpreted in a Humean (but not New Hume<sup>231</sup>) sense of arguing against the ‘occult powers’ of cause and effect, and in favor of a regularity theory of causality. In that interpretation, there is no necessity to causal relations, but certainly things happen in sequence: first a cause then an effect, with an intimate relation between them that blurs the distinction between them and the entities involved in the relation as separate entities or phenomena. This is called interdependent arising. In that chapter we provided a preliminary attempt at understanding what that could mean.

Recall from *Chapter Three: Metaphysics of Dependence* that we found independence in contemporary Western metaphysics becoming the question of intrinsicity: Are there intrinsic properties of an entity that are had in virtue of the entity itself, regardless of whether or not there is anything else in its possible world. Thus the

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<sup>231</sup> Read and Richman (2007)

entity is ‘independent of accompaniment’, i.e. the presence or absence of anything else in the world will not change intrinsic properties, yet will change relational properties, hence that is how we can determine which properties are intrinsic. I indicated that the domain of discourse concerning the entity relates partly to how we name it. For example, if we describe an emerald as green, it is green only in relation to our sense perception and psychology of color, yet it is a rock of a particular composition and structure independent of the observer. Hence, we may decide that the green rock is dependent on other things but the rock itself is not, even though we may think we are talking about the same thing. This was identified as *semantic relationality*. Note, however, that our discourse and classification scheme does not actually change the entity, just our form of discussion. We also determined that there was a modal aspect to intrinsicity: Properties that are necessary and essential to an entity being that entity or kind of entity should be the objective properties that are intrinsic and independent of other entities, distinguished from the extrinsic or relational properties. The status of accidental properties should be irrelevant to the problem of determining intrinsicity. This feature of intrinsicity exhibits semantic, epistemic and ontic relationality. Semantic relationality refers to the way we name the entity, as e.g. a green rock or a rock, and how the identity of an entity changes as we name it differently. Epistemic relationality refers to the scientific theories that we formulate to extract relevant features of the world that enable us to understand it in certain contexts, and how our understanding changes as domains change. Ontic relationality refers to the actual objective features or properties of phenomena and how those properties change as the domain changes. These three dimensions of relationality are explored further in this chapter.

We ask and attempt to answer questions about the possibility of intrinsic properties of entities, starting with asking whether there really are such properties. Complexities immediately arise. First, according to Physics Pluralism we must avoid unconsciously thinking that there is only one answer based on ‘ultimate’ or ‘universal’ properties, although that may be the case. If this means only in terms of the most reductively ‘fundamental’ theory of the highest energy = most microscopic aspect of entities, such as the standard model of particle physics quantum field theory or a quantum gravity unification, then we will find evidence that it is not the case. We had an inkling in *Chapter Six: Physics Pluralism* that there are many effective field theories, not one, and each are somewhat autonomous. Those theories will be examined in the next *Chapter Eight: Physics of Composition*. In terms of Physics Pluralism, an entity may indeed have properties intrinsic in one domain and not in another. It therefore becomes immediately difficult to call these ‘intrinsic’ properties if they vary across domains. Hence, we have a taxonomy of intrinsicity. We call properties which are intrinsic only within a specified domain ‘locally intrinsic’, hence the entity will be ‘locally independent’, exhibiting ‘local inherent nature’. If there is a property that is intrinsic within all known domains—and if we can demonstrate a necessity that it be so universally—then it will be called ‘globally intrinsic’ and the entity will be ‘globally independent’ and exhibit ‘global inherent nature’. If a property is locally intrinsic in one or more domains, but not globally intrinsic, then it will be ‘merely locally intrinsic’ or ‘globally relational’. If we find properties that are merely locally intrinsic properties then we have examples of ontic relationality. If we find any globally intrinsic properties then we have examples of

inherent nature. Madhyamaka argues that there are no globally inherent properties. We shall see about that.

A second complexity concerning the search for intrinsic properties of entities is that for quantum particles we may not be able to identify any entities at all, due to several characteristics of such things: (1) In those domains described by QFT, quantum particles are not particles, but rather are resonate bundles of quantum fields which exhibit properties of particles when measured a certain way and exhibit properties of classical fields when measured a different way; (2) quantum particles are usually considered bundles of relational properties, what Teller calls intrinsic relationality, although we will generalize that term with other meanings; and (3) quantum particles are indistinguishable one to another *of their same natural kind*. The ending phrase is key, however, because even though we may not be able to call, e.g. a specific electron a distinct entity in domains of quantum electrodynamics, we do know that it has state-independent properties, for example rest mass, spin, and charge and other conserved quantities in particular domains which identify it and distinguish it from other bundles of properties. Indeed, the *Particle Data Group*<sup>232</sup> provides “...a compilation and evaluation of measurements of the properties of the dozens of elementary particles”—‘composite’ and ‘ultimately elementary’—and those properties distinguish the ‘particles’ one-from-the-other. We will ask and attempt to determine whether those properties are globally intrinsic or merely locally intrinsic. This question relates to the ontic relationality of phenomena.

In this chapter we examine possible external dependency of one phenomenon on another, which relates to the concept of ‘external’ causality and determinism—not

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<sup>232</sup> [http://pdg.lbl.gov/2011/listings/contents\\_listings.html](http://pdg.lbl.gov/2011/listings/contents_listings.html)

relating a whole to its parts (which is discussed in the next chapter), but relating phenomena with ‘other’ phenomena (if indeed we can make the distinction and determine an ‘other’). In this chapter we briefly discuss causality as a generic concept in contemporary physics and as a context-specific or domain-specific concept as understood within the Physics Pluralism framework. We examine views of Nāgārjuna, Hume, Russell and John Norton, and classifications by Bunge, Strawson, Ned Hall and Psillos. We begin with a brief review and elaboration of Madhyamaka causal scepticism as presented in the *Madhyamaka causality arguments* which we discussed in Section C of *Chapter Two* arguing against the existence of any inherent causality of inherent entities. If Madhyamaka causality is interpreted as a Humean regularity, this does not mean that there is no causality, so what the concept might indicate, especially in the context of Physics Pluralism, is a focus in this chapter. In Chapter Two we stressed the difference between a production view of causality distinct from a dependence view. Nāgārjuna clearly argues against the former and in favor of the latter. However, instead of promoting a Humean regularity view, which I argue is insufficiently consistent with modern physics, I promote a different dependence theory called the ‘conserved quantities’ view, in combination with the ‘event’ view of a causal interaction. An event is a causal interaction without allegiance to temporal sequence of cause producing effect. Conserved quantities are properties such as mass-energy, charge, or spin which are described under conservation and symmetry principles, and are exchanged during an event. This view allows us to even purge ourselves of any entity-based analysis altogether by viewing the event as a movement of such properties, hence an ‘entity’ is merely a bundle of conserved and relational properties which move around and interact,

instantiating the classical bundle theory of entities of classic metaphysics, which is also consistent with some interpretations of Madhyamaka.

Russell and Norton talk about causality in ways that are coincident with the general idea of Physics Pluralism. As mentioned in Chapter Six, scientific concepts in the context of Physics Pluralism have meaning defined by particular theory systems, and do not necessarily have universal relevance. There are many theoretical terms (interpreted in the context of a theory system) which can only be interpreted instrumentally, and they are expressly identified as such in the theory: They are merely terms that assist in predictions but do not refer to actual physical phenomena. Yet, in many domains of many theory systems there are terms with physical ‘realist’ reference. However, those realities are constrained to their domains while similar terms of different theory systems are really homonyms because the ‘same’ word is actually a different term since they are confined in a different domain and perhaps within a different theory (hence context) altogether. I will argue that causality is such a term, and also acknowledge that there are significant relationships between different meanings across domains that may be recovered through intertheoretic reduction (yet also argue that there are significant limits to such reduction). After presenting a philosophic context and background for the concept ‘causality’, we examine different theories, models and domains of contemporary physics and determine what the meanings of causality may be in some representative domains. We conclude that Physics Pluralism adds clarity to the array of definitions and objections to each definition by confining each to their own domain. We therefore demonstrate the utility and validity of that framework, while finding examples of both local intrinsicality and global relationality.

## ***B. Dependence and production***

In this section we discuss the dependence and production theories of causality by first reviewing and enhancing our discussion of Nāgārjuna's opposition to production, and promotion of dependence types of causality. We then briefly summarize the categorization of different theories of causality by Bunge which provides a taxonomy that will assist our analysis. A more detailed examination of relevant concepts of production and dependence follow, including in particular the regularity theory famously promoted by Hume that some commentators also attribute to Nāgārjuna. We then look at two sceptical views, first by Russell and then by Norton. We find that their views are sceptical if we insist on a universal definition of causality, while especially Norton's accusation of extreme plasticity to the concept becomes a positive feature in Physics Pluralism.

### ***B.1. Nāgārjuna's anti-production, pro-dependence view***

In *Chapter Two Section C* we examined the *Madhyamaka causality arguments*, especially as found in Chapter 1 of Nāgārjuna's *MMK* and explicated in various commentaries.<sup>233</sup> We examined a brief analysis of the main argument of *MMK*1:1 and here will summarize this and some further relevant points from the rest of the first chapter of the *MMK*. Nāgārjuna argues that there is no intrinsic or inherent causality in any phenomena or event as a first step in his continuing argument that no phenomena have intrinsic or inherent nature. He argues against the production of results from some inherent reified thing called 'causes'. However, he does acknowledge that things happen

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<sup>233</sup> Contemporary commentaries include Kalupahana (1970), Garfield (1994, 1995, 2001) and Siderits (2004); ancient commentaries include Candrakīrti's *MAV* and Tsong-kha-pa's *Ocean* and *LRCM*.

when other things happen. One way to interpret this latter view might be that it promotes the acausal view of unexplained random occurrences, but alternatively—and more appropriate to the text as a whole—it is promoting a variety of dependence or interdependence called the regularity view of causality in which causes are associated with results in what is perceived as a regular pattern and interpreted only conventionally as necessary causal processes.

One way to understand the meaning of the idea that there is no inherent causality is by distinguishing cause from condition as an interpretation of *MMK*:Chapter 1:

When Nāgārjuna uses the word ‘cause’ (*hetu* [*rGyu*]), he has in mind an event or state that has in it a *power* (*kriyā* [*Bya Ba*]) to bring about its effect, and has that power as part of its essence or nature (*svabhāva* [*Rang* [*bZhin*])). When he uses the term ‘condition,’ on the other hand, (*pratyaḃaya* [*rKyen*]), he has in mind an event, state, or process, without any metaphysical commitment to any occult connection between explanandum and explanans. In chapter 1, Nāgārjuna, we shall see, argues against the existence of causes and for the existence of a variety of kinds of conditions. (Garfield, 1994:222)<sup>234</sup>.

Thus Nāgārjuna argues that what we typically identify as causes are actually non-inherent, relational and *sūnya*, and he calls them ‘conditions’, distinguishing them from causal productive powers which are denied. Note that conditions are not entities; they are relationships. If there are no inherent natures in entities, and no inherent causality, we are left with a conventionally-determined association for relationships between events or processes, called conditions, and other events or processes, that we call results. This leaves open the relationship between conditions and results, but such causal relationships are embodied in the concept *karma* as a background assumption which is also discussed later in that text.

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<sup>234</sup> That Nāgārjuna makes this distinction is controversial. See footnote 3 in Garfield (1994).

Nāgārjuna begins with his famous tetralemma rejecting inherent causality, which we explicated in our Chapter Two and restate here:

(MMK1:1)  
Neither from itself nor from another,  
Nor from both,  
Nor without a cause,  
Does anything whatever, anywhere arise.

This can be interpreted as a rejection of the production view. After listing the four kinds of conditions in *MMK1:2ab*—efficient, percept-object, immediate and dominant (Garfield, 1995:107)<sup>235</sup>—he argues that they are all without essential nature:

[MMK1:3ab]  
The essence of entities  
Is not present in the conditions, etc. ... (Garfield, tr., 1995:110)<sup>236</sup>.

The search for essence starts with a search within the conditions, but no essence is found there. Siderits (2004, 402), with Candrakīrti's help, interprets this demi-verse as arguing against “the theory that the effect exists in unmanifest form in the cause.” As argued throughout *MMK*, the reason why phenomena can be known and can change is because they have no essential, inherent or intrinsic natures. Nāgārjuna denies that there are causal essences in phenomena, nor are there any causal essences pervading the universe and guiding phenomenal processes:

[*MMK1:4ab*  
Power to act does not have conditions.  
There is no power to act without conditions. (Garfield, tr. 1995:113).

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<sup>235</sup> These have some correspondence with Aristotle's four types of causes, but notably do not have final causes, nor a formal cause with any essential natures. See Garfield (1995:107-109): briefly, efficient conditions are explanatory events; percept-object conditions are objects causing perceptions; dominant conditions are purposes; immediate conditions are continuous interdependent causal chains.

<sup>236</sup> I exclude the second halves of these verses to avoid complex exegetic discussion, and in general am avoiding many nuances due to space constraints, and because they have been analyzed more completely elsewhere; see Garfield (1995, 103-123) and Garfield (1994, 2001) and Siderits (2004) for a more complete discussion.

Garfield interprets this as the beginning of an “attack on the causal power/cement-of-the-universe view of causation and [Nāgārjuna’s] contrastive development of his regularity view of conditioned dependent arising.” (Garfield, 1995, 113) Nāgārjuna argues that either causality would require conditions, thus entailing a “vicious explanatory regress”, or would not require conditions, in which case causality is unexplained, and we are left “positing uncaused and inexplicable occult entities as the explanans of causation”. We discuss this below as the ‘terminus of explanation’ problem. So, how can cause and effect occur? Through regular conjunction:

[*MMK* 1:5ab  
These give rise to those,  
So these are called conditions. (Garfield, tr. 1995:115).

Without any essential natures, phenomena are free to interact interdependently, which is their relational nature. Garfield examines *MMK*1:5 and interprets it as espousing a Humean regularity theory of causal explanation:

[Nāgārjuna] argues that the midpoint between reification of causation—the adoption of a realist view with respect to causal powers—and nihilism—the view of a random and inexplicable universe of independent events—is the acceptance of the reality of conditions, and a regularist account of explanation. On such a view, what counts as explanans and as explanandum depends on explanatory interests and upon conventions for individuation and classification. Hume is often read (properly in my view) in roughly this way. Such a view is, hence, far from a nihilism. This is instead a moderate, sensible approach to explanation and to understanding. (Garfield 2001, 509).

The nihilist view is that there are no cause and effect relationships; the realist view (in this sense of realism) is that there are real causal powers in the world and/or in all objects and phenomena which constrain phenomena to conform to such relationships between ontically-identified cause-entities and effect-entities with intrinsic, essential properties. The regularist view, with which Hume has long been associated, is that through (perhaps

necessary) habits of mind we identify ‘cause’ and ‘effect’ in the constant spatial and temporal conjunction of events: We find a regular pattern in which we identify the temporally first event as ‘cause’ and the second as ‘effect’. However, according to this view, there is no ontologically defined essential or intrinsic necessity to each conjunction and no inherent powers that are the foundation of such regularities. The regularity view, which we discuss in detail in the next section, has a long history as an alternative to attempts at reifying a general production-based principle of causality, yet there are serious problems with the regularity view.

Note Garfield’s interpretation of Nāgārjuna’s view as stating that the relationship between “explanans and...explanandum depends on explanatory interests and upon conventions for individuation and classification.” I will argue against the conventionalization of all causal relationships and properties of entities. In *Chapter Six: Physics Pluralism* we found suggestions that there are ontic domains. Suppe took the stance that these are natural kinds, and there this could be taken as an intuitively reasonable starting point for analysis. However, I rather limit my analysis to the view that there are natural kinds that are classes of entities defined by properties called conserved quantities, such as mass of an object, or the mass, charge and spin of elementary particles—the state-independent properties of quantum mechanics. However, at least some if not all of those natural kinds will be found to be domain sensitive, and at least some conserved quantities will be found to be relational. Yet, they are also intrinsic, hence we use Teller’s term ‘inherently relational’. In *Chapter Eight: Physics of Composition* we find supporting indications that there are ontic domains which enable individuation and classification of phenomena regardless and sometimes in contrast to

our own interests and conventions. Electrons are not electronic because we use them to run our vacuum cleaner. They are *intrinsically* electronic, i.e. they have certain characteristics which are relational, yet those relational characteristics are inherent to them in just about any domain.

Siderits also finds a similarity between Hume's view of causality and Nāgārjuna's, in particular the idea that "the causal relation is conceptually constructed" (Siderits, 2004, 409). Siderits says that Bhāvaviveka (one of Nāgārjuna's commentators) concurs: Selection of the conditions chosen as causal "is found due to intentions of the mind on the desire for what is productive of the arising...just by virtue of expectation."<sup>237</sup> Again, in this view causality is epistemically and conventionally determined by intention or expectation, rather than being an intrinsic physical feature of entities or of the universe as a whole. Siderits also notes Hume's resistance to assuming that the future will be like the past (if it is, then past constant conjunctions could be reified into a global principle) (406), and also notes Hume's argument to support the notion that there is no logical necessity in any entailment between what we identify as 'cause' and 'effect' (410).<sup>238</sup>

Before we examine the nature of causality in contemporary physics in Section C, I think it would at least be helpful, if not necessary, to set the stage by providing background concerning different conceptions of causality that have been discussed in the literature of the past and that appear again and again in the contemporary literature. Specifically, we need to understand distinctions between causality as production and

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<sup>237</sup> Quoted by Siderits (409) from Bhāvaviveka's *Prajñāpradīpa* on MMK1.3, Pandeya 26.

<sup>238</sup> What Hume actually meant, whether Hume was actually a follower of the regularity theory of causality, and what Hume's variety of the causality theory actually was is both controversial and outside the scope of this chapter. See Read and Richman (2007).

causality as dependence, and nuances of those, if we are to approach evaluation of causality as involving inherent nature or only relationality. Section B.2 provides a quite brief survey of such concepts, focusing on distinctions and relationships between determinism and causality that will be discussed further in *Chapter Nine: Physics of Change*. Section B.3 examines regularity, dependence and production, focusing on Hume's and modern expressions of the regularity theory of causality, as a precursor to Dowe's theory of causation in the context of conserved quantities, which will be used throughout this and the next chapters. Norton's causal scepticism is introduced here, and examined in more detail, along with Russell's causal scepticism, in Section B.4. This discussion is relevant to the key point of this dissertation, that rather than being an archaic and unnecessary concept due to its plasticity that warps it out of all recognition, its plasticity is a central positive feature when we take a pluralist view. It is that perspective which is examined further in Section C. Thus we find further examples of relative truth (also called local) in particular domains and ultimate truth (also called global) from examination across domains. In particular concerning causality, there are different kinds of causality in different domains, and we may take as an ultimate or global truth the pluralism of causality conceptions, rather than their dismissal.

### ***B.2. A survey of causality***

The ancient dichotomy between causality as dependence and causality as production continues to be discussed in contemporary literature, as described by Strawson (1987), Hall (2004) and Psillos (2009). Additionally, from Russell (1913) to Garfield (2002) and Norton (2008) the idea of causality continues to receive sceptical criticism. Determinism and causality are distinguished as different concepts, and their relationship will assist in understanding causality as a distinct idea. Garfield (1994)

interprets Nāgārjuna's *MMK* in light of the dichotomy between dependence and production, as promoting the former and rejecting the latter, while Bunge (1959) promotes a version of the latter which he calls "the genetic principle". This dichotomy continues to be a reasonably helpful way of organizing current views as well, as demonstrated in Psillos (2009). In this section we provide preliminary definitions and a taxonomy based on Bunge (1959) in order to establish a basis for further discussion.

Bunge identifies three main views of determinism: causalism, semicausalism and acausalism, each with two or three varieties. (1) *Causalism* has two varieties: the *traditional* and the *rationalistic*. (1a) The traditional view is that "causation is the sole category of determinism, so that science is coextensive with causality; on this view, no scientific law or explanation is possible that does not hinge on the causation category" (Bunge 1959, 27) and is attributed to Aristotle. (1b) The *rationalistic* doctrine is a variation of causalism whereby "the causal principle is a necessity of thought...an *a priori* regulative principle, hence a presupposition rather than a result of science" hence "verifiable in experience, but not derived from it" (Bunge 1959, 27), and is promoted with significant variations by Leibniz, Kant, and Schopenhauer.<sup>239</sup> It might be argued that *a priori* concepts such as the causal principle and, e.g. conservation of energy *must hold* to the degree that explanations must conform to them, yet the former principle becomes stretched to be almost unidentifiable as such in order to fit empirical facts. The question is whether the concept is only a useful construct, without ontological significance. Contra Norton, we view this plasticity as a positive aspect of Physics Pluralism, in that we would

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<sup>239</sup> That this is promoted by those three is stated by Bunge, but is not quite as simple as he suggests. However, we will not get into the nuances of transcendental causality at this time.

not expect causality to be a universally defined concept with identical features in different domains, hence there are not necessarily problems with variations.

Continuing Bunge's categorization, (2) this plasticity is represented in Bunge's first variety of *semicausalism*, which is a second category of views composed of *nommic pluralism*, *functionalism* and *general determinism*. (2a) *Nomic pluralism* corresponds to Physics Pluralism as we have stated it, although we don't consider its plasticity a flaw as Norton does, and we discuss it further below. (2b) The second variety of semicausalism is the *functionalist* or "interactionist theory" which is a particular case of a broader interdependence category, a variety of which is advocated by Russell. On the functionalist view, "it is always a sheer abstraction to disentangle simple, linear, cause-effect bonds from the universal interconnection or interdependence...which has an organic character" (Bunge 1959, 28). (2c) The third variety of semicausalism is *general determinism*, and is advocated by Bunge as the preferred concept: "causation is only one among several interrelated categories concurring in real processes; on this view, the causal principle has a limited range of validity, being no more and no less than a first-order approximation" (Bunge, 1959, 29). General determinism in Bunge's view combines two components: *the genetic principle*, and *the principle of lawfulness*. The first component of general determinism is also called *the principle of productivity*, or "nothing comes out of nothing or passes into nothing" (Bunge 1959, 24). The second component of Bunge's definition of general determinism is *the principle of lawfulness*, that nothing happens unconditionally, lawlessly or arbitrarily. Combining lawfulness with productivity results in the *principle of determinacy*, that "everything is determined in accordance with laws by something else" (Bunge 1959, 26).

Kant's comments (B322) on internal and external add context in order to distinguish what 'something else' might be. He states that things which are external (to mind) are distinguished by their relations, or (as we may interpret them) interactions or causal relations.<sup>240</sup> Hence, when we talk of "something else" as Bunge does, we immediately are put in a situation where we are epistemically bound to understand what that may be according to its causal interactions. In some sense, 'something else' is the set of interactions that it is involved with—we know something by its interactions. This is a standard Madhyamaka view, from which it is concluded that things are not independent: To know something we must interact with it, therefore the thing is not independent; it is relational. Yet, this doesn't seem right: The teacup doesn't change its intrinsic properties of mass, hardness, shape or ability to hold tea simply because we put tea in it and drink up. The teacup's necessary and essential properties, its intrinsic and independent properties, have not changed. Rather only its relational properties have changed, whether it is with or without tea, whether it is on the table or in my hand; whether it is hot or cold (within limits). There seem to be intrinsic and independent properties of the teacup that are necessary and essential to its being from which we can conclude that the teacup, as such, is independent of us, yet may take on additional relational properties. The teacup in this domain is locally independent, exhibiting locally inherent nature. We can call the domain one of classical mechanics, and even call it an ontic domain if we (unnecessarily) make it relativistic. The question remains if the teacup exhibits globally inherent nature.

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<sup>240</sup> This comment (and many similar) has provoked a Kantian interpretation of Madhyamaka as one phase of Western interpretations of Madhyamaka, especially in the hands of Stcherbatsky (1920) and Murti (1955), but see also Bitbol (2003) in Wallace (2003) in the context of physics and causality. The three phases of Western interpretations of Madhyamaka *śūnyatā*, generally, are nihilist, Kantian, and linguistic. See Huntington (2007, Section 3.1) for details. It has been said that we are in the linguistic phase now, although this dissertation is an attempt to take a different view.

(3) Bunge's third general view on determinism is acausalism, with two varieties: the *empiricist* theory and the *indeterminist* doctrine. (3a) The empiricist view "reduces causation to external conjunction or succession of events—or rather, to the concomitance or the temporal sequence of experiences" (Bunge 1959, 29). This is Hume's regularity theory. Thus causal qualities and laws are contingent, and the latter are merely "rules of scientific procedure". There is no necessity in the sequence (this accords to the old Hume view, but not the new one), although there is necessity in our mental habits of interpretation of such sequences. This is also a typical Madhyamaka interpretation of causality, as one of the dependence theories discussed below. Empiricism views causation as "an outdated fetish that is gradually being replaced" by functional laws, statistical correlations or probability laws. Russell's (1913:1) famous statement applies: "The law of causality, we believe, like much that passes muster among philosophers, is a relic of a bygone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm." (3b) The *indeterminist* doctrine "asserts that events just happen", and thus denies the existence of causal bonds. Although Bunge states that nobody "systematically defended" this view, it is promoted for some classical systems (George Ellis, 2006b) and is commonly held and defended for domains of quantum mechanics. Indeed, even Bunge later on (346-350) notes that Heisenberg famously prophesied the end of determinism, while Bunge cites Bohm's (then quite recent 1951, 1952) causal-realist interpretation to support a universal causal principle.<sup>241</sup>

Bunge (Section 1.3) identifies eight kinds of determinism, of which only one is causal, yet in more recent literature all of them are frequently classified as different kinds

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<sup>241</sup> Yet today there are severe restrictions (the no-go theorems) to Bohmian mechanics, such that many agree that there is indeterminance in many domains of quantum mechanics.

of causal determinism. These include *statistical determination*, which in classical domains is assumed to be based in microphysical causal determinism, at least in principle; *structural or wholistic determination* in which the part or individual is determined by the over-all structure of the collection to which it belongs” (19), which is the inverse of dependence of the whole on its parts as discussed in *Chapter Eight*; *functional interdependence or interaction*; and *quantitative self-determination* which is the “continuous unfolding of states that differ from one another in quantitative respects only” (18). We discuss each of these further below, where they are either considered as varieties of pluralist concepts or as views that support a sceptical view of causality which counters its unusual ontological status.

Dependence theories of causation are distinguished by not including a productive principle, what Bunge calls a ‘genetic principle’. Dependence theories may be understood as some combination of (a) “...the rationalistic doctrine, [that] the causal principle is a necessity of thought (*Denknotwendigkeit*), an a priori regulative principle, hence a presupposition rather than a result of science” (27). This is a Leibnizian or Kantian belief.); (b) semicausalist of the functionalist variety, i.e. there are global or local relationships between things and events but no production of anything new; or (c) altogether acausal, such as the view that causality is simply constant conjunction of the Humean sort, or a Madhyamaka sort. Modern dependence theories may be quite complex, such as the conserved quantities variety discussed below, that nothing new under the sun occurs, but conserved quantities (energy, momentum, charge, parity, etc.) ‘move around’. As mentioned, many Madhyamaka interpretations are Humean, and Siderits (2003) identifies this as a central empirical hypothesis of Madhyamaka.

Production theories of causality are distinguished by having a genetic principle. Indeed, conserved quantities may move around, there may be constant conjunction of complex functional natural laws, but production theories identify that something new arises and this is due to causal relationships.

Therefore, dependence theory would identify the dependence of the movement of the red billiard ball on the collision with the white one, yet limit our description to a functional relationship between these actions, while a production theory would identify the motion of the red billiard ball as something new resulting as an effect of the causal action of collision by the white one. In the former view energy, momentum, etc. may move around, taking one form or another, in complex relationships but no actual production, for example when an electron-positron pair transforms into a pair of photons, with the total charge, energy, momentum, spin, etc. unchanged in the total system of the interaction. For the latter production view there is creation of something new from something old, that there are qualitative differences from one form to the other.

While we presented the situation as if the dependence and production views are simply different ways of looking at the same thing, with no real indication of any allegiance to one or the other, this presentation must be tested in different domains, as we test Physics Pluralism during our tour of different physics theories, in section C. With this brief summary of some alternative views and definitions, we turn now to more detailed examinations of particular views.

### ***B.3. Regularity, dependence and production***

Strawson (1987), Hall (2004) and Psillos (2009) distinguish two basic views of causality:<sup>242</sup> the dependence relation and the productive relation. “In particular, the thought that causation is regularity is meant to oppose metaphysical views of causation that posit powers or other kinds of entity that are supposed to enforce the regularities in the world or to explain the alleged necessity in causation” (Psillos, 132). Hence, modern expressions of causality in terms of counterfactuals as an increase in the probability of occurrence of an event or even in terms of natural laws can be made consistent with the dependence relation view (Psillos 2008, 8). Nāgārjuna argues for a dependence view and against a production view which entails causal powers either inherent in entities or in the universe. Natural laws can be invoked to support either view: Natural laws as empirical generalities support the regularity view, while natural laws as an expression of causal powers support the production view.

Hume’s concise expression of the regularity view of causality is found in the following:

The idea, then, of causation must be deriv’d from some *relation* among objects; and that relation we must now endeavour to discover. We find in the first place, that whaever objects are consider’d as causes or effects are *contiguous*, and that nothing can operate in a time or place, which is ever so little remov’d from those of its existence. (Hume, 1739/2000:54, Treatise Book 1 Part 3 Sect 2 Paragraph 6).

Hence, action at a distance is rejected within a relational view, or what we might call a functional view. Hume continues in the next paragraph:

The second relation we shall observe as essential to causes and effects is not so universally acknowledg’d, but is liable to some controversy. ‘Tis that of **PRIORITY** of time in the cause before the effect. (Treatise 1.3.2.7).

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<sup>242</sup> Psillos attributes this to Ned Hall (2004), although the distinction is also in Strawson (1987) and clearly has an ancient pedigree, with the productive relation being associated with Aristotle.

Psillos begins his formalization of the regularity view of causation with this Humean expression:

*c* causes *e* iff  
*c* is spatiotemporally contiguous to *e*;  
*e* succeeds *c* in time; and  
all events of type *C* (i.e. events that are like *c*) are regularly followed by (or are constantly conjoined with) events of type *E* (i.e. events like *e*). (Psillos 2009, 132).

Mill's variety incorporates natural laws, substituting the third criterion above with the view that laws of nature are merely regularities:

iii. *it is a law of nature* that all events of type *C* (i.e. events that are like *c*) are regularly followed by (or are constantly conjoined with) events of type *E* (i.e. events like *e*). (Psillos 2009, 140)<sup>243</sup>.

While spatial and temporal regularities are the starting point for a regularity view of causality, there are complexities entailing additional requirements, and there have been counterexamples offered in response to previous attempts to define how regularity entails causality.<sup>244</sup> Constancy of conjunction is problematic both in not being sufficient—night ‘causing’ day is the standard counterexample—and in not being necessary—some account of singular causal events is needed. Spatiotemporal contiguity is the locality requirement of local realism which is problematic when considering quantum entangled states (see Chapter Two, Section C.7). In some domains contiguity is simple (for classical mechanics domains the billiard balls touch), but it gets complex in

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<sup>243</sup> The ‘New Hume’ view is that Hume also included laws of nature, at least in this way, and that is my reading also, at least of the *Enquiry*. See especially his *Dialogues on Natural Religion* (1963:164-5, towards the end of Part IX:191 of the Kemp Smith edition)

<sup>244</sup> Concerning the adjustment of the definition of causality to conform to our intuitions concerning it: “There has been no shortage of such conceptual analyses and no shortage of counterexamples to all of them.” (Psillos, 2008:2). Baumgartner (2007) attempts to account for them in the regularity view with quite complex extensions to Psillos’ standard and simple formalization.

other domains (in classical electrodynamics domains the electromagnetic fields repel; in quantum field theories the virtual gauge bosons exchange). Temporal contiguity is inconsistent with temporal succession since if event  $e$  is temporally prior to event  $c$  then they cannot be temporally contiguous if time is continuous (e.g. there are an infinity of numbers between any two real numbers). This issue is analyzed by Russell, Bunge and Norton (2003), and is discussed below.

When considering inertial (non-accelerating) motion in a Newtonian world of billiard balls, what is important, of course, is the *relative* motion of an object, i.e in relation to a specified frame of reference or in relation to another object. There is no objective, absolute, frame-independent inertial motion.<sup>245</sup> However, due to this inherent relationality, even temporal succession itself must be considered to be relational, and this is true even within a classical non-relativistic sense when only a Galilean transformation is utilized, let alone in a relativistic situation when a Lorentzian transformation would be required. For the former case, consider the white billiard ball striking the red one that is at rest in the frame of the table. Now transform the system to the frame of the white ball: follow along, flying along with the white ball. This picture will make more sense if we take out the table and put the balls in space. Place the red ball in one location, and shoot the white ball at the red one. Then fly along with the white one. From our new, transformed perspective of the white ball, it is stationary, and the red ball is in motion and strikes the white one.<sup>246</sup> Hence, our normal understanding

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<sup>245</sup> There is a preferred frame in reference to the uniform cosmic microwave background radiation, hence when we are concerned with cosmological questions we must consider the pertinence of that frame.

<sup>246</sup> Since we are considering the event for which we seek a cause to be the collision, i.e. at the time of contact, which ball was initially accelerated could have been too prior to the collision to be relevant—in the case of asteroids, for instance, it could have been millennia before. As Hofer (2004,2) expresses it: “the physical laws give us no reason to think that “ball A struck ball B, giving it a new direction and

of temporal sequence must be revised: There are no distinctly identifiable cause that comes before the effect, hence we cannot identify the motion of one ball as the cause and the other as the effect, because if we transform the system the roles are reversed. Rather, we must look at this as a collision event.<sup>247</sup> The requirement for (at least Galilean-invariant) frame-independent causality means that, continuing this example, the collision itself between the balls causes the subsequent trajectories, rather than thinking that either one ball or the other or even the motion of one or the other is the cause.

In the case of relativistic Lorentz-invariance of inertial frames, without the classical notion of simultaneity the entire idea of temporal succession becomes problematic. Further complexities regarding frame dependence arise in high energy relativistic physics, e.g. measured from the point of view of frame *A* which is moving in relationship to frame *B*, frame *B* may have a larger number of particles than is measured in frame *B* due to the spontaneous creation of particles from increased energy density because of the relative motion of the ‘moving’ frame.<sup>248</sup> Hence, number of particles is frame-dependent: Unless causality is defined carefully in relation to a particular frame, one could conclude that the simple movement of frame *A* causes frame *B* to have more particles, thus violating a number of intuition-based principles. A solution might be

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momentum” is more correct than the time-inverse of the same process, “ball B struck ball A, causing it to change its direction and momentum” He also notes Huw Price’s reminder “that physics does not seem to tell us that one of these descriptions is the “right” way of looking at the events; either one is as good as the other” (quote from Hofer, 2, footnote 4).

<sup>247</sup> The rolling motion of the white ball complicates the picture, so it would be best to consider two objects in space rather than on a table, or particles being shot at a target, but the complications are not relevant to my point.

<sup>248</sup> It may be possible to postulate a preferred universal frame of reference for the entire universe relating to the point and time at which the big bang occurred, hence when we consider causality on that scale it must be examined, yet I do not think such a frame will change our local perspectives of causality, nor the relevance of the perspective promoted here in terms of event-centric exchange of conserved quantities.

found if causality is defined as exchange of conserved (symmetry-invariant) dynamic variables, as described by Dowe (2000, 2007) and discussed briefly below.

There are further problematic issues with the regularity theory and some of these are addressed by modifications to this variety of the dependence category, e.g. by probabilistic theories.<sup>249</sup> However, the major issue is how the regularities originate, or as Strawson (1987, 263) asks “*Why* does our experience have this regular character?” The “Producing Causation Realist” answers that “our experiences have the character of being experiences of a world that is highly regular in its behavior because the genuinely external existing world of which they are experiences is governed by constant, objective forces...” (Strawson 1987, 263). Psillos calls this the “*ultimate argument against RVC* [the regularity view of causality]—what we may also call ‘the terminus of explanation’ argument: RVC leaves unexplained something that requires explanation, namely, the existence of regularity in nature” (Psillos 2009, 134). For production realists the terminus may be powers, force-based production relations, or ‘thick’ laws of nature (i.e. laws as more than empirical generalities but entailing necessity or relation to inherent features).<sup>250</sup> Regularists may respond that the various termini should require explanation also, thus to avoid regress at some point one must say ‘because that’s the way the world is’, and in this context regularists propose that regularities can be their own termini: The world is regular and no further explanations are required.

Russell (1913) and Norton (2003, 2007) argue that causality is a concept without physical realization and that there is no universal causal principle which constrains

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<sup>249</sup> See Bunge Section 2.4 for some of the issues and his productive theory response, and see Baumgartner, 2007 for a contemporary attempt at revising the regularity theory.

<sup>250</sup> See Psillos (2009:134) for references to proponents and critics of these views.

phenomena.<sup>251</sup> Rather, in application of structural realism,<sup>252</sup> according to them there are functional relationships that are instrumental to phenomenal events and for heuristic, epistemic, conventional or habitual yet metaphysically unnecessary reasons we typically assemble the functional relationships into a concept-cluster which we call causality. As the reader will see, I strongly disagree with their point of view, and apply a pluralist perspective to resolve the difficulties that they identify in order to show how causality's plasticity (in Norton's words) is an asset rather than a nail in its coffin: I argue that we need the concept of causality and we will find that it is applied differently in different domains.

However, in their views there are no such things as causality in the world. Their views are a variety of Strawson-Hall production realism, yet instead of demanding a terminus of explanation in necessary causal powers or laws of nature as the Strawson-Hall theory requires, Russell and Norton are satisfied with the relational structures as the termini of explanation. This view would be a form of inherent causation, although in terms of relations rather than entity relata, and with causation as a derivative concept rather than a primitive notion. Hence, we call this a version of *causality as inherently relational*, as oxymoronic as this may seem. This view will prove to be appropriate to at least some domains of physics, to be discussed in later sections, hence we discuss the foundations in some detail in the following.

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<sup>251</sup> Note that the principle of entropy increase of the universe as a whole (i.e., the tendency towards more randomness, a cooling of the universe) could be a universal causal principle which must be considered in examination of, e.g. cosmology, yet it does not seem to be particularly relevant when we restrict ourselves to local domains where the entropy increase of the universe does not play a role, and there may even be local entropy decrease, i.e. increase of organization and differentiation.

<sup>252</sup> See my Chapter Six or Ainsworth (2010).

#### ***B.4. Russell's functional relationships and causal scepticism***

Russell famously supported a variety of causal scepticism, but not for Humean reasons, i.e. not by promoting an explicitly regularist view. Russell's (1913) essay "On the Notion of Cause" was, however, notably written before quantum indeterminance was fully appreciated, which would add even more fuel to the sceptical fire. Russell identifies several problems that would arise if we adopted a general principle of causality, thus counseling against that adoption. These problems have been analyzed by numerous more contemporary commentators of philosophy of physics, including Earman (1986) and Norton (2003). For now it is worthwhile looking briefly at Russell's original view.

As a straw man, Russell considers a definition for causality from Baldwin's *Dictionary*: "Cause and effect...are correlative terms denoting any two distinguishable things, phases, or aspects of reality, which are so related to each other, that whenever the first ceases to exist, the second comes into existence immediately after, and whenever the second comes into existence, the first has ceased to exist immediately before" (Russell 1913, 2). Russell notes (1913, 5) that the temporal contiguity of cause and effect is problematic if time is continuous (and for now we will assume that it is) since there would be no last moment of cause and first moment of effect in a continuous sequence, just as there is an infinity of real numbers between any two real numbers. Nāgārjuna in MMK:1 took a similar tact to criticizing this concept, and Madhyamaka generally denies discreteness of space, time and matter, as discussed in *Chapter Two*, especially *Section E* on impermanence and momentariness.

Thus we shall be led to diminish the duration of the cause without limit, and however much we may diminish it, there will still remain an earlier part which might be altered without altering the effect, so that the true cause, as defined, will not have been reached, for it will be observed that the definition excludes plurality of causes. (Russell 1912, 5).

Bunge (1959, 18) identified this “continuous unfolding of states” as “quantitative self-determination”, one of seven kinds of determinism that should not be counted as causal. A plurality of causes is possible, but this would not alleviate the problem with continuous time, but merely magnify it if we attempt to distinguish the separate continuously-evolving causes (or conditions). Alternatively, a cause could be

purely static, involving no change within itself, then, in the first place, no such cause is to be found in nature, and in the second place, it seems strange—too strange to be accepted, in spite of bare logical possibility—that the cause, after existing placidly for some time, should have done so at any earlier time, or have gone on unchanged without producing its effect. This dilemma, therefore, is fatal to the view that cause and effect can be contiguous in time. (Russell 1912, 5).

Here we note another strong parallel with Nāgārjuna’s reasoning, where a ‘static cause’ would be an intrinsic or inherent cause, which cannot interact to produce an effect, thus cannot be causal. Thus (although Russell does not mention this) there must be a moment when cause and effect are one, which is also suggested by Garfield’s (1995, 105-106) interpretation of Nāgārjuna’s MMK1:1 as we noted in Chapter Two, Section C. We can even conceptualize a continuous evolution from cause to effect that blurs the distinction.<sup>253</sup>

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<sup>253</sup> A way of expressing this that responds to Russell’s concerns is by continuous integration: a particular property  $P$  at time  $t_2$  is computed from an integration of the functional interaction between relevant properties from all previous times to time  $t_2$ ,  $P(t_2) =$

$$\int_{-\infty}^{t_2} P(t)Q(t) dt$$

where  $P(t)$  represents the value of the ‘effect’ property indexed to time and  $Q(t)$  represents the values of all ‘cause’ properties that could relate with  $P$ . Here  $P(t)Q(t)$  is not necessarily a simple multiplication, but is a shorthand for the interaction between factors that we may label causes or conditions which have relevant influence on the present effect property  $P(t_2)$ , hence  $P$  and  $Q$  may be functional that are multiplied by index,  $P(t)Q(t) = \sum_i P_i(t)Q_i(t)$ . As an alternative to taking the integral over all infinite previous time, an initial value  $P(t_1)$  at some arbitrary previous time may add to the interaction definite integral, now integrated from time  $t > t_1$  to  $t_2$ . Additionally, the properties and integration should be over space as well, or simply spacetime. This form applies Russell’s functional relationship between factors that replaces cause-and-effect relationships, since it does not require separate identities as ‘cause’ or ‘effect’, but are rather expressed as properties in functions—and there may be many factors. When combined with modern formulations such as the conserved quantities approach the functionalist variety of the dependence view of causation has

Russell discusses the plurality of causes in some depth, concluding with echoes of Nāgārjuna that “every advance in a science takes us farther away from the crude uniformities which are first observed, into greater differentiation of antecedent and consequent, and into a continually wider circle of antecedents recognized as relevant.” (8). He also considers various maxims that each “seem to depend upon assuming some unduly simplified law of causality” (9), such as “Cause and effect must more or less resemble each other” and “The cause *compels* the effect in some sense in which the effect does not compel the cause” (10), all of which he rejects. He also notes that with a plurality of causes comes a plurality of effects, thus complicating our intuition of causal determinism as a one-to-one or many-to-one relationship, i.e. with a unique solution.

The core of Russell’s positive analysis is that “There is no question of repetitions, of the ‘same’ cause producing the ‘same’ effect; it is not any sameness of causes and effects that the constancy of scientific laws consists, but in sameness of relations” (14). Thus, as has been noted by others, Russell supports a structural realism and identifies such structures as central to the concept of causality. To him, structures are identified with the differential equations of motion of physics theories which apply in the particular domain of interest. “There is a constant relation between the state of the universe at any instant and the rate of change in the rate at which any part of the universe is changing at that instant, and this relation is many-one, i.e. such that the rate of change in the rate of change is determinate when the state of the universe is given” (14). By “rate of change in the rate of change” he refers to the second derivative with respect to time, which is typically used in such equations. He makes several observations about this “law of

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much in its favor, and production views can be brought into question. However, these different views and formulations must be tested within separate domains, as we do below.

causality”: It is an empirical generalization from empirical generalizations, and not *a priori*; it is symmetric with time; it is not verifiable; and it assumes the “uniformity of nature”.<sup>254</sup>

The central positive feature of the paper is the definition and defense of the conception of a deterministic system obtained by fleshing out the relations of the state at one time with that at another.

A system is said to be “deterministic” when, given certain data,  $e_1, e_2, \dots, e_n$  at times  $t_1, t_2, \dots, t_n$  respectively, concerning this system, if  $E_t$  is the state of the system at any time  $t$ , there is a functional relation of the form

$$E_t = f(e_1, t_1, e_2, t_2, \dots, e_n, t_n, t)$$

The system will be “deterministic throughout a given period” if  $t$ , in the above formula, may be any time within that period, though outside that period the formula may be no longer true. If the universe, as a whole, is such a system, determinism is true of the universe; if not, not. A system which is part of a deterministic system we shall call “determined”; one which is not part of any such system we shall call “capricious”. (Russell:18).

Note again that Russell’s essay pre-dates Heisenberg and Bohr’s seminal papers on quantum indeterminance by more than ten years, and he would not be the only philosopher (or physicist for that matter) to consider the quantum domain ‘capricious’. While the universe may not be universally deterministic in every domain, the question remains whether some domains are deterministic, a question that we examine below.

Earman (1986) and Norton (2003) examine Russell’s definition in some detail.

One of the points that Russell makes concerning determinism, and which Hoefer (2004) echoes, is that determinism is time-reversal invariant while causality is time-

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<sup>254</sup> By ‘uniformity of nature’ Russell refers to a “principle of permanence of laws” rather than regularity of “same cause, same effect”. By permanence of laws he is referring to the idea that a scientific law, once established, will be forever true unless replaced by one that subsumes it, i.e. that recognizes how the preceding one worked prior to the time when the successor became effective. Russell’s explication and defense of this principle is, in my opinion, quite weak, is vulnerable to Goodman’s (1955) analysis, and should be replaced by a more sophisticated analysis of the permanence of laws, such as that which is provided by the Physics Pluralism of my Chapter Six, which places laws within the context of set of mature theories which are not replaced, but rather supplemented.

asymmetric. The past determines the future as much as the future determines the past—change one and both are changed. That is because the form of the Newtonian classical physics laws of particle motion is symmetric in time: substituting negative time for positive time gives the same form.<sup>255</sup> Hence, since the past determines the future, the future cannot change without the past changing as well. Cause, however, supposedly always temporally precedes effect. Thus causality and determinism are different concepts. However, as we saw previously in applying a Galilean transformation to the inertial frame of a white billiard ball identified as ‘cause’ in the table’s frame, cause and effect can switch places unless the cause is identified with the collision event rather than with one or other object. The collision is an event that instantiates the functional relation and attendant evolution of both objects and associated phenomena. Thus, incorporation of at least Galilean invariance (which is necessary)<sup>256</sup> entails analysis that is more consistent with the functional relationship view suggested by Russell than if a particular frame of reference is chosen.<sup>257</sup> The collision-approach would incorporate the temporal conjunction—which we demonstrated in the integration calculation above in footnote 248—within the interaction event of the collision and the time-series of events which precede and in some sense build up to the collision. In some domains for some

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<sup>255</sup> Reversal of a movie of particle collisions will not look strange, while of course there are many situations in which such a reversal of time cannot be tolerated, such as the breaking of a wine glass falling on the floor, as mentioned by Ellis(2006) (although an argument can be made that this is an example of symmetry breaking not in a classical mechanics domain) or a thermodynamic situation involving entropy increase. Reversal of entropy increase and all the fragments of glass reassembling are not impossible situations, but they are counter intuitive.

<sup>256</sup> While necessary it is not sufficient, since Lorentzian-invariance—which is the conjunction of Galilean invariance and the principle of the constancy of the speed of light—will be needed in relativistic domains. However, this is irrelevant in the current context.

<sup>257</sup> In modern particle physics, the center-of-mass frame of reference is used, thus disavowing any allegiance to the frame of one or other of the particles that participate in collisions.

phenomena, however, some notion of a direction of time is still needed in order to establish a sequence amenable to an attribution of cause and effect. This will become important in thermodynamics and cosmology. Ellis and Rothman (2009) and other recent analysts (discussed below) suggest that quantum entanglement and the associated decoherence can establish a direction to the arrow of time (contra Aharonov, Bergmann and Liebowitz, 1964) that would enforce a temporal invariance to causal relationships, and in a cosmological context the Big Bang may also provide a direction. Entanglement may also dispose of the concept of determinism altogether, as we discuss below when we deal with thermodynamics.

Hume discusses necessity as a necessary mental association of cause with effect, and only in the “*New Hume*” perspective is objective necessity found in Hume between events that are separately called cause and effect. Russell discusses objective necessity, but finds it wanting. Mackie (1965/1993, 1974) considered causality as *INUS-conditions*, an “*insufficient, but necessary* part of an *unnecessary, but sufficient* condition” (Hofer 2004, 5). INUS conditions identify the many-to-one relationship of conditions which are separately each unnecessary but each sufficient to bring about the effect, where they are part of a set of “cause-complexes” or clusters which are together necessary in some combination (see Hofer 5-6), yet where any of the different clusters would be sufficient. Thus it is seen that the precise definition of what is necessary becomes of the utmost importance.

For Russell there are necessary functional relationships *inherent* in phenomena that are part of the nature of the physical world which determine the evolution of events. These are currently categorized as state-independent properties and the forces inherent in

relations to those properties, e.g. electron charge and electromagnetic fields (in classical electrodynamics) or photons as the gauge bosons exchanged in interactions (in quantum electrodynamics). In the domains of quantum mechanics this determinism becomes statistical for aggregates and is complicated by the inability to identify precise initial conditions to ensure a deterministic result, even though Schrödinger's equation (which is deterministic) is the relevant equation of motion. Yet, even for quantum mechanics the functional relationship view has merit. However, though such relationships are inherent in phenomena, they are inherently relational, as Teller (1989) explicates and as we discuss in *Chapter Eight: Physics of Composition*, especially in *Section B.3* for the way rest mass, a conserved state-independent intrinsic parameter is inherently relational.

Dowe (2007) expresses the causal functional relationship as one based on conserved quantities, such as momentum and energy. Intersections of the path of travel of objects through spacetime (their world lines, see below) which involve exchange of conserved quantities are termed 'causal'. This is actually a definition of 'interaction', since if there is no exchange of conserved quantities then there is no interaction. For example, when the white billiard ball strikes the red one, momentum and energy are transferred, and the total momentum and energy of the two-ball system is conserved (ignoring heat transfer to the environment for the moment, with no loss of generality). However, if there is no transfer then there could not have been a collision, so it is the *transfer* of conserved quantities from one entity to another which we identify as a causal event. Thus causality (not as production, but as dependence) may be regenerated within the functional view. More on this can be found in *Chapter Nine: Physics of Change*, where we examine persistence as (among other things) a causally-connected sequence of

events. Norton (2003, 2007) further supports a causal scepticism with a functional relationship view of causality.

### ***B.5. Norton's causal scepticism***

Norton, also for non-Humean reasons that are quite consistent with Russell's causal scepticism, argued that causality is an empty concept and should be considered 'folk science'. By this he suggests an approach that is similar to Nāgārjuna's identification of the conventional nature of such a concept, i.e. that 'cause', distinct from 'effect', does not refer to actual physical features of the world, and 'causality' itself is not a universal principle which constrains phenomena. This view has become known as 'causal skepticism' or 'causal anti-fundamentalism' and is opposed by 'causal fundamentalism'. The latter is that there is a global causal principle to which phenomena must conform, just as phenomena must conform to symmetry and conservation principles.<sup>258</sup> Due to a counterexample to Newtonian determinism in Norton's paper (thus earning the label 'Nortonian' mechanics), this discussion has provoked an extensive literature and become entwined with analysis of whether Newtonian systems are deterministic, i.e. that a Newtonian system provides a unique solution to the equations of motion of a phenomenal system. This topic is discussed because we know that the standard formalism of quantum mechanics is not deterministic (while hidden variable theories postulate an underlying determinism, discussed later), compared with the

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<sup>258</sup> As discussed in Chapter Six, such principles are domain-specific, but by hypothesis that is frequently tested are also considered to be universal, at least until they are violated and then they are modified accordingly. But such modifications are at the boundaries of domains with developing theories. Symmetry and conservation principles are related by Noether's theorem, as discussed in previous chapters, and much of physics can be derived from symmetry and conservation principles in combination with initial and boundary conditions. These latter relate to the actual physical situation that exists, while the basic physics equations of motion which are derived with the help of symmetry and conservation principles will predict the final conditions, within the limits of determinacy as discussed in this chapter.

classical theories (include relativistic theories) which are deterministic.<sup>259</sup> A serious challenge to the determinism of Newtonian theory could be a major blow to any determinism, potentially undermining any notion that a global causal principle consistent with causal fundamentalism could be devised. Denial of the possibility of a global causal principle would argue for Nāgārjuna's view that there is no intrinsic causality in phenomena, while substantiation of such a principle would argue against his view. We further discuss the issue of Newtonian determinism in the next section following the discussion below of Norton's causal scepticism with its relevance to Nāgārjuna's causal scepticism.

Norton takes issue with the idea that cause and effect "is routinely asserted in a law of causation or principle of causality—roughly that every effect is produced through lawful necessity by a cause—and our accounts of the natural world are expected to conform to it" (Norton 2003, 2). Hence, there are two issues: (1) whether causality (either nomic or conventional) is a universal principle that transcends particular domains of different sciences or theories, or really represents a cluster of domain-specific principles; and (2) whether causality (either universal or domain-specific) is a nomic principle which constrains phenomena or is merely conventional. In his negative thesis Norton urges "that the concepts of cause and effect are not fundamental concepts of our science and that science is not governed by a law or principle of causality" (2003, 3). Causality is, rather, a 'folk science' notion—not a fiction or without meaning or utility—but causality has been subjected to so many changes from new theories that its plasticity allows "any new science to conform to it. Such a plastic notion fails to restrict possibility and is physically empty" (2003, 3) if it does not constrain phenomena.

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<sup>259</sup> However, see Norton (2010), Dieks, 2004 and the literature of the 'hole argument'.

In his positive thesis Norton urges “that ordinary scientific theories can conform to this folk science of causation when they are restricted to appropriate, hospitable processes; and the way they do this exploits the generative power of [intertheoretic] reduction relations,<sup>260</sup> a power usually used to recover older theories from newer ones in special cases” (2003, 4). Norton provides examples: In domains of Newtonian physics, force is a fundamental concept, and in applying Newtonian laws of gravitation the force of gravity is considered to be the prime causal factor. In standard expressions of general relativity there is no such concept; rather, motion ‘due to gravity’ is considered as the motion of an object following the local geodesic<sup>261</sup> consistent with the local energy density.<sup>262</sup> However, one can apply an intertheoretic derivation of Newtonian gravity physics from general relativity. Thus, Newtonian ‘force’ as a cause in physical interactions can be recovered from general relativity’s ‘cause’. The concepts ‘force’ and ‘following geodesics’ are quite different, yet they both describe the motion of a test particle in a gravitational field, and both may be used in explication of the notion of causality in their separate domains: We think of causality in one domain in a different way from how we think of it in another domain, and each concept has heuristic utility in its domain. Additionally, we can relate one concept to the other using intertheoretic reduction. In a similar fashion, the flow of caloric as causation in elementary

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<sup>260</sup> Also called correspondence principles.

<sup>261</sup> A geodesic is the shortest distance to travel considering the constraints of a system and especially is dependent on local spacetime curvature, defined operationally by the direction of travel of light and described by the Einstein field equations.

<sup>262</sup> However, it is possible to reformulate the Newtonian theory of gravitation in terms of the deformation of space and to reformulate general relativity in terms of gravitational forces, while in string theory gravity is a fixed background while deformation of space is no longer central (Coley, personal communication, 2012).

thermodynamics can be recovered from the motion of atoms and transfer of energy and momentum as causation in statistical mechanics.

“The generative power of reductive relations is important and familiar. It allows Einstein’s general theory of relativity to return gravity to us as a Newtonian force in our solar system, even though Einstein’s theory assures us that gravity is fundamentally a force at all. And it explains why, as long as no processes interchange heat and work, heat will behave like a conserved fluid, as caloric theorists urged. In both domains it can be heuristically enormously helpful to treat gravity as a force or heat as a fluid and we can do so on the authority of our best sciences. My positive thesis is that causes and causal principles are recovered from science in the same way and have the same status: they are heuristically useful notions, licensed by our best sciences, but we should not mistake them for the fundamental principles of nature. Indeed we may say that causes are real to the same degree that we are willing to say that caloric or gravitational forces are real.” (2003, 4).

Norton’s perspective coincides with many views of theory reduction, including those of Physics Pluralism as we have presented, although the latter distinguishes merely pragmatic from ontic domains. Thus, causes and causal principles are also “heuristically useful notions, licensed by our best sciences, but we should not mistake them for the fundamental principles of nature. Indeed we may say that causes are real to the same degree that we are willing to say that caloric or gravitational forces are real” (2003, 4). (However, these specific terms are generally interpreted instrumentally in their merely pragmatic domains. Yet see *Chapter Nine* for further insights on the latter.) ‘Reality’, however, is not a universal characterization; rather we must limit our notion of what is real to a domain within a theory that gives the term meaning and reference to something tangible and not merely conceptual, unless we are talking about universally applicable general principles. Those are discussed further below.

Therefore, consistent with Norton, we find that the notion of universality of a single principle of causality that is applied in the same way in all domains must be

rejected, although it seems that we can characterize some kind of phenomena as causal in every domain of at least our mature and accepted theories, and if those causality concepts are important enough to deserve the name and similar enough to each then they deserve the same homonym. Norton says there is something like it, but the meaning given to causality in some domains is so different from that given in others that it is not useful to consider what universality might indicate. Again, if we are using Physics Pluralism then Norton's interpretation should be easily understood but countered with acceptance of the plurality as a positive feature of the physical world, and adding domain distinctions. Thus the problem with causality—as with so many other concepts—is the contentious attempt to demand universality. Once we realize that this is unnecessary, clarity is provided to some of the literature of causality which is laden with analysis of different concepts without consideration of the domain context.

In these sections I have argued for the plausibility of the view that causality is a cluster of concepts, with particular variations applicable more in one domain than another, yet as a cluster it is an integral part of physics. This view may be seen as an expression of the relative truth or local nature of domain-specific qualities and the ultimate truth or global nature of the results of cross-domain analysis. Support for this view will be provided in the following section of this chapter. Additionally, I have indicated allegiance to a variety of dependence theory of causality involving exchange of conserved quantities, while criticizing a Humean regularist view. I have also suggested that the conserved quantities variety of dependence theory is consistent with Madhyamaka, and will also show in further sections of this chapter and in later chapters that it is consistent with contemporary physics.

## ***C. Causality in contemporary physics***

In this section we examine concepts of causality and determinism that are demonstrated in some of the main physics frameworks or clusters of theories. As pointed out by Norton, different domains with their associated theories and models have significantly different expressions for these concepts, and I agree. Yet, rather than providing reason to dismiss the concepts as no more than heuristic devices as Norton suggests, with Physics Pluralism I argue that the different meanings of causality can be made coherent if we restrict them to separate domains rather than try to forge a universally valid concept that is everywhere identical in implementation. *Causality in a domain* can refer to a significant and real (ontic) relation between entities. The question before us is also determining the nature of these relations, especially as being either of a production or a dependence variety, where we have found that the latter is consistent with Madhyamaka. Again, let us remember that the purpose of this dissertation is not to solve all problems in philosophy of physics, but only to address its relationship to issues of inherent vs. relational nature.

### ***C.1. Classical mechanics***

We begin with a brief review of relevant concepts. Classical physics is considered to be causally determinate in the sense that all entities have precise values for which the time evolution is described by determinate equations of motion.<sup>263</sup> Note that ‘classical

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<sup>263</sup> This is generally agreed to, except for what are called possible acausal pathologies. However, they seem to be outside of any classical physics. There is, of course, lack of complete causal knowledge, even in classical mechanics, yet in those domains it is assumed that complete knowledge is obtainable from the microphysics. Yet that assumption has been rejected due to quantum mechanics’ findings. See George Ellis (2006, 2009) for treatment of causal indeterminacy. For background on causal determinism and possible acausal pathologies in classical mechanics see Alper et. al. (2000), Norton (2003, 2008) Malament (2008) Laraudogoitia (2009), Hofer (2010), and Atkinson and Johnson (2010). Malament argues that the

physics' includes relativity, both general and special, hence is generally considered to be true in its domains, although there will be more to say about that later. Causality is frequently associated with Bunge's *principle of lawfulness*, that things happen only for reasons, which is an expression for our belief that the universe is not capricious. However, such caprice is precisely what the universe has been charged with in quantum interactions, hence causality—if it is to be preserved as a constitutive feature of the universe—must be defined differently in different domains. Rather than applying the view that entities interact, a more coherent way of looking at causality is from the view of events rather than entities. Using events also corresponds with Madhyamaka views to a greater degree, but is independently preferred for physics reasons, such as relativistic physics using frame independence. An event involves a cause-effect interaction between entities. While the cause-effect relationship in an event is generally associated with an asymmetric direction of time in some domains such that the cause precedes the effect, as mentioned previously, at least for some events even a classical Galilean transformation from one inertial frame to a different inertial frame of reference can transform our perspective about what physical phenomena are occurring when, thus blurring the distinction between time and entities that participate in the causal relationship. Thus an event-perspective actually incorporates all the relevant functional or dependence relationships that generate equations of motion for the system. In classical physics domains we can say that causality is a deterministic set of functional relationships which relate the past to the future according to the classical equations of motion. These

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acausal pathologies are outside of the domains of classical mechanics, and probably outside the domain of any physical science, and this seems right.

relationships are formally expressed in terms of modern mathematical physics,<sup>264</sup> summarized as follows: The values of variables of the system are real-valued and the order of measurement does not necessarily influence the results (the variables commute). This is in contrast, as we shall see, to quantum domains in which the values of variables are discrete and the order of measurement of certain (canonical) variables necessarily influences the results (these variables do not commute).

One effect may have several causes, and determinism is defined such that given a distinct set of causes and conditions, a unique effect must result.<sup>265</sup> As previously mentioned, determinism (at least in regard to some common phenomena) is symmetric in time for two reasons: If the past determines the future, then if the future changes then the past must also, or must also have been changed (tenses become difficult in this discourse). Additionally, the equations of motion for classical or quantum particle motion

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<sup>264</sup> In classical mechanics, the dynamical variables of a system are represented as real-valued functions on the phase space of the system and form a commutative algebra. The subalgebra of idempotent dynamical variables (the characteristic functions) represent the properties of the system and form a Boolean algebra, isomorphic to the Boolean algebra of (Borel) subsets of the phase space of the system. (Bub, 1997:4)

Briefly, a dynamical variable is a variable representing a property involved in the equations of motion of particles or objects within a system (hereafter, objects). Phase space is a 6-n representation of the three dimensions of the vector-valued location and the three dimensions of the vector-valued momentum of each of the 'n' objects in the system. A system is a formalized collection of potentially interacting objects. The real-valued nature of these functions represents the continuity of space, time and the corresponding possible values of dynamic variables. An algebra is the set of combinatorial elements and rules for manipulating variables. Commutative variables are such that  $xy = yx$ , where x and y are dynamic variables, thus the order of measurement does not change their values. Idempotence is the characteristic of variables and interaction with measurement such that merely measuring the value at one time will not change its value at another in an undetermined way. The characteristic function of a system is the Hamiltonian (essentially the energy as a function of system properties) which will be solved to determine the equations of motion of objects of the system or the system as a whole. A Boolean algebra is a set of elements and combinatorial rules for a system with precise values, since precise values can be expressed as having a particular value or not having a particular value, hence boiling down to selection of one of a Boolean set of  $\{0,1\}$ . Isomorphism is a 1-to-1 relationship between two sets. A Borel subset is the set formed from open, closed or half-closed intervals of the set. Restricting the isomorphism to Borel subsets rejects the possibility that the values of dynamical variables can be confined to certain unwieldy types of sets, e.g. only rational numbers (which have gaps and are not, therefore, dense).

<sup>265</sup> Note that contemporary classical physics does not necessarily distinguish between causes and conditions as Garfield characterizes Nāgārjuna doing so, and does not necessarily identify causes as powers and conditions as regularity relationships, although it may turn out to be so in some interpretation.

are the same with positive or negative times: There is no preference, and ‘running the movie’ backwards will not disturb either our intuitions or the equations. (However, in thermodynamic domains entropy does determine a preferred direction of time—see below—as do phenomena such as black hole collapse and the origin of the universe in cosmology, so the concept of determinism is variable and should have a pluralist interpretation.) Causality, however, in at least the classical non-relativistic interpretation has a particular direction towards the future. ‘Causal fundamentalism’ is defined as the requirement that “Nature is governed by cause and effect; and the burden of individual sciences is to find the particular expressions of the general notion in the realm of their specialized subject matter” (Norton 2003, 6). There are many problems and issues with these concepts and views, hence we must provide a caveat and say that ‘generally, classical physics is considered generally causally determinate.’” The question that we address in this section is whether classical physics is actually causally determinate, or whether the ideal of causal determinacy even for classical physics is an anachronistic illusion.

Causality in non-relativistic domains requires a notion of time with a clear understanding of frame-independent simultaneity with an asymmetric direction from ‘past’ to ‘future’. The world-line concept from relativity can be used even in non-relativistic domains such that causality is expressed as the intersection of world lines. A world line is a representation of the spatiotemporal evolution of an object or phenomena as a continuous sequence of spatiotemporal locations and events. When world lines intersect, an interaction between different objects may occur, and the physical relationship represented by a functional relationship (within the context of a theory-

system) between objects or phenomena represented by each world line determines the interaction. Causal skeptics like Russell and Norton promote the view that there is nothing above and beyond the functional relationships between world lines that can be identified as causality— ‘causality’ (in this view) is an entirely unnecessary conceptual overlay on facts that does not constrain phenomena in the way that conservation principles constrain phenomena. I disagree, and argue instead that the problem is the imposition of a requirement that causality be interpreted identically in every domain, while a pluralist interpretation allows different implementations of the same sort of concept in separate domains. The skeptical view is fueled partly by the inability to determine which world line should uniquely be identified as cause and which as effect, similar to our use of the Galilean transformation with billiard balls previously. Consider a rock falling to Earth: it is believed that Earth also ‘rises’ to the rock, although it is not perceptible, i.e. that they mutually attract due to gravitational force (in this domain). (However, in cosmology we may apply a preferred frame of reference determined by the cosmic microwave background radiation, so there are limits to the view that there is no non-relational frame.) In the skeptical view there is mutual interaction rather than cause and effect, reminiscent of Madhyamaka dependence. We may think of such interaction as causality, by identifying the force of gravity as the cause for a rock falling to Earth, but in this view causality is a convention for describing such interdependent interactions. Which object/event/phenomenon is cause and which is effect may be entirely conventional or epistemic or assigned for what may be quite useful heuristic purposes, or may be irrelevant or misleading, as the case may be. This view is a complete denial of any production view.

Causal determinism is defined as every interaction having a unique outcome.<sup>266</sup>

Classical physics is securely deterministic in its own domains. As is well-known and concisely provided by George Ellis (2006b) this security is based on the classical principle that complete knowledge of the necessary microphysics can be obtained in order to uniquely determine the macrophysics if necessary to enable determinism. Yet, by fundamental principles of quantum mechanics complete knowledge of the microphysics excludes certain features that would enable exact predictions. For example, complete knowledge cannot include the simultaneous knowledge of exact values of both position and momentum of any particle. Thus, we cannot know the exact motion of every particle necessary for exact causal determinacy. However, to discard causal determinacy entirely would be premature since there are many phenomena to which it applies. It is even more than simply a useful heuristic device, but it is a central feature of the dynamics of many phenomenal situations, even with the limits imposed on our complete knowledge of the microphysics.

To reiterate, classical physics is fundamentally deterministic, embodying what we might call ‘classical causality’. However, it is not possible to obtain precise values of microphysical dynamic variables without crossing the domain boundaries into quantum mechanics, and in those domains such precise knowledge is not possible. Therefore, for many effects we are forced to parameterize those boundaries by using a statistical distribution. We identify this as a pragmatic idealization which works well in mature, accepted and established classical domains: Regarding what we considered as the merely

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<sup>266</sup> However, Earman points out a problem with this approach: “Perhaps the most venerable of all the philosophical definitions holds that the world is deterministic just in case every event has a cause. The most immediate objection to this approach is that it seeks to explain a vague concept—determinism—in terms of a truly obscure one—causation” (1986:5). See his comprehensive book for analysis of this situation.

pragmatic domains of classical non-relativistic physics, and the domains of classical relativistic physics, we will see in *Chapter Nine: Physics of Change* whether they can be considered ontic or must be left as merely pragmatic. Utilizing Physics Pluralism, the nature of entities is what is described in their domains by the mature, accepted and established theories. We have yet to establish whether classical relativistic physics is a true theory, hence we only have confidence that it is empirically adequate. However, even van Fraassen admits empirically adequate is the same as being true when we are dealing with many of the entities and phenomena even theoretically amenable to direct perception. Precise distribution of wine glass shards is ultimately a microphysics problem, and although it may be soluble for some highly ordered lattice structures, I would argue that it is in general a quantum statistical problem, not deterministic, and exhibits a quantum type of causality.

### ***C.2. Statistical mechanics, thermodynamics and the asymmetry of time***

As mentioned previously, asymmetry of time was not supported in all domains of classical dynamics. Indeed, the classical Newtonian dynamics of particle motion as is used to account for particle motion in the classical statistical mechanics of dilute gases is famously symmetric in time, also called time-reversal invariance. However, temporal asymmetry does have a foundation in the Second Law of Thermodynamics, also a classical domain, which describes increase in entropy, or randomness, of a closed system over time. Thus, time has a direction determined by increasing entropy.<sup>267</sup> As mentioned previously, there is a significant problem with this foundation, which is that thermodynamics should be derivable from statistical mechanics through intertheoretic

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<sup>267</sup> See Callendar 2006 for a summary and bibliography.

reduction, yet statistical mechanics has no asymmetry—the concept of entropy increase is found only within thermodynamics. Thus, what is the foundation for the asymmetry of time? In this section we examine the controversy, and the attempt to derive entropy-based asymmetry from statistical mechanics, especially embodied in formulations of the H-theorem.

Simplistically, entropy is a measure of randomness, and this law says that closed systems tend towards equilibrium states that are more randomly organized, rather than non-equilibrium states which have concentrations of order. For instance, consider a closed, fully insulated container with gas which is hotter than its gaseous environment in a closed room fully insulated from the outside, in which the container and the room are separately in their own equilibria. Once the container is opened to the room, the hotter gas in the container will distribute throughout the room, resulting in warmer equilibrium of the entire system of {room+container}. The state which is the conjunction of the separate states *hotter in one place* and *cooler in another* entail a lower entropy disequilibrium state, while the uniform distribution of heat throughout the environment is a higher entropy equilibrium state. If such entropy evolution is necessary for any closed system—and it seems to be, supported by mature and accepted theories and empirical data—then it would identify time’s arrow in one direction and not the other. This is expressed as the ‘spontaneous tendency towards higher entropy in the future compared with no spontaneous tendency towards higher entropy in the past’, embodied in the second law of thermodynamics and the Boltzmann equation. The major philosophical problem involved with the thermodynamic basis for time’s arrow is that thermodynamics should be derivable from microphysical statistical mechanics. Yet, the

latter is invariant to time reversal, since Newton's Laws have the same form even if time is replaced by its negative in the statistical mechanics of classical gases idealized as independent point particles modeled as perfectly elastic spheres, while Boltzmann's equation demonstrates an arrow of time to increasing entropy, and is not invariant under time reversal.

There have been various attempts at addressing this problem and none that have been entirely successful. Thus, although the second law is empirically justified in an enormous number of examples in daily life and laboratory measurements, no reductive foundation of thermodynamics to microphysical statistical mechanics is without serious issues. One attempted solution is the so-called H-theorem. Boltzmann first generated the equation which has his name, which is an equation for the probability distribution over time of position and momenta of molecules in a dilute gas. He immediately noted the irreversibility issue and also generated an equation in order to demonstrate how the irreversible tendency towards increasing randomness or entropy could be derived from the particle motion which had no such time asymmetry. The H-equation concerns the quantity H which is a function of the probability that the system is in any particular accessible state. The H-theorem says that the system tends towards equilibrium, which is the state of highest entropy, thus demonstrating that the time-irreversibility of thermodynamics is derivable from particle mechanics. Almost immediately after Boltzmann generated the H-theorem Loschmidt noted that it must be logically impossible to directly derive a time irreversible process such as the Second Law of Thermodynamics from time reversible (i.e. time-symmetric) dynamic processes such as Newtonian mechanics. Thus, one of Boltzmann's assumptions must have been flawed,

and this has been identified with Boltzmann's assumption of 'molecular chaos', that particles are independent and their velocities are uncorrelated (and the fallacy of the assumption suggests a connection with Madhyamaka views). More recently Lanford (1975, 1976, 1981) derived the H-theorem from time-reversal invariant Hamiltonian equations of motion under specific assumptions. The problem, according to many analysts, is that the assumptions used in deriving the H-theorem are far from realistic. This problem has been extensively reviewed by Uffink and Valente (2010), who concluded that the assumptions were not conventional, as Lanford maintained, but rather were due to his formulation and should be identified as explicit assumptions necessary for the validity of the theorem. Specifically, after considering less important objections: "However, in our opinion, a more serious drawback to the applicability and physical relevance of Lanford's theorem lies in the usage of the Boltzmann-Grad limit" (Uffink and Valente 2010, 166). The latter is one of the assumptions used to justify Boltzmann's equation, and which pertains to the range of interaction potential between the two-particle collisions. They continue:

As we have seen, this limit implies that the density of the gas goes to zero, and hence that the result applies to infinitely diluted gases. And while it seems reasonable to impose this limit in order to give the Boltzmann equation a fighting chance to be valid, it also means that the thus-obtained result can hardly be relevant to real-life gas systems in which the density is not close to zero. The main merit of Lanford's theorem is therefore conceptual, in that it makes a case that, under precise conditions on the initial data, the Boltzmann equation can be derived from Hamiltonian mechanics, although just in rather idealized circumstances. (166)

Perhaps realistic assumptions on the microscale may generate entropy on the macroscale, yet I do not know of them.

Another solution to the generation of an arrow of time worth mentioning in the current context is application of the decoherence programme of quantum mechanics, which may serve to demonstrate why that microphysics time symmetry is broken.<sup>268</sup> Any kind of decoherence of entangled states entails an asymmetry in the direction of time which we designate as pointing to the future. Hence classical domains emerge from quantum domains through a process of decoherence, to be discussed further in *Chapter Eight: Physics of Composition*. We also examine the nature of time in more detail in *Chapter Nine: Physics of Change*, but for now, in some classical physics domains we are left with an unexplained manifestation of causality and clear example of a domain boundary in which temporal priority relates to cause and effect in the macroscopic thermodynamic domain and temporal priority must be left as an *a priori* imposition in the classical microphysics of particle motion upon which the former is supposedly based.

In the context of Physics Pluralism there is nothing philosophically wrong with including an arrow of time and causal determinism in thermodynamics domains, since the latter provides useful descriptions of our physical world—look at refrigerators and steam engines—and our philosophy should correspond to it, not impose upon it.

Statistical mechanics is useful for other problems, and we should not require intertheoretic reduction in all situations. Causality is a term that has many meanings. The

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<sup>268</sup> Schlosshauer (2004) offers a comprehensive and technical review. See also Bacciagaluppi, 2007, Bub (2010), Esfeld (2010), Ghirardi et al (GRW, 1986, 1990) and Penrose (1989, 1994) for background. Penrose has developed this into ‘objective reduction’. GRW and Penrose-OR describe entanglement as ubiquitous—any interaction entangles two phenomena and any further interaction reduces them. Here, an interaction does not require a person as observer—light hitting an entangled state will cause decoherence, as will the interaction of quantum fields. Even a system that is as isolated as possible will decohere; an atom will objectively reduce in at most  $10^6$  years and a 1 kg macroscopic object will decohere in at most  $10^{-37}$  sec. While off topic, it is interesting to note that Hameroff and Penrose (1996) adapted this to identify thoughts with OR of microtubules in the brain at a rate of 40-60 times per second, which they associated with Buddhist ‘moments’.

domains of these theories are likely merely pragmatic, defined by pragmatics rather than some ontologically clear divisions. Hence, each of these may be quite mature, accepted, etc., but neither should be considered universally true. We still will need an internally consistent way of defining ontic domain boundaries, and this will be specified in the next chapter.

### C.3. *Non-relativistic quantum physics*

In this section we examine the relevance of causality to quantum mechanics. Indeterminacy is an integral part of quantum physics, as embodied in Heisenberg's uncertainty principle, and this has motivated either a total denial of the validity of any concept of causality or at least a major revision of it. I argue that these special features of causality in quantum physics pertain to those domains and do not necessarily pertain to non-quantum domains. The special properties of quantum mechanics are best demonstrated by an encapsulated presentation of its formal properties in contrast to those of classical mechanics. Recall that classical mechanics has fixed values represented by the continuous real number line, with no *necessary* effect from the sequence of measurements of canonical variables (like momentum and position—see also Bub's presentation and my explication in footnote 259 above), and compare it quantum mechanics, where there are statistical and discrete values with a necessary effect from certain sequences of measurements.<sup>269</sup>

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<sup>269</sup> In quantum mechanics, the dynamical variables or 'observables' of a system are represented by the *noncommutative* algebra of operators on a *Hilbert* space, a linear vector space over the complex numbers, and the subalgebra of idempotent operators (the projection operators) representing the properties of the system is the *non-Boolean* algebra isomorphic to the lattice of subspaces of the Hilbert space. (Bub, 1997:4, my highlights)

Note that in quantum mechanics the order of measurement of certain variables matters, which is expressed by non-commutation in the Heisenberg uncertainty relations  $q_i p_i - p_i q_i = h/2\pi$  where  $q_i$  is the position and  $p_i$  is the momentum of the  $i^{\text{th}}$  particle, and  $h$  is Planck's constant. Hence, the values are not

One result of this quantum formalism is a lack of precise causality: Particular situations cannot be successfully predicted with precision, thus there is only statistical determinism. This is importantly not the same as indeterminism. These processes are stochastic, or random, but are described by very precise statistics that specify a mean and standard deviation for measurement of dynamic variables of the processes involved. Thus much is determined about these processes, and as the number of entities, such as the number of atoms in the ensemble, get large, by the large number theorem they tend to a very precise determination of the values of the variables.<sup>270</sup> The results of this kind of determinism are similar to results of the statistical determinism that is used to predict values of variables in classical statistical mechanics (although based on different assumptions and also dissimilar in other significant ways). For instance, we know that there is a finite non-zero probability that all the air in my office will suddenly condense to a tiny corner of the room. However, the probability of this happening is so astoundingly close to zero as to be considered zero for *all* practical purposes—and we are also as certain as possible about anything that it will not happen because the chance that it will is astronomically small. Similarly, the likelihood of a billion atomic decays in

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precisely known, hence “the transition from classical to quantum mechanics involves the transition from a Boolean to a non-Boolean structure for the properties of a system” (ibid).

<sup>270</sup> Consider phenomena that follow a Poisson distribution (for the sake of simplicity), which approximates a Gaussian (normal) distribution for large numbers. Using radioactive decay as an example, the standard deviation is the square root of the number of counts. Hence, one cannot predict when a single particular nucleus or unstable particle will decay. However, if the average decay rate is, e.g. 10 per second, we can predict that in ten seconds there is 99.9% probability of between 70 and 130 decays in 10 seconds, which is still a wide range: 30 counts, or 30% of the mean on either side of the mean expected value of 100. This indicates that with 1000 trials of this 10-second test only about one would demonstrate less than 70 or more than 130 counts. However, in 100,000 seconds (a little more than a day) we will know with 99.9% likelihood that there will be between 997,000 and 1,003,000 decays, confining this high likelihood to 0.1% of the mean expected value of one million. And we know with 99.9999% likelihood that the number of decays will be within 0.5% of the mean, etc. When we deal with the really large numbers of atoms that typify many commonplace objects, quantum statistical determinism tends to classical determinism in the limit and statistical remnants become effectively zero.

a half-life period that has the expectation value of a hundred decays is also astronomically small, and is effectively zero.

However, philosophically, i.e. in principle according to the mathematical formalism at least in terms of phenomena amenable to measurement (as opposed to hidden variables that may perhaps be underlying them), we know that quantum processes are indeterminate. Schrodinger's equation for time-dependent trajectories is deterministic, so it only requires precise initial values. The indeterminism lies in the fact that we cannot know precise initial values. Hence, for many classical systems there are quantum mechanical limits to the precision of initial values that would enable utilization by classically determinate equations of motions. Both classical and quantum are pragmatically determinate for some phenomena and pragmatically indeterminate for other phenomena.

One indeterminate phenomenon particular to quantum domains without classical analog is entanglement. As is well known (see *Chapter Two, Section C.7*), the superposed coherent states of a single entangled system make results of decoherence unpredictable, which has been the thorn in causal determinists' sides since 1925. This is the epitome of principled indeterminance, and has inspired various attempts to interpret it in terms of hidden variables (countered by no-go theorems) or multiple universes.<sup>271</sup> While the state of 'separate' particles in an entangled quantum state cannot be known (and we showed in Chapter 1, Section B.5.c how the use of 'separate' is fallacious in any event), and the final states after wave function collapse cannot be predicted precisely, the statistical distribution of final states can be predicted precisely, which motivates

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<sup>271</sup> I do not address these attempts here, nor go into the details of the measurement problem, discussions of which can be found in numerous places.

concepts of statistical determinism. The combination of these two observations for entangled quantum states of enormous numbers of particles, such as in classical macroscopic objects, means that the final state of, e.g. a rock with  $10^{20}$  atoms, can be known with incredible precision.

Additionally, Esfeld (2010), proposes entanglement as a feature of the physical world which defines a direction for time's arrow, thus providing justification for the asymmetry of time that can be recovered from statistical mechanics. This feature of entanglement and collapse is valid under at least a state-reduction or wave-function collapse interpretation, but also in the Wheeler-Everett multiple worlds interpretation of quantum physics. Esfeld chooses the model of entanglement described by Ghirardi, Rimini and Weber (1986, henceforth GRW) as the appropriate dynamic interpretation, although there are other 'environmental collapse' theories. Penrose also has transformed GRW into an 'objective reduction (OR)' account. As is well-known, interacting quantum systems become entangled and remain so until another interaction has occurred. The reducing interaction—the interaction which may be a measurement but may also be environmental (and for GRW/OR interpretations the environment includes the background quantum fields)—collapses the entanglement from a state without separable properties to one that has separable properties, and this type of reduction defines a direction of time. In these interpretations of quantum systems, the collapse of large entangled quantum states may be understood as the emergence of classical domains from quantum domains.

In quantum domains, therefore, there are several different conceptions of causality, and while classical causal determinism certainly does not apply, there are

forms of statistical determinism and sequences of causal interactions that do apply. Those quantum forms of causality appear to be dependence forms, not production forms. For, while within the constraints of the uncertainty relations huge energies may arise—if only for a tiny amount of time—any measurable interaction must always be constrained by conservation and symmetry principles. Additionally, we can see how causality in quantum systems can relate with causality in classical systems through entanglement and resultant wave function collapse.

#### ***C.4. Relativistic physics***

For special relativity there are two relevant requirements that distinguish it from classical physics, as itemized by Norton (2007:226): The latter asserts (1) “There is a finite, invariant velocity in space-time...” which equals the velocity of light; and “(2) There are no propagations in matter faster than light.” The latter is sometimes expressed as the velocity of light being a constraint on the velocity of any information transfer.<sup>272</sup> These requirements are graphed as three regions of spacetime defined by double, opposite-facing open cones with apexes at the here-and-now and with one cone opening ‘up’ (on paper) to the ‘future’ time and the other cone opening ‘down’ to the ‘past’. (See [http://en.wikipedia.org/wiki/Light\\_cone](http://en.wikipedia.org/wiki/Light_cone) for a visual representation.)

Throughout this representation of spacetime can be found discrete points called ‘events’ and lines called ‘worldlines’, as mentioned previously. The region in the future that is outside the future light-cone is called space-like and represents regions of spacetime that cannot be connected by any information signal from the here-now, and the regions in the past that are outside the past light-cone cannot have influenced the

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<sup>272</sup> Thus, even collapse of the wave function of an entangled state does not cause an effect faster than the speed of light. See Bassi and Ghirardi (2008) for a recent review.

here-now. Non-space-like regions include the light-like or null surface of the cones, representing regions that can be connected by light or any other mass-less signal from or to the here-now, and time-like regions which are inside the cones and which can be connected to or from the here-now by less than light-speed transmissions, e.g. trajectories of objects with mass. For special relativity, therefore, an event identified as an effect must be within or on the future light-cone, the non-space-like region relative to any event that might be a candidate identified as a cause. Other than that requirement, I do not think that there are any further requirements distinct from other domains of physics, and actually this requirement is a universal principle throughout all domains: No physical entity of mass and/or energy may travel faster than light, nor effect communication.<sup>273</sup>

Norton expresses scepticism that there might be utility in applying the predicate ‘causal’ to non-space-like regions. He cites the ubiquitous invocation of this predicate in relativity literature, but finds no substantive utility to it:

So far, these notions simply implement assertion 1 above. They all pertain to the existence of the invariant velocity in space-time without really expressing its significance, beyond the vague connotations of the word ‘causal.’” The articulation of the significance comes through the implementation of 2. It is the demand that matter in the space-time admit no propagations outside the light cone, so the invariant velocity is identified as the upper limit to the velocity of these propagations. (227).

At first blush, it is hard to see how ‘vague’ the ‘connotations’ of ‘causal’ are. I argue that the conic representation expresses the limits of causal influence, and additionally

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<sup>273</sup> Although this is not quite correct, depending on how we define ‘entity’. Shadows, which, it may be argued are not entities of matter or energy may travel faster than light, but may not result in causal effects or communication. It is controversial whether they are even entities. Yet a spot of light shined towards far away locations, when the source is panned across the sky, could conceivably move faster than light, and do have mass-energy. However, again, no communication or causality can entail from one spot to another. The only communication or causality would be from the source to the spot, and that is limited by the speed of light. However, see Liberati (2002) and the many citations of that work which identify at least theoretical potentially faster-than-c situations, although as far as I know without current empirical verification.

indicates a time asymmetry which enables us to identify at least restrictions on what might be a cause and what might be an effect as long as we can identify the here-now (although more on this in *Chapter Nine*). However, Norton's comments are an extension of his (2003) causal anti-fundamentalism: All the 'causal light-cone' representation actually means is that light travels with an invariant velocity (in vacua) and no propagation of information can exceed that velocity, not even the collapse of an entangled wave function. We are told by Norton that such causality is not a universal *a priori* conceptual prerequisite that restricts empirical content.

However, I disagree, as I have been arguing. I have pointed out that taking a different view of causality in certain domains secures an effective role for such a principle in each domain, although demonstrating a plasticity which is anathema to Norton (whose view could be construed as allegiance to fundamentalism). Yet, that plasticity is merely a feature of Physics Pluralism. Whether causality can be construed as dependency, production or a mixture will be reviewed in the conclusion. In domains of classical physics the role for causality is important and secure, as a principle which (in Norton's terms) constrains phenomena. However, there is temporal symmetry in non-relativistic classical equations, and Galilean transformations demonstrate how causal asymmetry of cause before effect should be replaced with an event-interaction view.<sup>274</sup> Such asymmetry is built into thermodynamics with the entropy principle, and in domains of at classical thermodynamics causality is also secure, while for quantum thermodynamics our understanding of causality must be adopted to the indeterminance of those domains. Causality is needed and used in calculations and interpretations and refers

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<sup>274</sup> Which, as I have mentioned, is more conducive to a Madhyamaka interpretation.

to actual physical processes, yet with an arrow of time. Hence the question is: Where does the arrow come from? Quantum entanglement and wave function collapse may provide a mechanism for that direction of time in the emergence of classical systems (contrary to Aharonov et. al. 1964), and domains of quantum physics have unique concepts of causality—more in *Chapter Nine*.

In this section, we saw how causality plays an integral role in special relativistic domains, and is at least derivable from or perhaps even is conceptually equivalent to the our understanding of the facts that the speed of light is both constant and cannot be exceeded.<sup>275</sup> Norton (2007) goes on, however, to suggest that the ‘causal principle’ of relativity finds more significance in general relativity. From Hawking and Ellis (1973, 60), we find a ‘local causality’ which “amounts to requiring that the field equations of the theory enable the fields at an event to be fixed by the fields in that event’s causal past, that is, its past light cone and the events contained within it” (Norton 2007, 227). However, the light-cone structure varies from model to model in general relativity. Some causal curves can be closed, and this can generate apparent temporal paradoxes such as influencing one’s own past. Hence (as Norton notes) Hawking and Ellis (190) invoke a “causality condition” that disallows closed causal curves<sup>276</sup> as an example of the kind of imposition of principles which constrain the domain to actual physical worlds, rather than including all logical possibilities.

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<sup>275</sup> Although there are significant issues around time in relation to the concept of simultaneity that will be discussed in the next chapter.

<sup>276</sup> However, others such as Arntzenius and Maudlin (2005) find that no contradiction arises in closed causal curves, that the evolution of that worldline becomes consistent, without paradoxes.

Norton, however, concludes that the causality conditions are representations of the fact that the speed of light cannot be exceeded,<sup>277</sup> and that those conditions have no independent status:

[The causality conditions] are best understood as devices for cataloging the different ways that the light-cone structure may be spread globally over space-time. They are elaborations of the basic assertion that space-time has a light-cone structure and amount to categorization of the different types of that structure. They are not principles that are to be demanded universally, like the Einstein field equations, for it is routine to consider solutions of the Einstein equations that do not conform to them...Their utility is that they enable us to divide the models of general relativity into classes with different properties.” (228).

Unfortunately, Norton does not specify the nature of the categorized types. Yet, this is of prime importance. As mentioned previously, it seems that the major categorization which is used throughout many domains is of (1) causal models—which are therefore at least potentially physically realizable, and if ‘true’ (in that they correspond to reality) they are physically realizable—and (2) non-causal models—which are necessarily non-actual and non-physical. (In this context, ‘model’ refers to a particular solution of the Einstein equations, and may be interpreted as a model in the context of the semantic conception of theories.) This is the central categorization that the light cone structure embodies, and the point is not that non-causal models are by their nature non-actual and non-physical, that is all physical models are causal. At the boundaries of domains of developing and even mature theories like general relativity and effective field theories of the standard model, non-physical solutions may indicate new phenomena requiring new physics. Hence, discarding the non-causal solution may only be justified in certain domains of well-

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<sup>277</sup> This requirement of light speed limits is embodied in the hyperbolic form of the partial differential equations of motion which are required in relativistic physics. This hyperbolic form requires that causality, for instance as a propagation of changes in initial conditions of the state of a system, do so causally, in comparison with Newtonian gravitation theory which allows for action-at-a-distance. Thus, for example, the gravitational effects on a test particle due to change in position of an source object must propagate at the speed of light, while the Newtonian theory falsely allows instantaneous changes.

known causal phenomena types. The apparently aberrant or pathological cases may indicate need for further attention in developing new theories such as quantum gravity. Yet, in many domains away from those furthest reaches of developing science, causality rules.

Relativity is classical in terms of causal determinism, establishing symmetric determinism even more than non-relativistic physics, as entailed by the block universe view which will be discussed further in *Chapter Nine*. The block universe view, a consequence of the relativity of simultaneity, indicates that the past and future have equal status and all the world's events are determined.<sup>278</sup>

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<sup>278</sup> However, there is a problematic issue: in classical physics, even including special relativity, spacetime is a “passive background structure” (Esfeld, 2010:10), while for general relativity “space-time, as constituted by the metrical field, is itself a dynamic entity and interacts with other energy-matter structures as well as with itself.” Hence, the metrical field should be considered as material as other physical fields. However, some have argued (the ‘hole’ argument) that the view of spacetime as substantial (as a material substance) has a cost in entailing indeterminacy for general relativity. However, examination of the topic of spacetime substantivalism would take us far afield.

## ***D. Conclusion***

Russell and Norton's complaint includes the judgment that causality is an outmoded concept that should be discarded or relegated to folk science, and that 'it' has so many meanings as to be meaningless—as further demonstrated by Bunge's and other's extensive classifications of different kinds of causality and determinism. Their causal scepticism may even be made consistent with Madhyamaka views. Yet, with application of Physics Pluralism, such scepticism can be understood as what we previously called the contentious attempt to achieve understanding of a single universal nature and theory, or in this case a single universal meaning and purpose for the concept of causality. Such a pluralist view is, I argue, more consistent with Madhyamaka views, in terms of the relationality between domains and global lack of inherent nature of causality when the concept and reality of causality is compared between domains. Instead of such fundamentalism that Russell and Norton utilize (at least implicitly), I emphasized the view that we can accept the idea that there is no universal implementation of a general concept of causality, no one true nature of causality, just as there is no single true theory applicable in every domain, and that causality can mean different things in different domains as described by different theories and their models. However, there are constraints to this relationality in the fact that there are certain general principles which represent apparently universal features, including aspects of causality. Conservation of mass-energy qualifies, as does Hamilton's Principle of Least Action. As far as we know, no situation in any domain violates the general principles, and they could be interpreted as embodying the causal nature of the universe. Yet, in each domain these general, global principles must be mixed with the more specific characteristics of local domains. Hence,

the implementation of causality demonstrates a pluralist plasticity which, I argue, is captured by Physics Pluralism.

Causality may be considered the very nature of relationality, and because it must be implemented pluralistically it is a globally relational concept with no inherent nature of its own. Causality reflects a central feature of modern science, that there is order and reason, and the reason is cause. I have argued that there is no reason to give up this notion, nor have we found a reason to choose one true meaning for it that is beyond being indexed to particular domains. As a matter of fact, the “plasticity” of the concept of causality that Norton discusses is further support for Physics Pluralism, rather than cause for rejection.

Modern regularity theory which ascribes ontological necessity to regular relationships is one example of a dependence view of causality, and can be understood as variation of a more sophisticated functional relationship view which incorporates statistical features and identifies causal interaction as an event which transfers conserved quantities from one entity to another. I have argued that a regularity theory without ontological necessity, but with only conventional necessity, does not have more than a heuristic role in contemporary physics: a more reasoned terminus of explanation should be determinable. We initially categorized varieties of dependence views in opposition to varieties of production views. For Nāgārjuna, as with Hume, a version of dependence theory was proposed to counter the prevailing supposition that there were ‘occult’ powers, i.e. capacities of features of the natural world which entailed necessary causal relationships. But if electromagnetic fields, nuclear and sub-nuclear forces, quarks, quantum vacuum fields and spacetime curvature aren’t occult (to the uninitiated), then we

don't know what could be. "Any sufficiently advanced technology is indistinguishable from magic" (Clarke 1962, 36). But to the initiated, all that need be done is discover the explanations for why regularities necessarily occur, by examining different theories, models and domains. I also argue that such discovery is necessary for a complete explanation: We cannot rest on a description of regularity; rather, the task of physics is to explain them. I conclude that the more contemporary version of regularity might seem to explain some things, but not others, and therefore might be an appropriate way of thinking about causality in some domains, while some other forms of dependence theory, production theory or a synthesis of the two would be more appropriate in other domains. As a synthesis, the functional theory enhanced with statistical features and the approach that considers conserved quantities exchanged through interaction when world lines intersect<sup>279</sup> may be viewed as an interdependence variety that unifies some features of dependence and production, and this view can be applied in several domains. This contemporary functional approach may even form the core of a generally applicable view with inclusive enough features that can be applied appropriately in different domains, thus providing us a universal principle. The terminus of explanation in dependence theories is 'that's the way it is', and the terminus in production theories is intrinsic properties, causal powers and capacities<sup>280</sup> yet intrinsic properties viewed reductively (i.e. in domains of quantum field theories) 'terminate' with intrinsic relationality of quantum particles, which therefore fails to terminate, and brings us back to interdependence. Here we find more support for the central thesis of this dissertation that there is global relationality in physical phenomena, as suggested by Madhyamaka views,

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<sup>279</sup> From Dowe (2007); also see Dowe (2009) for other causal process theories.

<sup>280</sup> See Mumford (2009) for an overview

and that a determination of global inherent nature is more difficult to support. This means that in one domain or another an entity or its properties may be considered independent of other phenomena. However, the same entity and properties are found to be relational in other domains, thus demonstrating global relationality. Such support for relationality is not conclusive as yet, since we must continue and look at the compositional and temporal aspects of relationality and inherent nature, which brings us to the next chapters.

## CHAPTER EIGHT.      PHYSICS OF COMPOSITION

### A.    *Introduction*

In this chapter we continue our examination of the three components of inherent vs. relational natures of non-organic physical phenomena as understood by contemporary physics through application of Physics Pluralism. Here we focus on unitary vs. composite natures. In the previous chapter we looked at causality, which relates to independence vs. dependence. In this chapter we look at matter-energy as it relates to composition, and in the next chapter we look at time, which must be spacetime, to examine persistence vs. impermanence. Here we also use the concepts of modern quantum physics and condensed matter physics to define in a precise way what it means for a domain of applicability of a theory to be ontic.

According to the interpretation of Madhyamaka outlined in *Chapter Two: Madhyamaka*, no phenomena are unitary. This could entail several possible views: (1) Composite entities of our commonsense observations (macroscopic objects) cannot be constructed in any coherent fashion from fundamental parts which have inherent nature (permanent, singular and independent). This is the conclusion of the anti-reductionist, anti-atomistic Madhyamaka analysis, but without positive thesis. In physics terms, the conclusion is that there are no fundamental elementary particles with inherent nature, but rather the search for such particles involves us in an endless search and discovery of further parts of parts of parts, etc. (2) All physical entities have relational parts and there are no non-relational parts. This is the conclusion of interpreting Madhyamaka as promoting a positive thesis that all physical phenomena are relational. There may indeed be fundamental elementary particles, but they have relational parts, or they are *by their*

*very nature* relational. (3) There are no fundamental elementary particles, and the endless search of (1) above results in the realization that all matter is merely empty space.

These views are examined by looking at the fundamental constituents of our world, the basic ontology, what they are and how they are built into the medium sized dry goods of our common knowledge. The relationality of Madhyamaka suggests that there are no fundamental constituents if we mean by that something with inherent nature. Hence, we should be open to the option of not finding any such entities, or finding entities that are relational yet fundamental—or what we have called inherently relational. To examine this question we will use quantum field theory and the general theory of relativity. These two are our best ‘clusters’ of theories, meaning that there are many different varieties of sets of models which can be subsumed under these general theory-system frameworks. We also question whether use of those frameworks is sufficient and consistent—it is well known that they are not consistent as they are, hence the research into a more fundamental theory. We also will look at the relationship between various theory systems that are generated with those frameworks. We focus more on options (1) and (2), leaving option (3) in its analysis of spacetime for the next chapter.

In this chapter we examine the relationships between a whole object and its parts (if any) in one time period—a synchronic internal dependency problem—and in particular we examine concepts of being ‘unitary’ or being ‘composite’. What we mean by those terms will be quite important and central to this chapter. Superficially, something is composite if it has parts, and something is unitary if it does not. While one might think that this is fairly simple and straight forward, from various points of view in contemporary physics and Physics Pluralism this is not necessarily the case. In general,

the reason why it is not simple is because even though something has physical extent, i.e. some finite size, this does not entail that we can ‘break it apart’ into pieces without thoroughly destroying what it is forever. This does not mean that the entity is impermanent, since we may never actually break it apart. It may sit there, as a unitary object, forever. If we do break it apart, and find pieces, does this mean that it had pieces, or have we created something entirely different? Can we break apart an electron from its electromagnetic field? Can we break apart a proton into its component quarks or break apart the quarks that compose a proton? Can we even break apart a rock with its billions and billions of entangled particles and fields that are locked into a tight lattice structure? The answer to these questions will involve us in some details of modern physics. In particular, a chariot can be taken apart, as in the *sevenfold reasoning* analysis of Chapter Two, and then put back together, without any significant change from the original. Yet, we cannot reasonably consider an entangled quantum system or even a rock to be composed of parts simply because when we observe it in particular ways, including measuring the former or striking the latter with a hammer, we find two separate parts. The system has been destroyed, so there is no coherent way of saying that it was composed of parts—it has been destroyed and we have lost information about what it was, and just have information about what is currently in front of us. There is no reasonable way to glue the separate particles back into entanglement that is the same as the system as it was, or to glue that chunk of rock that took millions of years to form back into a whole that is the same as the original. This analysis can perhaps be interpreted as a modern form of *sevenfold reasoning* in our first option above, because there is no coherent way of considering the system as composed of parts, even while parts are found

once it is taken apart. However, another interpretation is that the entangled system is a unity, a single entity which should be considered as having inherent nature due to its unity, and this interpretation is contrary to the fundamental conclusion of Madhyamaka that no unitary phenomena exist. In order to understand these different ways of looking at the same system we will apply Physics Pluralism.

We discover, as suggested in previous chapters, that in any one domain we may be able to reasonably ascribe inherent nature to an entity, yet since in other domains we find relationality, each of those domain-specific natures are merely locally inherent, and all together are globally relational—a nature that is dependent on context. We have explicated the meaning of semantic relationality in our discussion of Western metaphysics in Part II—that what an entity is in philosophical or even common discourse should be at least partly understood in terms of how we identify and name it—and we find further meaning of that relationality dimension in the way we identify physical entities. In this Part III, however, we are mainly examining the epistemic and ontic relationality that is demonstrated from the relationships between phenomena and explanatory schemes, and between phenomena and their properties, respectively.

We begin with a general introduction to a contemporary analysis of the relationship between parts and wholes in the quantum mechanical context, and then proceed to the foundations of modern microphysics: quantum field theory. We discuss findings of the standard model of particle physics, which is quantum field theory based on the special theory of relativity; and the relationship between quantum field theory, effective field theories, and possible grand unified theories. We then apply some of the

concepts which we explicated in those contexts to the context of solids, which is called condensed matter physics.<sup>281</sup>

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<sup>281</sup> Actually, some of the concepts of quantum field theory began with research into condensed matter.

## ***B. A Contemporary look at parts and wholes***

### ***B.1. Introduction***

As a proxy for commonplace objects that we can observe directly (even though we see them with uncommon objects called photons!), we sometimes use a rock of pure quartz or a crystal block of pure iron, both of which we call rocks. We know that these are ‘made of’ silicon dioxide ( $\text{SiO}_2$ ) or the element iron, Fe, respectively. The question before us is whether this means that each rock is composite, regardless of what phenomena they are involved in. We have seen suggestions to the contrary in previous chapters. In *Chapter Four: Metaphysics of Composition* we analyzed the eliminativist metaphysical arguments of Unger, van Inwagen and Merricks which promoted the view that there were no such composite objects, but only atoms. There, we noted a contrast between the way a pile of dust—as an approximation of loose, non-interacting and independent atoms—would function compared with the way a rock would function. The difference is the presence of binding between the atoms due to their entwined electromagnetic fields. I endorsed the point of view that the rock, when examined in terms of certain phenomena, such as merely sitting on a table or being tossed at a window, should be considered a unity. In terms of radioactivity (perhaps considering a rock of uranium instead with no loss of generality) or chemistry (when exposed to a solute) then we must examine the rock in terms of its molecular or atomic makeup. If sliced thin and exposed to a beam of subatomic particles, we need to look even at its subatomic makeup.

This context dependence is an example of what we have called epistemic and ontic relationality, which are two of the three dimensions of relationality or śūnyatā that

we have identified. In order to explain the phenomena being examined, we define the domain and identify the best explanatory theory, which in the semantic conception of scientific theories is a set of models. The theory will relate the phenomena mutually with the object in terms of the temporal development of the properties of the object under specified conditions of the defined phenomena and domain. With phenomena that can be explained by classical relativistic mechanics, such as the rock sitting on the table or being tossed at the windows, for example, we model the rock as a solid object, a unity without parts. We may even refine the model by including deformability, or even that the rock can be broken into parts. We start with a description of the trajectory in the six dimensional phase space of location and momentum of the center of gravity, and add rotational variables around the center of gravity, deformation parameters, tensile strength parameters obtained through experimental testing, etc. For analysis of many phenomena, there is no reason for further analysis.

Yet, these are idealized models utilized for specific purposes. We ‘know’ that the rock is ‘composed’ of molecules, and is not a singular entity—or do we? As we discussed in *Chapter Two: Madhyamaka* in *Section D: Mereological analysis*, the Madhyamaka arguments concerning composition—*sevenfold reasoning* and *neither one nor many*—analyzed an object in terms of its component parts. However, that analysis—being of ancient origin—of course did not include electromagnetic fields, quantum fields, quantum entanglement, or relativistic spacetime. We ask whether including those phenomena in our analysis will change the conclusions.

In asking whether the chariot or the rock is composite or unitary, the distinction was made between conventional ‘truth’ and ultimate ‘truth’. Conventionally, the chariot

and the rock will be considered real objects, yet applying ultimate analysis (which involves analytically breaking the object down into its component parts) we get the three possible interpretations mentioned above. The first interpretation is that no form of relationship between the whole and the parts is coherent if we consider the whole, the parts or the relationship as having an independent nature. However, I argued that analytic reductionism that does not consider how the parts are bound together must be considered fallacious. This requirement applies to Western and Madhyamaka arguments. We proceed to other possible interpretations: The chariot and rock are not ‘real’, but are only conceptual constructs because ultimately there is nothing substantial upon which to base a compositional structure. Perhaps all objects—whether considered as composite wholes or ultimate parts—are relational and have relational parts. Possibly, there are no ‘ultimate’ parts, and the analysis will go on forever, finding that there is nothing but empty space. Perhaps all of these views are mutually consistent. However, we need modern meaning for these possible interpretations.

It is a legitimate enterprise from a modern physics point of view to seek the ultimate nature of causality, matter, energy, space and time through analytically *and* physically breaking an object down into component parts and investigating the nature of those parts. Indeed, this has been the guiding vision of modern microphysics seeking the ‘ultimate’ components, the fundamental elementary particles. We call this the ontological reductionist programme. Yet, with an understanding of the semantic conception of theories, Physics Pluralism, effective quantum field theories and the effective field theory approach to condensed matter physics that was briefly mentioned in previous chapters, is

it reasonable to assume that such activities give further information about the ‘nature’ of a rock, as opposed to merely the nature of elementary particles?

If we attempt to answer that we can get understanding in this way, then we immediately are stopped by the realization that we cannot break the charged elementary particles apart from their EM fields, and any thought-experiment such as *neither one nor many* which attempts to do so must take into account the way the fields are *unbreakably bound* to their particles. The fact of this binding gives us justification to think that many objects are whole unities for many contexts. Even for our rock, we can argue that simply because it can be broken does not entail that the whole is simply a bunch of parts. Justification for this argument is provided below.

As we shall see, I argue that modern quantum field theory and condensed matter physics demonstrate boundaries between domains based on the concepts of *decoupling*, symmetry and symmetry breaking, and quantum entanglement which make it *impossible* (not just difficult now, awaiting the final theory to fill in the gaps) for the current best theory of fundamental particles (quantum chromodynamics) or any imagined grand unified theory or hidden variable theory of quantum mechanics to provide further information on the trajectory of a rock or its mechanics when sitting on a table beyond what we already have from classical non-relativistic mechanics. Those theories could, of course, provide further information in their own domains, but the boundaries between many domains are ontic, not merely pragmatic, and will not fall to further computational vigor. For many objects of our world, we *must* utilize different theories, theories that are concerned with ‘larger’ (lower energy) scale phenomena, such as quantum electrodynamics, quantum chemistry, the various theories of condensed matter physics,

statistical mechanics (quantum or classical), thermodynamics, classical electrodynamics and classical (even relativistic) mechanics, and general relativity.

Our initial question in Part III of the dissertation is whether there is inherent nature in phenomena as far as modern physics is concerned. We may apply a fundamentalist, reductionist view and determine that the nature of an object is the nature of its elementary particles. We may then see that the elementary particles are inherently relational, i.e. as quantum particles they have inherent properties, had in virtue of their own internal properties, yet which necessarily involve them in interactions with their environment (the vacuum, spacetime) and with other particles, and for composite particles like hadrons that their inherent nature is due at least in part to relational properties of their constituents when examined in higher energy domains. However, I argued against a fundamentalist, reductionist view, hence we must ask for a context of phenomena—defined more precisely as ‘domain’—before we can answer a question pertaining to an object. Requiring a domain is an example of relationality. Hence, taking either a fundamentalist or a pluralist point of view yields the same answer: At least many phenomena are relational.

### ***B.2. Reductionism***

Madhyamaka argues that reductionism is incoherent, and reductionism is also rejected by many arguments based on quantum mechanics generally—as provided in this section—and quantum field theory—further discussed in the next sections. Maudlin’s (1998) analysis of the “Part and Whole in Quantum Mechanics” identifies relevant issues as between three separable stances: Classical mereology considers wholes as simple sums of parts; contemporary reductive Humean supervenience includes the spatio-temporal and functional relations between parts in summing to the whole; and holism invokes the

emergence of new properties that do not supervene on the parts. Maudlin's analysis is quite similar to both *sevenfold reasoning* and *neither-one-nor-many* down to analysis of atoms, where he diverges into a more modern field theory perspective. Some of the following analysis may seem to duplicate previous analysis I provided in Chapter Four: Metaphysics of Composition, yet I think it is important to begin freshly in the physics context, hence I beg the reader for patience: we will get into new territory quickly.

Using a watch as his example, Maudlin questions relationships between the whole and the still composite parts, such as springs and gears. He starts by setting up an opposition between reductionism and holism: "Reductionism is to be opposed to 'holism,' according to which a whole is something more than the sum of its parts, or has properties that cannot be understood in terms of the properties of the parts. It is further often stated that contemporary physics, specifically quantum mechanics, surprisingly incorporates a form of holism absent from classical physics" (46). However, we previously showed how even classical mechanics and other theories exhibit holistic reasoning. Maudlin then examines the typical mereological ways of considering such parts, of how to 'sum' the parts into a cohesive whole.<sup>282</sup>

The most obvious attempts to make the reductionist credo clear, though, run into immediate difficulties. In what sense could my pocket watch be thought of as nothing but the sum of its parts? If the watch is just the sum of its parts, then it seems to follow that at any time the parts of the watch exist, the very same sum of those parts will exist, and hence the watch as a whole will exist. Furthermore, at any time the parts of the watch have all the same properties as they do now, the sum will have the same properties, and hence the watch as a whole. (Maudlin 1998, 46)<sup>283</sup>.

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<sup>282</sup> See Simons (1987) for a comprehensive parts-whole analysis, but especially Chapters 8 and 9 which more directly pertains to the topic of this paper

<sup>283</sup> Compare with the *sevenfold reasoning* in Candrakīrti's *Introduction to the Middle Way* (*Mādhyamakavātarā* 6:151), also analyzed in detail in Huntington (1989), and very similar to Nagasena's discussion with King Milinda, Müller (1890): "We cannot claim a chariot is other than its parts, Nor that it

Maudlin points out how this simple mereological analysis is problematic as soon as we take the watch apart and lay the parts on a table, which demonstrates the ineffectiveness or irrelevance of applying the kind of unrestricted mereological constitution principles that some philosophers promote that unite uncoupled and otherwise unrelated items such as the Eiffel Tower and my left foot into some kind of unity.<sup>284</sup> Classical mereology is therefore rejected, but a more sophisticated variation might be relevant. Clearly there must be some relevance given to typically spatial and especially functional, i.e. causal, interactive coupling relations between the parts when in a whole for them to be relevantly considered a unity, and this would be the second option, a contemporary reductive Humean supervenience conception of parts and whole which includes the spatio-temporal and functional relations between parts in summing to the whole:

Perhaps we ought to try this: the watch is the sum of its parts iff all of the facts about the watch are determined by the intrinsic (nonrelational) state of the parts together with the relations between those parts [coupling]. This formulation gets closer but fails due to the unclarity of the term 'relation.' A holist about watches presumably would say that although there are some facts determined by the intrinsic properties of the parts together with their relations, there are some further facts not so determined. The holist would say that there are properties of the watch *as a whole* that are not fixed by the state and relational disposition of its parts...that, when put together, the watch acquires a heretofore unsuspected property... (Maudlin 1998, 47).

The reductionist “asserts that any whole may be divided into parts, each of which may be characterized by an intrinsic, non-relational physical state, and that *all* physical properties of the whole supervene on the nonrelational physical states of the parts together with the

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is their owner, nor identical with them. It is not in its parts; its parts are not contained in it. It's not the mere collection of the parts nor yet their shape.”

<sup>284</sup> See van Inwagen (1990), who also argues against UMC.

spatial relations between the parts.” (48) This is a reasonable characterization of reductive Humean supervenience,<sup>285</sup> which is related to local realism.

But this type of decomposition of phenomena into an intrinsic non-relational segment that is somehow separate from relational interactivity<sup>286</sup> is highly problematic in principle, due to entanglement at least, and also due to more complex facets of what we understand about systems, quantum, semi-classical<sup>287</sup> and classical, specifically chaotic systems and symmetry breaking conditions, especially spontaneous symmetry breaking. Teller convincingly argues for “*intrinsic relations*” to characterize quanta and quantum systems. However, the decomposition into isolated and interactive components will effectively characterize some phenomena in some domains, while others will require consideration of relational aspects and such decomposition will not be effective or sufficient—the unity of intrinsic and relational properties is required. In those latter situations holistic reasoning is required, which is Maudlin’s third option.

Maudlin then extends the analysis in a fashion that is similar to *neither one nor many’s* analysis which resulted in a rejection of reductionism. Maudlin, however, invokes field theory as the ultimate view instead of the naïve atomism supported by Abhidharma and denied by Madhyamaka:

In the case of the watch, the commonly mentioned parts, the gears, spring, and so forth, are all themselves spatially extended objects with parts of their own. Proceeding in the same way, reductionism would contend that the physical state of a gear is completely fixed by the physical states of the parts of the gear together with the spatial relations between those parts. The analysis of parts into their parts

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<sup>285</sup> See Earman and Roberts (2005a,b) for an extended discussion explicating the Humean view.

<sup>286</sup> See David Wallace (2008).

<sup>287</sup> ‘Semi-classical’ refers to the asymptotic region of physical and representational domains boundaries where emergent properties arise relating to collective behavior, and described by new physics. See Batterman (1995, 2002).

will obviously end only with the introduction of parts that themselves have no further parts. Since we are analyzing objects into spatial parts, these partless parts must be spatially unextended: they must be points. So we arrive finally at field theory: a classical field is specified by the attribution of a physical quantity to every point in a region of space. (Maudlin, 1998:48).

Even using classical fields, in domains of classical electrodynamics, we find problems with Madhyamaka arguments. In the classical Madhyamaka *neither-one-nor-many* argument a reductionist approach analyzes atoms that are supposed to be simple—partless parts—yet have physical extent, to demonstrate the incoherence of such a structure. When we consider EM fields that form atomic bonds, since EM fields are part of even elementary particles that cannot be analyzed separate from the particles, we must say that this ‘part’ is relational, but is not separable from the rest of the particle. Hence, they are not actually parts: the central particle and its fields are one. Additionally, modern quantum field theory describes the ‘ultimate constituents of matter’ as quantum fields, which adds further relationality, since the difference between classical and quantum fields is that quantum fields assign functions to every point—what could be interpreted as causal, structural relations—instead of physical quantities in classical fields. Yet, one can’t separate parts of these fields either.

There is still an issue between reductionism and holism—quantum entanglement can be interpreted as producing holistically emergent properties. Depending on the experimental situation, these quantum fields may be measured as particles—localized energy density or as classical fields that permeate all of space. Each experimental situation involves us with a different domain since it is involved with different phenomena, but whether those domains are merely pragmatic or ontic may not be all that clear. The ‘particle’ manifestations are frequently entangled, hence must be considered as

systems which exist throughout non-local regions as single unities. Therefore, the ‘ultimate’ reductionism—finding the ultimate particles—results in quantum fields which are non-reductive, and in order to understand what these are we require holistic and non-reductive reasoning, as discussed further below.

Maudlin concludes from entanglement that local realism does not universally apply. Local realism is: “Once the local facts have been determined, all one needs to do is distribute them throughout all of space to generate a complete physical universe”. However, “Quantum holism suggests that our world just doesn’t work like that. The whole has physical states that are not determined by or derivable from the states of the parts. Indeed, in many cases (according to the ray view), the parts fail to have physical states at all” (58-59). Indeed, local realism,<sup>288</sup> what has been called Humean supervenience, what Howard (1985) calls Einstein’s “separability and locality condition” has been tested and fairly well proven false in the various EPR-Aspect experiments over the past 30 years. Entanglement is a real and some think ubiquitous phenomenon.<sup>289</sup>

Note that a justification for the idea that an entangled system is composite is hard to find. It is a fact of the matter that once we measure such a system it ceases to be entangled, and we find separate entities. This does not, however, entail that there were interdependent components prior to measurement. It is also a fact of the matter that to

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<sup>288</sup> Analysis of local realism will take us unnecessarily beyond our scope. Local realism has two ingredients. Locality is a rejection of action-at-a-distance, hence no signals may go faster than the speed of light, and realism in this context is that dynamic variables have well defined values prior to measurement. While locality is a fundamental principle that has never been violated in isolation, experimentation has not been able to isolate realism independent of locality, and the two in conjunction have been denied by the violation of Bell’s Inequality in Aspect-type experiments. We may conclude that there is no realism, which is the Copenhagen interpretation. However, there are many other options for interpretation. See Schlosshauer (2004) for an excellent modern review.

<sup>289</sup> However, followers of hidden variable theories promote the view that there are underlying properties that determine the outcome of decoherence of an entangled system. See my comments on hidden variable theories in the next chapter.

generate an entangled system we start with separate entities that undergo an interaction. Hence, we start with parts and end with parts and we call the system entangled, which suggests that there are parts which are entangled. Nonetheless, the parts are described by a joint wave function that is not a sum of two separate wave functions. The fact of the non-linear summation of the wave functions  $|S_i\rangle$  and  $|S_j\rangle$  into a joint wave function— $|S_{ij}\rangle \sim (|S_i\rangle \times |S_j\rangle) - (|S_j\rangle \times |S_i\rangle)$ —combined with the understanding that the value of any measureable is a function of the square of the wave function, means that there is little justification for thinking that the system has parts. The wave functions are simply not separable without the destruction of the entire system, and I argue that without such separability there is no parthood.

### ***B.3. The standard model of particle physics***

We now fill in some background details on relevant physics, and specifically on particle physics. It will be convenient to use a few acronyms, much as they may be anathema to the uninitiated. We will re-identify the acronym on first usage.

QFT: quantum field theory

EFT: effective field theory

STR: special theory of relativity

SM: Standard model of particle physics of STR-based QFT

GTR: general theory of relativity

QG: quantum gravity

GUT: grand unified theory

RG: renormalization group

The standard model (SM) is the best microphysics that we have, incorporating special theory of relativity-based quantum field theory (STR-based QFT), which is

considered a mature and accepted theory: its models give true answers to numerous important questions. Additionally, in response to instrumentalist objections, I argue that the entities it describes can be interpreted realistically in many domains, since the entities are observed in many ways, including through the human eye (photons) and fingers (electrons), at least in bunches, and also individually, through many devices that are well understood, and are used to make things. Hence, they are actual physical features of our world by our criteria, and exist as described by the theory. The theory is generally considered to be true in many domains, although in some domains we still require an instrumentalist interpretation. We may think of the domains of QFT as a hierarchical series relating low energy-large objects to high energy-small objects. Many domains are described by an effective field theory of its own, hence STR-based QFT is considered an umbrella framework, hence the label ‘standard model’. The framework is about fifty years old, having been motivated by Dirac’s first attempts at unifying STR with quantum mechanics in 1926, and the SM has been revised considerably since its inception.

The latest version of the *Review of Particle Physics* (RPP, 2010) is a 1400 page compilation and review of the most recent knowledge about elementary particles. According to our current knowledge, there are three classes of particles that have no internal structure: leptons (in six varieties including electrons and neutrinos), quarks (in six varieties which ‘compose’<sup>290</sup> the neutrons, protons and other composite particles called *hadrons*) and gauge bosons (the quantized forces of fields, in four varieties including the photon for the electron electromagnetic field, and gluon for the quark strong nuclear field). These have entirely unitary nature, i.e. as particles they have zero spatial

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<sup>290</sup> Scare quotes due to decoupling, to be explained below. All future use of the term ‘composite’ or the noun form ‘composite’ should be read with scare quotes.

extent, no internal structure (yet they do have fields). Yet, they are not really particles, but actually quantum fields. Additionally, there are numerous ‘composite’ particles, yet it is a significant question whether we can consider those particles to be composite or unitary, as we shall see.

Each of the elementary and what are popularly called composite particles has (as listed to remarkable precision in RPP) specific rest masses, charges, spins and other less familiar properties, which must be considered intrinsic: These properties are had in virtue of the particles themselves, without any relationship to the existence or non-existence of anything else in the universe. These are called *state-independent* properties, in contrast to the state-dependent properties which relate to relative velocity, position, etc. Many of the composite particles have short lifetimes in their rest frames, hence are impermanent because they decay to different entities through no other cause than their own internal instability. Many also may be destroyed by external forces, but the question is if they can be permanent without those external forces—some can, and some cannot, as we shall see in *Chapter Nine: Physics of Change*. Their life-times, however, depend on their velocity relative to the measurement frame of reference, just as mass is frame-relative, although we define their state-independent lifetime as that measured in their own co-moving frame, just as their rest mass is identified. Their decay products together preserve the original values of the state-independent properties, making them conserved quantities, as discussed in *Chapter Seven: Physics of Dependence*. Interestingly, “neither quarks nor gluons are observed as free particles” (Dissertori and Salam 2009 in RPP, 114): Even when the composite hadron is broken apart, quarks recombine faster than can be observed. Quarks are, by their nature, relational, in that they must occur together with

other quarks whenever they occur at all, hence we cannot justifiably talk about a single quark. Gluons are the quantization of the quark strong nuclear field: They mediate forces between quarks, embodying the forces of the fields which keep quarks together as hadrons. Gluons, as with photons, are also by nature relational particles, as resonant quantization of force fields which embody the forces between particles.

Taking particles as our basic ontology has been quite controversial in physics and philosophy of physics, and it is generally agreed that quantum fields are instead the basic ontology, and particles are simply what are measured under certain circumstances, while classical fields are measured under different circumstances—the wave-particle duality:

A consistent interpretation of QFT, suggested by the operator formalism, seems to be this. The basic ontology is the quantum field. The particles, or the quanta, as the manifestation of the excited states of the field, characterize the states of the field. They can be empirically investigated and registered, but they do not exhaust the physical content of the field. In a very deep sense, the concept of quanta, as objective but not primitive entities, as phenomenological indicators for the complicated structural features of the primitive field (or substratum) manifested in various situations, has well embodied the idea of structural realism. (Cao 1999, 10).

In this view, the basic ontology of all matter is inherently relational in that what exists are causal interactions of the field, rather than particulate entities, and the latter are considered resonances or quantizations of that field.

Yet we should not overstate the relationality of the situation. There are state-independent properties, such as charge, spin, rest mass and (rest) lifetime which are conserved quantities and must be viewed as inherent to the entity, whether it is identified in relation to some interaction as a particle or interpreted as a quantum field. However—and this is a major point—the rest mass of a rock, for example, is the sum of various factors inherent and relational, including the contributions in various domains from

chemical, atomic and nuclear bonding energies, and the relativistic mass-energies of motion of the quarks of nucleons, let alone considering the conjecture resulting from the standard model that the mass of elementary particles is due to interactions with the Higgs field. Nonetheless, that total rest mass-energy is conserved, and should be considered inherent. Therefore, like general causal principles which are implemented variously in different domains, these state-independent parameters are interpreted variously in different domains, yet still are global characteristics of inherent nature.<sup>291</sup> However, I have been arguing that this is not a violation of śūnyatā, but rather an indication of the proper interpretation of śūnyatā in the context of modern physics. Since inherent nature demonstrated by the conserved state-independent parameters are due to relational interactions when we consider all the domains of different phenomena described by our various mature, accepted and true-in-their-domain theories which apply, we call their nature *inherently relational*.

#### ***B.4. Grand unified theories, effective field theories and decoupling***

One of the motivations and foundations of pluralist physics epistemic frameworks such as Physics Pluralism is what we have learned from two disparate theory clusters: the effective field theories (EFT) programme to develop EFTs as part of the SM, and the science from condensed matter physics involving understanding of solids. The core relevant concept is ‘decoupling’ which grew out of the latter programme first and was

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<sup>291</sup> Analysis of rest mass seems to be clear in this way, that it is due directly to relational properties as well as inherent properties, in interaction. With charge the only relationality seems to be with the vacuum, called vacuum polarization, where what we measure is the renormalized charge and the ‘bare’ charge is hidden—at least for now. Charge is a macroscopic and microscopic phenomena, but spin is only a microscopic phenomena, as is parity and other more exotic conserved quantities, hence those are domain specific and not global properties to begin with.

adopted by the former.<sup>292</sup> Decoupling involves relative autonomy of the physics of one domain from the physics in a higher energy domain, from which the fundamentalist would seek intertheoretic reduction. The fundamentalist alternative comes from our realization that, while the SM is the best microphysics theory that we have and is generally considered to be true in many of its domains, physicists are not satisfied with the completeness of the theory. There are several reasons for this, not the least of which is the “incompatibility” (Cao 1999, 24) or inconsistency (see Section D.4 in the next chapter) between the general theory of relativity (GTR) and STR-based QFT, in addition to further “meta-questions”, i.e. questions pertaining to microphysics that must require further theories to answer. These include the theory’s lack of ability to derive and explain at least 19 ‘free’ or ‘phenomenological’ parameters used by the SM which must be acquired through measurement. These include the masses and field strengths (coupling constants) of the fundamental particle and forces. Therefore, a possible grand unified theory (GUT) is sought that can derive these parameters. A GUT will describe the physics at energies higher even than those of the SM, hence can describe the energies that existed during the first milliseconds after the Big Bang which began our universe when those parameters became ‘frozen’ in value at the energies which we now experience. Hence, the CERN accelerators<sup>293</sup> use energies that have not existed since that time.

Yet, it is still understood that any GUT will not be able to answer all questions. It will be a ‘unified’ theory because it will hopefully unite such particles as the quarks and the leptons as different sorts of the same thing (Raby 2005 in RPP, 193), as Newton

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<sup>292</sup> See Hartmann (2001) and Cao (1997, 1999). The decoupling theorem is attributed to Symanzik (1975). There are similarities to ontological or functional integrity or dependence as discussed in Simons (1987:Chapter 9, esp. 9.4, 9.5, and also Chapter 8)

<sup>293</sup> European Organization for Nuclear Research

united the gravitational fields of planets with the gravitational field on earth, Maxwell united the electric and magnetic; Salam, Glashow and Weinberg united the electromagnetic and weak nuclear forces into the electroweak force; and with the strong nuclear force which holds nuclei together as described by quantum chromodynamics (QCD) the electroweak was unified into the SM. Thus, if more of the current fundamental elementary particles can be understood as merely transformations of the same particle, we will have a theory that can explain more aspects of the high-energy microphysics world. The only major force that is left out of the unity is the gravitational force, as described by GTR discussed in the next chapter.

However, the lower energy microphysics and the even lower energy macrophysics world will not be fully explained by that grand unified theory without the assistance of other theories, including the effective field theories. Effective field theories are generated for several reasons, including computational pragmatics, yet it is also generally agreed<sup>294</sup> that there are ontology-based divisions according to different energy scales relating with the renormalization group (RG). The latter began as a mathematical technique, yet over the past half century has become more:

RG is a defining principle for organizing physics...scale by scale, together with one of its profound implications (which itself is an *essential feature of nature*), namely the decoupling of low energy phenomena from high energy processes (which is characterized by mass scales associated with spontaneous symmetry breakings), has enabled us to understand not only the structure and dynamics of QFT models, but also the inter-theoretical relationship among these models and beyond. (Cao 1999, 16; italics mine).

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<sup>294</sup> For more on EFTs, see Cao and Schweber (1993), Hartmann (2001) and Cao (1997) and the Introduction by Cao and the many articles in Cao(1999). However, see Weinberg's response to Rohrlich's extreme support of pluralism in the Panel Discussion in Cao (1999, Chapter 26) for a universalist/fundamentalist reply.

Several concepts in this selection require explication: RG, symmetry and symmetry breaking, and energy scales. These are important to understand in our context because they determine the ontic character of domains that are central to understanding the significance of Physics Pluralism.

In general, the RG is a set of techniques to end the asymptotic growth of values of parameters in a particular EFT when the energies of field coupling between entities approach domain boundaries. However, instead of applying an arbitrary cutoff, as with the pragmatic divide between the Newtonian and STR-based classical mechanics, the cutoff is ontologically-based. Hence, the entities described by a renormalizable theory may be interpreted realistically, and the renormalizable EFT may be considered true in its ontic domain.

The domain of a renormalizable theory is bound by the phenomena called *spontaneous symmetry breaking*. To explain symmetry and symmetry breaking we provide two analogies, two mundane examples from classical physics and an example from quantum mechanics. As analogies they point to similarities, hence an intuitive understanding may be obtained, but of course they have dissimilarities also to the actual phenomena represented, hence are not true examples; as classical examples they are easier to understand yet are idealizations, hence also are not true representations of the phenomena.

The first analogy involves a coin in your pocket. For spending, the fact that it has two sides is irrelevant, yet if called upon to settle a wager, heads must be distinguished from tails. For the first problem there is symmetry between heads and tails—there is no relevant difference whether the coin is given in payment heads up or tails up; it is still the

same coin. However, for the second problem the symmetry must be broken. This breaking is pragmatic and the domains should be considered merely pragmatic, hence this analogy has limited utility in demonstrating spontaneous symmetry breaking. The second analogy is looking from a very long distance away at a telephone wire hanging between two poles. The wire will seem to be one-dimensional, a single line. Yet, as we approach it we realize that it is three dimensional, and ants may be walking all around it. This is an analogy to the way there may be hidden dimensions wrapped in our own three spatial dimensions which are discernible only through high-energy interactions.<sup>295</sup> This analogy has no ontic domain boundary, while the dimensions do.

A classical example of spontaneous symmetry breaking is Norton's Dome:<sup>296</sup> A frictionless ball-bearing sits atop a perfect half-sphere frictionless dome. The situation has perfect symmetry, but at least in Norton's view the symmetry must spontaneously break by the ball-bearing dropping down the dome in some direction or other. The breaking is spontaneous because there is no external reason for it to break (although in an alternative view the symmetry may break only from background quantum vacuum field fluctuations, taking it out of the classical domains). The second classical example is a compression force symmetrically applied to a solid rod in the direction of the rod's length. The rod will compress symmetrically until the symmetry is broken and it shatters in an undetermined way. Note that these classical examples are idealizations—there are no truly frictionless classical systems, nor domes and balls that have perfect symmetry,

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<sup>295</sup> Thanks to Lisa Randall for this analogy, presented at a talk at Dal several years ago.

<sup>296</sup> As discussed in the Appendix on acausal pathologies connected with discussion in *Chapter Seven: Physics of Dependence* (also discussed in Penrose 2007)

nor ways of applying pressure in perfect symmetry, nor rods that are so perfectly symmetric.

However, quantum mechanical systems do not require such idealizations. The example from quantum mechanics is an entangled system. Two particles become linked through an interaction, thus the system is a single state whose values are calculated as a linked sum of the states of its 'composite' parts. However, because of the linkage, the parts are not separable, either analytically or physically, until the entanglement decoheres into separable components. Prior to decoherence there is perfect symmetry and we cannot distinguish the components; after symmetry breaking we have separable components. Many explications and examples of symmetry and symmetry breaking are available in the literature, typically involving the identity of a type of particle which transforms into different types of particles under different energy conditions—there was symmetry of the two types of particles (like the sides of the coin) prior to the transformation, and the symmetry broke when the two different particles showed up. See Brading and Castellani (2008) for a summary and bibliography.

Energy scales should be understood in reference to the *ultraviolet divergences*. Ultraviolet light are higher energies compared with visible or infrared light, hence this term refers to high energies generally. Divergence in this context indicates that the energies are going to infinity, which is generally not allowed in the physical world. Consider two electrons, hence both with the same charge, approaching each other. Since, as we know, the force between them is repulsive and varies as the inverse of the distance between them squared, as they get closer and closer the repulsive energies increase without bound. An early consideration of this issue in quantum field theory was an

electron's self-energy, the affect of its own field on itself. This was quite problematic, to say the least. "Physically, the ultraviolet infinities have their origin in the hidden assumption that the bare parameters are measured at zero distances or infinitely high energies" (Cao 1999, 12). Hence, when we speak of energy scales, they are based on an unlimited amount of energy in one (open) end of the scale, from 'infinity' down to the very low energies of our normally observed middle-sized dry goods.

While it seems like this is a continuum, with only arbitrary, pragmatically decided boundaries, there are physical processes—spontaneous symmetry breaking—which occur in certain systems which determine ontic boundaries. Within these energy scale-determined domains, an effective theory provides description and explanation, and each of the EFTs and the phenomena in each of their domains are *decoupled* from the theories and phenomena of other validity domains. Decoupling is established by a *decoupling theorem* that is developed for each scale and theory.

In particular, RG and the decoupling have helped us to understand why a description by renormalizable interactions seems selected by nature as suggested by the success of the standard model. The explanation is clear and simple: at low energies, any general theory will appear as a renormalizable theory because all of its nonrenormalizable interactions will be suppressed ... Put another way, any renormalizable theory is only a low energy manifestation or an effective field theory (EFT) of a more general theory. (Cao 1999, 16).

Cao is pointing out the reasons for epistemic considerations as being based on natural, ontologically-determined situations: the reason why our theories are successful is that there are natural kinds within naturally-determined ontic domains. Science indeed *sometimes* divides nature at the joints. Yet, it is generally agreed that QFT and GTR are effective theories of a further, underlying theory of much higher energies, the quantum

gravity (QG) theories such as, perhaps, string or loop theory.<sup>297</sup> It is also generally agreed that any final theory will be a theory of very high energies, and will not replace the many EFTs for lower energies. EFTs are locally relevant in their own ontic domains, connected one to the other in that they ‘match’ at the boundaries, yet they cannot be combined or fully reductively related due to the spontaneous symmetry breaking or entanglement decoherence (decoupling) at the boundaries.

In theory justification, the EFT approach is more pertinent because only a limited consistency within its validity domain, rather than the unnecessary and irrelevant global consistency at short distances) is required. This stance is justified by the fact that each EFT has a well-defined validity domain delineated by a characteristic energy scale associated with a relevant spontaneous symmetry breaking, and thus any deliberation on its consistency beyond this domain becomes relatively irrelevant. (Cao 1999, 17).

The ideas that theories must be related to each other through intertheoretic reduction, and that there might be one fundamental and universally applicable theory, are not tenable if we have ontic domains. In this selection we find a refined definition of ontic domain: “a well defined validity domain delineated by a characteristic energy scale associated with a relevant spontaneous symmetry breaking.” The first part relates to the EFT which is “valid” (explanatorily robust, empirically adequate, describing features of the physical world which are measured and identified to exist, etc.). The second part relates to the nature of the domain boundaries. These features do not involve gradual changes that we arbitrarily divide, say between the non-relativistic and the special-relativistic calculations of classical dynamics. They are not pragmatic or epistemic alone (although they certainly will have those advantages), but are determined by binary features of the physical world—on/off, symmetric/not symmetric, single state/multiple states.

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<sup>297</sup> See Lee Smolin’s (2001)

If we take the idea of renormalization group seriously, that is, if we take physics as changing with scales, then there is no ground for saying that some theory is more fundamental than others if they are valid at different scales. In this case, they are equally fundamental, and each of them has its own validity domain and enjoys theoretical autonomy in the sense that it cannot be reduced to or derived from another theory. In particular, a theory valid at smaller length scales is not necessarily more fundamental than others because it may not be valid for phenomena described by other theories. (Cao 1999, 25).

And it is a fact of nature that physics changes with scales, i.e. there are different ontic domains.

For example, the *neutron* as described by classical chemistry or quantum chemistry has ‘intrinsic’, i.e. state-independent, properties like rest mass and spin, and these could be identified as the neutron’s inherent nature, as previously mentioned.

However, there is still a global relationality that is demonstrated: relationality in comparison of the neutron’s different natures in different domains.

Is the neutron in different domains, chemistry and QCD, for example, named improperly with homonyms, hence we should rather call the QCD version *neutron*\*? Of course they are (or ‘it is’) in different domains described by different theories. In this particular case, QCD ‘explains’ the state independent properties of *neutron* by the properties of *neutron*\* and its quark components, so there is some intertheoretic reduction apparent in their relationship. However, that reduction is limited, and (as far as I know) a complete derivation of the properties of the quantum chemistry *neutron* from QCD *neutron*\* are still missing, partly due to a systemic problem that free quarks cannot exist in nature (at least not for long), hence we cannot study them outside of a bound state. Also, the neutron is an entangled system. We could say that the two entities are simply the same thing looked at with different microscopes. In this case, some of the structures of each theory are retained—to a degree—yet restricted to different domains, and the

concepts in each are adjusted, while the borders of the domain exhibit parameters that are matched, providing for both the continuity and refinement of our understanding rather than replacement and discard of the older mature and accepted theory. Yet, since we cannot derive chemistry from QCD, we cannot really consider the domains merely pragmatic. Chemistry is not a discarded theory. Must we consider it false? It has a term ‘neutron’ which indeed refers to a feature of the physical world, yet the properties it assigns are idealizations to enable ease of calculation. This is a common feature of many theories. As we look closer, we see more structures that were not seen when looked at from afar, but there is decoupling of the phenomena of chemistry from variations in the particular details of the QCD microphysics due to the entanglement and symmetry of the bound quarks. We therefore need not deal with quarks for chemistry interactions, if we had to we would never be able to do chemistry anyway, and there are physical processes which determine that the neutron is a unity, just as any entangled system is a unity.<sup>298</sup>

The same situation applies to atoms. Elements are identified by the number of protons in the nucleus, which determines the range of numbers of neutrons in the nucleus and the number of electrons ‘in orbit’ around an isolated complete atom. Chemical interactivity between atoms is due mostly from the electrons, which combine with other atoms through exchange or sharing, through their EM fields in various ways. There is no element with 23 and a half protons and electrons; elements come in unbreakable whole

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<sup>298</sup> Yet note Wallace’s softer approach compared with Cao’s or even Fisher’s (in Cao 1999): “In nucleon physics at very short ranges, the approximately-free particles are *quarks* (this is referred to as *asymptotic freedom*); at longer ranges, the interactions between quarks become far stronger and it becomes more useful to treat *nucleons*—neutrons and protons—as the approximately-free particles. (There is of course a sense in which a neutron is ‘made from’ three quarks, but the matter is a good deal more subtle than popular-science treatments might suggest!)” (Wallace, 2008:82). His approach, as described in the article from which this is excerpted, still supports the pluralist conclusion with ontic domain boundaries. Note, however Weinberg’s expressed hesitancy at the idea of doing completely away with fundamental and universal physics, as mentioned in previous footnote 289.

numbers of components, since those components are unbreakable (or if broken, they recombine too fast for their separability to be anything but virtual). There is no element half way between Nitrogen and Oxygen. The combination of these two elements results in a substance that is different from both of them individually—they aren't simply 'added'. Elementary particles, nucleons, atoms and molecules—and even larger structures like crystalline solids—are entangled systems. Since the nucleus is more shielded from interaction with other atoms than the electrons, the nucleus remains entangled longer, although each may go in and out of entanglement in flashes. While protons and neutrons are symmetrically considered to be two kinds of the same nucleon (isospin symmetry), and the free neutron spontaneously transforms into a proton (and other parts) and frequently immediately transforms back to a neutron, the bound neutron is stable. Elements are natural kinds, with particular physical structures, chemical properties and physical properties that are intrinsic to them, yet define their relational properties. The domain of phenomena pertaining to each element is ontic. The physical and chemical properties cannot be derived from their basic quantum mechanical makeup from the basic Schrodinger equation that should apply. Quantum chemistry is apparently not derivable from quantum field theory, and not all physical properties of matter are derivable from fundamental principles of quantum field theory—and it is not simply a question of computational efficacy. These theories are in different ontic domains due to the spontaneous symmetry breaking of elemental structures. As the energy goes down in our hierarchy of energy scales, from the extremely high energies of QCD to the comparatively low energies of chemistry, the complexity increases (the particles of QCD have very few characteristics, and combine in very few ways), as demonstrated by the

enormous array of chemical and physical interactions and resultant structures. As the complexity goes up through different ontic domains the number of free parameters – recall we started with 19 that are undetermined by QCD – go up, where each element must have measured parameters that describe their physical properties. Hence, there are many of what Cartwright calls phenomenological laws and measured parameters for each of the elements and compounds that enable us to understand their causal structures in larger contexts. Indeed, the requirement for those laws and measurements is only partly due to ontic domain boundaries, and also partly due to computational limitations which may improve, yet there are definitely ontic domain boundaries defined by symmetry breaking as well.<sup>299</sup> We will see more symmetry breaking in the behavior of solids, which brings us back to our original crystalline rocks of quartz and iron.

### ***B.5. Decoupling and unitary vs. composite in solids***

Recall that our main question is whether phenomena have inherent nature or not, or are rather solely relational. In this chapter we are considering the unitary vs. composite

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<sup>299</sup> For the basics of quantum chemistry see Lowe and Peterson (2006). Water is one of the most studied substances, and in a slightly biographical note that will demonstrate both motivation and substance: I was seeking to find out *how* to derive physical and chemical parameters from the quantum mechanics of constituents of water, and could not find it—yet found indications that it *could not be done*. I found this shocking. I was impressed by both how much was known and how weak the derivational link between fundamental quantum mechanical principles and the chemical and physical properties of water. See Hassan and Mehler (2004) and Cabane and Vuilleumier (2006). So many parameters have to be measured and apparently *cannot* be derived. This situation formed a substantial part of my initial motivation for discovering why, and finding ontic domain boundaries. For symmetry breaking in water see Stillinger and Lemberg (1975). For macroscopic ontic domain boundaries see Batterman (2002), some of which pertain to water drops and rainbows, as do his (2005, 2006). See also his (1995) which was a basis of his (2002) and pertains directly to intertheoretic relations. For a presentation of further relationships between derivation and measurement see Stillinger and Head-Gordon (1993). For a summary of what water is: “The present consensus seems to be that liquid water is a macroscopic network of molecules connected by frequent but transient hydrogen bonds, which allow unbounded neighbours to occur in numbers that vary with temperature and pressure. Attempts to identify unambiguous patterns of local molecular order that represent portions of the known ice polymorphs have generally proved to be unproductive. In any case, several independent computer simulations for liquid water, using only molecular equations of motion and estimates of the fundamental intermolecular interactions, confirm the random, defective-network viewpoint while automatically producing the characteristic thermodynamic water anomalies” (Stillinger 1999).

aspect of inherent nature vs. relationality: If there are no parts to an entity, then there is no internal dependency of the entity to its parts, and in lieu of any external influences the entity may be independent and persistent, and by our definition it would have inherent nature. It is one thing to look at the exotic elementary particles of quantum field theory, for which we have no relevant intuitive notions, and it is another thing to look at the medium sized dry goods of our common experience, like a rock. The latter is examined with what used to be called solid state physics and is now called condensed matter physics. Decoupling, effective field theories and the pluralism which they entail are not limited to SM and QFT, but are extensively used in condensed matter physics, in which concepts like symmetry and symmetry breaking are used.<sup>300</sup> As we have seen in regards to quantum particles, in solids also the unitary and composite properties are defined by using decoupling and EFTs: Objects are unitary in a given domain iff their functioning in that domain is decoupled from the details of the structure and function of their components or constituents (if any) when the latter are examined with higher energy EFTs that focus on understanding such constituents. Due to ontic domains defined by symmetry breaking and decoupling in solids we conclude that it is therefore fallacious to think that such an entity is globally composite if it is composite in an ontic domain which concerns phenomena on a smaller physical scale while being unitary in an ontic domain of phenomena on a larger physical scale. The more justified approach is to say that its compositional makeup is domain-specific, which is an example of epistemic and ontic relationality, of *śūnyatā* as we have discussed it.

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<sup>300</sup> The concept of symmetry breaking actually originated in condensed matter physics. See Brading and Castellani (2008) for an SEP summary.

So are there ontic domains concerning a rock? We will use a crystalline rock such as quartz, or even more so iron as a simple example that has fewer complications, and acknowledge that with rocks that are complex composites or mixtures the domains may not be clear. Are our rocks unitary or composite? First, we must determine if such entities are classical or quantum objects. Recall that a reasonably common sized rock may be perhaps  $10^{21}$  molecules bound tightly in a lattice structure by electromagnetic fields. There are several different ways of looking at such a structure. We may consider it a fluid; it may be an entangled system; it may be a loose collection of separate molecules; or it may be a single solid entity. Each way of looking at the rock requires a different theory and defines a different domain, pertaining to a different phenomenal context of problem, and some of the problems and domains may be merely pragmatic. We ask whether some may be ontic. Using what we have discussed previously, this question becomes the following: Is there a symmetry which determines that the rock is a unity in some energy scales, which is spontaneously broken at other energy scales, with decoupling from one scale to the other, and a clear ontologically-determined domain boundary not dependent on epistemic conditions alone?

The answer is that for some situations, such as a rock which is a tight crystalline structure such as our examples, a tight lattice of interlaced EM fields and atoms or molecules that are aligned in strict symmetric patterns, we must consider this a *single unity in domains of energies which do not break that symmetry*. For instance, such a rock, sitting on the table, in standard temperature and pressure conditions, maintains its lattice symmetry. When brought to higher temperatures and/or pressures, symmetry will be lost during phase transitions as the rock melts. Similarly, symmetries will be broken during

exposure to intense magnetic fields or other conditions. Exposing the rock to such conditions puts it in different domains, and the transitions from one domain to another are objectively determined by symmetry breaking. Also, tossing the rock in the air defines a domain amenable to calculations by classical dynamics and involves local energies that do not break the rock's symmetry. If we take a hammer to it, and break off a chunk, thus exposing its composite nature, we have locally broken its symmetry by imparting energy to it, thus we are in a different energy scale, and locally we can see that the EM bonds keeping what became that chunk as part of the rock have been broken. The symmetry is spontaneously broken if there are radioactive isotopes, and it is externally broken if we pour acid on it. "It is no exaggeration to say that the infinite variety of condensed matter is just the manifestation of broken symmetry" (Feng and Jin 2005, 19).<sup>301</sup>

Our conclusion is that the rock is a unity in some domains and is composite in others, a conclusion which supports our idea of epistemic and ontic relationality, a further expression of śūnyatā.

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<sup>301</sup> See also the rest of Feng and Jin's Introduction, pp. 2-22, plus Chapter 18 for a discussion of superconductivity, which also exhibits the collective symmetries necessary for ontic domains and the ascription of unitarity. For other macroscopic situations see Batterman's works which I have previously mentioned.

### ***C. Conclusion***

In previous chapters we hinted at the limited validity of reductionism, and in Chapter Two we also discussed Madhyamaka arguments against the reductionism and atomism of Abhidharma and some non-Buddhist approaches. Earlier in this chapter we found that ontic domain boundaries limit our ability to establish ontological reductionism—that the lower energy larger objects are combinations of higher energy smaller objects. We are also limited in establishing inter-theoretic reduction of one theory of lower energy to (or from) another of higher energy.

We began this chapter by providing three different options as conclusions of Madhyamaka analysis concerning the unitary vs. composite component of inherent nature vs. relationality. How well did each of those possibilities fare in light of the ensuing discussion? Our first possibility was that no coherent construction of wholes from parts can be justified if the parts (or the wholes) have inherent nature, hence the search would involve endless dissection of the so-called elementary particles, finding more particles, forever. This does not seem to be the case, and rather, there are ultimate parts with inherent nature (although see the caveats below). Due to the reductionist and unificationist process in physics theorizing and experimentation, we have found—at least in their domains—three apparently ultimate component classes (leptons, quarks and gauge bosons) of 16 kinds of particles which we believe to have no further structure (no parts), and also to have state-independent (intrinsic) properties. The caveats ‘in their domains’ and ‘apparently ultimate’ are due to the idea, which should be clearly understood, that a grand unified theory—if achievable—will possibly unite at higher energies our current separate classes of particles (more appropriately, classes of quantum

fields) as manifestations of more fundamental particles and fields, like a multisided coin. This new theory may provide some explanations for their characteristic properties, but may not be able to thoroughly derive them, and will almost certainly not be able to derive all the features of phenomena in all domains—although this is the fundamentalist wish. Hence, the above statement that ‘there are ultimate parts with inherent nature’ must be made domain-sensitive, and also we have seen that their ultimately inherent nature is inherently relational.

While we barely hinted at the nature of the vacuum, the standard model does refer to those intrinsic properties in terms of renormalized properties that involve interactions with the vacuum. In this case the measured mass or charge, for example, is due to the interaction of the actual ‘bare’ mass or charge—which is not measurable, at least at this time—interacting with the surrounding vacuum (which is not empty nothingness) to produce clouds of ‘virtual particles’ due to what is called charge polarization or the Higgs field interactions, respectively. We have not discussed this extensively both because it is complex and also since it is described by a set of developing effective field theories where details have yet to be worked out completely: A realistic interpretation of virtual particles in the vacuum is still somewhat controversial, and will be until (and if) the Higgs mechanism is fully understood. While such a situation would bolster our contention that elementary particles are still by their nature interactive (with the vacuum at least), we should not place too much trust in this conclusion based on the knowledge that we have at this time.

In any event, those vacuum interactions, even if real as determined by future EFTs or even GUTs, are in further high-energy effective field theories which are being

worked out with the help of current CERN research, and we can all read the news about the recent possible discovery of the Higgs field. In slightly lower energy scale-based domains, we find more secure understanding provided by mature, accepted, established and by all intents and purposes true effective field theories, in a hierarchical series of such theories working their way down to the extremely low energies of the furniture of our lives. This process takes us from simple systems to extremely complex ones, but as we go we find ways of interpreting the entities as having locally-determined unitary or composite natures, and perhaps even both, depending on context. Thus we find global epistemic and ontic relationality. We have found that there are particles in certain microscopic domains which have state-independent properties, but these should be considered to have merely *inherently relational* nature when we compare domains and consider all the relational contributions to those properties.

Our other two possible conclusions from the Madhyamaka interpretation were that all particles have relational parts, or that they are nothing but space. To the former, we have to remember that they are not particles at all: the basic ontology is quantum fields, and we perceive particles or classical fields, depending on the observational situation. Such fields do not have parts in any sense for which we have intuitive understanding, i.e. in terms of classical extensional mereology based on reductionist principles, locality and realism. Those bases for our intuition simply do not apply in quantum realms. We can arbitrarily (conventionally) discuss EM fields and ‘solid’ particles separately, but we must know that they are mere conveniences and are actually fallacious ways of talking. Hence, this conclusion option must be considered meaningless in a modern context.

For the option that ‘particles are nothing but empty space’, since we believe it highly unlikely from QFT that space is empty, but rather is composed of extremely high energy quantum fields throughout, and we know also from GTR that space is not empty due to the omnipresence of non-zero gravitational fields everywhere throughout the universe (and local spacetime *is* actually those local fields) it still may be the case that particles—or quantum fields—are nothing but space, at least in some notion of the meaning of that term that involves understanding how space can be our basic ontology.<sup>302</sup> This hypothesis, however, brings us to topics in the developing theories of quantum gravity. The paths to quantum gravity are different, but at the fruition should be a situation where particle and field—quantum and gravitational—all lose their meaning, in favor of string, loop or some other structure. This brings us finally to the last chapter.

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<sup>302</sup> See Cao (1999, 18-24) for a summary of the idea of a GTR-based QFT.

## CHAPTER NINE. PHYSICS OF CHANGE

### A. *Introduction*

We continue to examine inherent and relational natures as an application of Physics Pluralism, in this chapter in regards to time and change: persistence vs. impermanence. In *Chapter Two: Madhyamaka* Section E we discussed Abhidharma insistence that all phenomena were impermanent and momentary, while Madhyamaka argued against discrete momentariness as an argument against inherent nature. Hence, by Madhyamaka arguments, there is no discrete time and no discrete phenomenal existence with either causal independence or mereological unitarity that can provide a reductive basis to generate persistent phenomena with inherent nature. Yet, phenomena are impermanent. In that chapter it was suggested that the Madhyamaka critique could be regarded as a rejection of discreteness, leaving us with continuous change. However, with any kind of change we come face-to-face with Leibniz Laws: A change of properties entails a different entity, and different entities entail different properties. In *Chapter Three: Metaphysics of Dependence* we concluded that only essential change should come under that directive. Hence, examining the relational and non-essential changes to, e.g. a vase sitting on the table, in order to justify the view that the vase is impermanent, not persisting for even a moment, we had to appeal to mereological essentialism and mereological reductionism, which is, however, contrary to the general anti-reductionist perspective of Madhyamaka.

In this chapter we examine these issues from the point of view of physics. We are concerned with the nature of time and with the occurrence of entities within time, and therefore need to know what time is. In Howard's (2005, 236) analysis of the

endurantism vs. perdurantism debate (endurance of objects that are 3D or 4D, respectively) in the context of objects as modeled by classical physics (either point particles or extended continua) he writes “‘Persistence’ is the neutral word for the undeniable fact that objects are not instantaneous: objects, or at least most objects, exist for a while. The debate is over how to understand persistence.” However, as discussed in *Chapter Five: Metaphysics of Change*, if we view the classical extended object as four-dimensional with instantaneous stages—the 4D-stages view—the object exists in four dimensions, while each stage is instantaneous, and each stage is what is ‘fully present’ in only the present moment, and does not persist, thus corresponding to the presentist view. The main justification for adopting a 4D view of classically-modeled objects is twofold: first, to avoid puzzling violations of Leibniz’ Principles, since a 3D object changes properties over time yet according to much Western philosophy the ‘same’ object endures. We then have puzzles of material constitution, coincident objects and vagueness, as discussed in *Chapter Four: Metaphysics of Composition*. If 4D, the object perdures (exists in extended space *and* time) and successive temporal parts or stages may have different (even contradictory) properties, hence no puzzle entails. If we look at a simple object such as a rock in various domains, such as those of classical electrodynamics, non-relativistic quantum mechanics or quantum field theory, we have a variation of Heraclitus’ river: Internal constituents of the object are in continual motion, even appearing and disappearing to and from the vacuum, yet the ‘object’ persists. One way of viewing this is that the whole object is a conventional supervenience<sup>303</sup> on

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<sup>303</sup> Supervenience is usually defined as follows: “*Supervenience* is an ontic relationship between structures. A structure,  $S_x$ , is a set of entities,  $E_x$ , together with their properties and relations,  $PR_x$ . A structure,  $S_B$ , characteristic of one level,  $B$ , supervenes on a structure,  $S_A$ , characteristic of another level,  $A$ , if and only if the entities of  $S_B$  are composed out of the entities of  $S_A$  and the properties and relations,  $PR_B$ , of  $S_B$  are

constituents (as may be applied to the river), but there are also objective ways of considering the situation: (1) by structural realism it is the necessary structure of the object that persists, while parts may come and go; (2) conserved quantities persist; (3) by the environmental decoherence research programme theories<sup>304</sup> and George Ellis (2006) and Ellis and Rothman( 2009), discussed in a later section, even a macroscopic object is in a quantum entangled state that decoheres into the classical object in a sequence of discrete flashes that may be interpreted as 4D-stages. In fact, all of these three may be combined. The second reason to adopt a 4D perspective is to accommodate relativity, which most analysts argue is inconsistent with presentism without a 4D-stages interpretation.<sup>305</sup>

Analysis of these three options (presentism, endurantism and perdurantism) is frequently combined with or conflated with the dimensionality of the world. Relativity since Minkowski (1908) has dictated that the world of time and space is four dimensional spacetime, and presentism has been disputed in relativity's name, while the

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wholly determined by the properties and relations,  $PR_A$ , of  $S_A$ . One way to understand the relevant sense of 'determination' is as requiring that there be no differences at level  $B$ , say different values of a parameter such as the temperature of a gas, without there being a corresponding difference at level  $A$ , say in the mean kinetic energy of the molecules constituting the gas." (Howard, 2007). The problems with this, as Howard points out, is the 'wholly determined' relation, which is frequently idealistic and not actually computable. Also, this leaves open the multiple realizability such that differences in the entities  $S_A$  upon which the structure  $S_x$  supervenes may be significant, while the supervenient structure  $S_x$  demonstrates minor or even nonexistent changes. Hence, while the components of a river may change drastically, the same river may continue (if we adopt this convention), or while the quantum constituents of a rock may be in violent flux, the rock seems to be the same from moment to moment. Thus a same structure may supervene on different underlying structures, which is the structural realist position.

<sup>304</sup> See Schlosshauer (2004) for a review of the decoherence research programme, plus further references and explanation in footnote 263 in *Section C.2* in *Chapter Seven*.

<sup>305</sup> The classic arguments are in Rietdijk (1966) and Putnam (1967) and Stein's (1968) response discussed below, See Petkov (2006) in Dieks (2006) for a contemporary technically detailed and strong argument based on special relativity against presentism, but see Savitt (2006) and Dorato (2006) also in that volume.

4D view (both stages and worm) has found support from relativity. Yet it must be remembered that there are two general modern-physics modes of regarding spacetime:

- (a) that spacetime is best modeled by (a given aspect of) the solutions to the Einstein equations in general relativity;
- (b) that spacetime is best modeled by the ground state for quantum field theories of matter, gauge, and metric fields. (Bain, 2006:304 in Diets, 2006)<sup>306</sup>.
- (c)

These two modes are not generally mutually consistent outside of domains of quantum gravity which applies (in the Physics Pluralism framework) only in Planck scale domains, yet within the Physics Pluralism framework these two different theory-systems are segmented as applying to different domains, thus minimizing the inconsistencies.

Therefore, depending on the domain, a particular theory corresponding to one or the other of these modes may be utilized.

In domains where the theory of relativity and its models pertain, in reference to the issue of persistence the block universe perspective (that the world is four dimensional) is applied to support the notion that objects are four-dimensional. The block universe models spacetime as a four-dimensional manifold with no allegiance to the here-now, and is motivated by special relativity's perspectives on simultaneity which determine that 'now' is frame-dependent and general relativity's perspectives on the substantivalism of spacetime. The latter is that the local spacetime manifold (which with a metric, fully describes spacetime) is a dynamic and substantive entity identical to the local quantum field rather than merely a geometric coordinate system used to index events. Thus, informed by this view—especially the block universe—some philosophers say that the 'future is as real as the present'. However, careful attention to tense and the precise meaning of each of the terms in the phrase in that scare quote is quite necessary,

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<sup>306</sup> Although in some situations space and time may decouple. For example, see Durkee and Reall (2011)

as we pointed out in *Chapter Five: Metaphysics of Change*. The block universe view resolves some of the puzzles relating to persistence, but the notion that an object perdures as four-dimensional (without allegiance to the present as a unique temporal slice) rather than endures through time as three-dimensional is counter to both common sense and some more cogent theoretical arguments, so there are costs related to this view. The block universe is frequently interpreted as a fatalistically determinist worldview. While the determinism of the block universe is supported by some very good arguments,<sup>307</sup> it is still quite controversial, and is disputed by arguments that I judge to be more convincing.<sup>308</sup>

At the heart of the question of an object's persistence must be an understanding of the object's identity altogether. For domains of classical mechanics and dynamics neither identity nor persistence are problematic: Objects may persist. As far as the physics is concerned, classical objects may certainly persist for many moments without any change whatsoever, and may then be destroyed in some other moment.

In domains of more fine-grained classical and quantum physics the issue of identity in one moment and change in a subsequent one is substantially different than in the less fine-grained domains of classical mechanics and dynamics. In the fine-grained domains of classical and quantum electrodynamics and the effective field theories of condensed matter physics and quantum field theory, we see change and continual flux, with constant vibration, exchange of atomic constituents, and at higher energy scales even annihilation and creation of 'particles'. There is chaotic vacuum 'foam' (Wheeler, 1998) exhibiting continual coming and going of virtual and real particles. The 4D block universe picture uses worldlines (or extended worldliness called worms) that track the

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<sup>307</sup> Rietdijk (1966, 2007), Putnam (1967), Petkov (2004, 2006, 2007, 2009), Balashov (1998, 2000, 2005)

<sup>308</sup> Stein (1968, 1995, 2008), Gilmore (2002, 2006), Clifton and Hogarth (1995).

entire life history of an object (where ‘history’ has no allegiance to the present, thus includes what we normally call ‘future’) from creation to destruction. But if constituents are coming and going, then such a picture would rapidly entail a maze of intersecting, interconnecting and diverging world-lines such that identity of ‘objects’ through time would become impossible. The idea that quantum particles, fields or systems persist—through either endurance or perdurance—becomes highly problematic when not only the properties but also the particles themselves—individually and as constituents of larger systems—disappear and appear in apparently (and actually) random fashion.

However, while coming and going in apparent random fashion, that coming and going also is consistent with the most central principles of physics that (apparently) apply in all domains: symmetry and conservation. These principles characterize the individual particles or system that is to persist as a carrier of conserved quantities, thus the issue of persistence of objects becomes the issue of persistence of conserved quantities (which is what conservation means), while objects come and go. With this perspective we can understand what it is for a macro-object to persist, while its micro-constituents even though the latter are in chaotic change or even annihilation and creation.

This view solves Heraclitus’ problem without resort to mere convention. The convention-solution is that the river is what we say the river is, or how we use the river, etc. regardless of its composition or other properties. The structural solution is that the river is has structures and properties that persist even while the composition and other properties change. The two solutions correlate when we agree that the river is what we say the river is and we define it as such because it has necessary and essential structural properties that persist. This solution to the problem of persistence can be viewed as a

variety of structural realism where the structure of an object *as a whole* is what must persist in order for the object to persist. The main point is that even though there are subtle changes going on in the microscopic parts of a macroscopic object, those changes may not be necessary or essential to the identity or relevant nature of the object. We can therefore conclude that in those situations it is quite possible for the macroscopic object to persist. The alternative is an extreme mereological essentialism and reductionism which, however, is a view that is defensible in some situations, yet arguably not in many other situations. In particular, the ‘essentialism’ must be stressed, rather than the ‘mereology’, as previously indicated: what is essential to the identity of an object must be considered.

An alternative view would be taking results of the quantum decoherence programme seriously, and especially naturally occurring entanglement and environment-induced decoherence, as reviewed by Schlosshauer (2004) and incorporated with relativity by George Ellis. Many naturally occurring objects, such as hadronic collections of quarks, atomic collections of nucleons and electrons, molecules and even macroscopic entities of certain types (such as our crystal rock) under certain circumstances (essentially, between interactions) must be understood as quantum entangled systems.<sup>309</sup> It should be noted that for macroscopic systems, such as our rock, at any significant temperature above absolute zero there will be sufficient interactions to decohere the system on a time scale well below measurement, hence the theories describing entanglement of macroscopic entities at room temperature should be considered unverified, hence in our ‘developing theory’ category. Thus, this alternative view

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<sup>309</sup> Superconductivity, for example, should be considered a macroscopic, quantum entanglement phenomena stemming from interaction of the Cooper pairs of entangled electrons.

incorporates some speculation, and as it is in the closing chapter of the dissertation it is appropriate to indulge. However, the fact that "...the ability to create entanglement merely by cooling an interacting quantum many-body system..." (Cramer et. al 2010, 2) provides some indication that the theory is sound, and actually these phenomena are a basis for the theory.

Even if these theories are true, however, it does not mean that all of a sudden we must understand all phenomena to be in quantum domains. In fact, as long as there are interactions entangled systems decohere, and it is hard to produce a macroscopic or even decent sized mesoscopic system without interactions for even a nanosecond. In George Ellis' theories (discussed below) this is how the classical world is generated from the quantum, and the classical world should be interpreted as a set of ontic domains distinct from those of quantum phenomena.

Entangled systems remain entangled until either interaction with other 'traditional' entities or until interaction with background vacuum quantum fluctuations. See GRW (1986) and Penrose (1989, 1994). Penrose calls his theory 'objective reduction' or OR, as one of what Schlosshauer classifies as the environmental decoherence theories, which would include GRW. Macroscopic entanglement is called a macroscopic quantum superposition (MQS) state, and there has been an intense effort to understand the possibility of using such states in, for example, quantum computing. See Martini and Sciarrino (2012). Upon decoherence, separable objects emerge. According to the GRW and OR model, some systems may go immediately back to being entangled, and then decohere again. The fluctuating entanglement-emergence sequences could be interpreted as sequences of momentary existence or as sequences of 4D-stages in a

persistent 4D object. For a small system of molecules this process could take a long time since there is not much to interact with, but for our rock the moment from coherence to decoherence and back again could be  $10^{-30}$  of a second. Remember, any interaction would flash it out of entanglement, and the larger the object the more opportunities for such an interaction. Then the system interaction entangles it again. This situation exhibits an extreme discrete momentariness—in support of Abhidharma and contrary to Madhyamaka—and accompanied impermanence of all objects that may be entangled. Understanding this situation requires a synthesis of relativity with structural realism, conserved properties and symmetry principles, and entanglement-decoherence as embodied in George Ellis' *crystallizing block universe*. Due to the interaction between matter and spacetime, as objects crystallize from their entangled state to their decohered states, so also does time past crystallize into the present, but it does so locally. Thus, global present time—the now—will have a global duration, even though in one location the decoherence is instantaneous and a precise local present results. In other words, the undetermined future crystallizes into the determined past during the locally-defined present corresponding to the time when local systems decohere. We discuss Ellis' view in Section D.3 prior to the discussion of quantum gravity that closes our chapter. We begin with analysis of much 'simpler' situations, moving from classical domains to quantum and relativistic ones as we seek persistent objects.

## ***B. Persistence in one frame of reference***

There are many complications in comparing events which occur in frames of reference that are moving in relation to each other, or to frames which are in different locations, and those complications will be addressed in later sections. The simplest situation would be to first limit our concern to events in different times but the same location in space and in the same frame of reference. For example, consider our favorite rock. The question is whether the rock persists.

### ***B.1. Domains of classical mechanics***

We begin by confining our discussion to domains of classical mechanics—relativistic and non-relativistic. Are these domains ontic? As a particularly relevant example which serves to point out key motivations behind some of the key points of Physics Pluralism, consider classical non-relativistic dynamics of trajectories ‘well below’ the speed of light. Remember, relativity is also a classical physics theory, in that it posits precise values for all variables in all situations, as opposed to domains of quantum mechanics for which certain parameters of entities in certain situations do not have precise values. As mentioned, regardless of the fact that classical non-relativistic dynamics is used in innumerable instances in many real-world applications without consideration of special relativity and still gives accurate predictions, it has been found to require a relativistic correction for velocities as low as 10 m/sec, and in consideration of the general theory of relativity we find that gravitational differences due to differential distances above Earth’s surface of only 1 m. (Chou, 2010). Hence, the theory provides a good approximation for many purposes, and is empirically adequate for many questions, but its answers are clearly only approximate in all domains for calculations involving

velocities and gravity—although the error signal may be well below the noise of the rest of the measurements (they are in the 8<sup>th</sup> or later decimal points of Chou’s measurements). We also know that the foundational principles of relativity identify objects and their relationships, as well as the nature of spacetime, differently. Since there is no simultaneity, and since space is not flat, we know that classical non-relativistic mechanics is false when these features are relevant, hence defining domains in those theories is a pragmatic and/or conventional, epistemic exercise. However, relativity does not suffer from these problems, and only has issues in its relationship to quantum mechanics. We may consider classical objects as the result of a quantum decoherence, hence we have symmetry breaking as an objective demarcation between what is classical and what is not. Therefore, we can consider many domains of classical relativistic mechanics to be ontic, and integrations of the special theory of relativity and quantum mechanics result in some ontic effective field theory domains, as discussed in the previous chapter.

Now we search for persistent entities, and consider different cases, from the mundane to the exotic.

**Case 1: No time limits, stable objects.** In domains of classical physics, which includes STR and GR, but excludes QM, if there is infinite expansion of the universe, or if an equilibrium situation is reached, then it is vaguely possible that at least some rock-types somewhere might stay in their current form forever. If the rock is made of stable isotopes that also do not sublime to gaseous form, is hard enough to resist the ceiling falling on it when the house decays, and has high enough melting point to resist change if the house burns down; if the sun doesn’t explode, magma doesn’t envelope the rock, the moon’s orbit doesn’t decay and crash into the Earth, etc., then one could imagine that the

rock may last forever—or at least a very long time—in its current form. It would be hard to imagine that it could do so without losing an atom of its composition, and then we would have to take a philosophical stance by denying mereological essentialism through utilizing structural realism in determining that this lost atom was not essential to the rock if we wished to be assured that it is the ‘same’ rock; or we would have to create an elaborate definition of similitude, thus entangling ourselves with problems of change in material constitution, vagueness and temporary intrinsics, as we did in *Chapter Five: Metaphysics of Change*. But it is possible to conceive of the situation that not even an atom would be lost, although this stretches our scientifically-informed imagination. The rock will change in many different characteristics. If there is entropy death of the universe things will get mighty cold, but this property could be considered extrinsic—it is not essential to the rock being the rock it is to have any particular temperature, just as it is not necessarily essential to two hinged planks of wood to be bent or straight. As its temperature changes, so also do its physical properties, but those are relational properties, and are not necessary, essential and intrinsic to the rock qua rock. Of course, at great heat the rock will melt, and that should be considered change in intrinsic properties, and there may be superconductivity phenomena near absolute zero which would entail intrinsic change: superconductivity and melting entails drastic qualitative differences in the properties, chemical, compositional, and physical, while temperature changes within a moderate range (defined by the intrinsic properties of the rock) only involve relational properties. The distinction between relational and intrinsic properties may sometimes be ambiguous, but may frequently be clear-cut, and we can stay in the latter range for our purposes. (For example, we are not considering liquids, gases and plasmas since solids,

and particularly crystalline lattice structures, are more well-defined.) Instead of our rock sitting on the table, we could consider a lone stray asteroid sitting in intergalactic space, and we can more easily imagine infinite persistence, within the limits of universe evolution.

**Case 2: Some time limits, stable objects.** How about simply a week? It is easy to imagine—and we could test it—that the rock could persist without *apparent*, *macroscopic* change for a week, month, year or a few years. Or for a day, hour, minute or second—or simply two moments. It seems possible to have persistent and even ‘effectively’ permanent, entities—by ‘effectively’ is indicated that we are considering very long times. Even if we assume that our sun will expand to a red giant and consume everything on earth, the idea that everything on earth will be destroyed in millions of years seems irrelevant: in these domains macroscopic objects may indeed persist for quite a while, and many do.

### ***B.2. Classical electrodynamics, thermodynamics and statistical mechanics***

**Case 3: Our favorite rock again:** A rock in domains of these theories is a system of many ( $>10^{20}$ ) atoms, molecules and/or ionic atomic cores bound in a lattice by electromagnetic fields which must be understood to be material and which permeate the entire unity of the rock. Additionally, there may be a large number of free and roving electrons. The atoms vibrate in their lattice, and there are associated fluctuations in the electromagnetic field, dependent on various conditions. There may be ‘flows’ of heat, i.e. transfer of heat throughout the rock, depending on further conditions and the particular details of internal structure. There is movement, change and flow, and we must ask if the rock persists or if it is a different rock for each change.

Consider rock  $R_1$  at time  $t_1$ , with ‘nature’ represented by  $A_1=A_1(x_{1,1}, x_{1,2}, x_{1,3}\dots x_{1,N})$  and rock  $R_2$  at time  $t_2$ , with nature  $A_2=A_2(x_{2,1}, x_{2,2}, x_{2,3}\dots x_{2,N})$ , where the  $A_t$  are functional representations of the nature of the rock at a given indexed time as itemizations and further functional dependencies of properties  $x_{t,i}$ . In order to identify  $R_1$  and  $R_2$  as being the same rock it would be necessary to have a causal relationship between the itemized properties, but by itself this requirement would not be sufficient for such identification. There will be other conditions which will very rapidly bring us to vague notions which require conventions of similitude or structural realism. One may wish to impose a strict mereological essentialist position that any change in characteristics—and there always will be changes when the object is examined in these merely pragmatic and ontic representational domains—entails that the rock does not persist. This convention would not be problematic from the point of view of non-relativistic physics—although it is not currently a metaphysically favored view. The more common view is that the rock persists, thus ‘a rock at time  $t_1$ ’ and ‘a rock at time  $t_2$ ’ without drastic and obvious changes *is* the ‘same rock’ iff (1) internal structural changes are insufficient to modify essential and intrinsic chemical and physical properties, e.g. chemical composition and molecular structural organizations, total mass (even give or take a few atoms), density, melting point, etc; (2) if there is a causal connection between the rock at those two times enabling a continuous identification of the rock in each intervening time according to the previous criterion; and (3) even if relational, accidental, non-essential (non-intrinsic) properties change. As far as the physics in these domains is concerned, there are no obstacles to applying either philosophic view.

However, there are insights to be made through application of theories in other domains which involve us with issues of symmetry breaking, supervenience and emergence based on quantum entanglement and subsequent wave function collapse, and the nature of spacetime. We saw that a crystalline rock is a strictly bound lattice structure demonstrating symmetries which indeed may be broken by a hammer, heat or pressure, yet those symmetries enable us to treat this entity as a unity. We could say that if a part transforms into another identical part, with a momentary gap, that there is now a new and different entity. Or, we may say that the change was inessential to the structure as a whole. Let us continue to look with quantum theories.

### ***B.3. Quantum field theory***

**Case 4: A solitary proton.** From the results of the previous chapter, we can be fairly assured that there are numerous ontic domains pertaining to effective field theories that are part of the standard model of particle physics (STR-based QFT) and condensed matter physics. As a proxy for a number of somewhat similar entangled symmetric systems, consider the lone proton. The SM predicts that protons eventually decay. However, through elaborate underground experiments with huge pools of water (thus full of protons) no such decay has ever been found, and it has been determined that if protons do decay then their half-life is longer than the current age of the universe—thus indicating a requirement for the mature effective field theory governing this energy scale. It is reasonable to say, therefore, that protons are relatively persistent. They may combine with other ‘particles’, and in combination they will change in essential ways—recall that quantum ‘particles’ are not really particles: They just manifest as particles sometimes and as classical waves sometimes. Actually, they are quantum fields and when they ‘combine’ they become entangled into units and the constituents then lose their individual

identities. However, a single unitary proton, alone in the low-energy void (and there are assuredly many such entities out there in the enormous space of the universe) may persist forever unless there is a ‘big crunch’ deflation of the universe, in which case it may simply persist for a very long time.<sup>310</sup> It may be suggested that being a composite object when examined in domains of high energy—thus as composed of quarks in continual motion and interaction with their gauge bosons (the gluons) in ‘virtual’ (yet real) creation and annihilation—entails the proton being a dynamic, changing entity, being annihilated and created anew in each moment. However, in relation to the interpretive framework of Physics Pluralism this view of protons must be limited to high-energy domains of the effective field theory called quantum chromodynamics. In lower-energy domains the proton is a unitary whole, bound by its symmetry as an entangled system. The symmetry may be broken, enabling us to see the quarks, only at much higher energies. The proton in low energy ontic domains may continue as such, unchanged, forever—or nearly forever, just as the rock in domains of classical mechanics and many domains of dynamics. These entities may change relational properties such as position and velocity, but they will not change intrinsic or essential properties, hence should be considered persistent. Of course, even a lonely proton must be immersed in a background of electromagnetic and gravitational fields, material energy which permeate the entire universe, plus the quantum vacuum background field. Yet, there is nothing to entail essential change of intrinsic properties in the proton due to minor, low energy variations in these fields. True, the vacuum may produce sudden, high energy variations in short

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<sup>310</sup> However, see Carr and Coley (2011) for a discussion of the persistence of black holes through universe collapse and expansion.

time that could drastically alter our solitary proton, but then again it may not. Unbound, lone protons should perhaps be considered essentially permanent.

However, they are certainly persistent through a very, very long time, and that is sufficient to argue against Madhyamaka. Recall that the latter argues that nothing lasts even for a moment, and protons certainly do, unless we utilize a mereological reductionism of delving into deeper domains of the effective field theories of QFT like quantum chromodynamics. There, a proton is a composite of quarks which are continually moving at high speeds (such that most of the mass of the proton is a result of the relativistic mass of the component quarks) and gluons running this way and that. However, if we use this technique of going into a higher-energy domain of entangled quantum fields in order to demonstrate impermanence, we are both denying Madhyamaka's prime directive against reductionism and also ignoring the unity that entanglement provides. The proton is not made of parts: it is a unitary entangled system. It is just that when targeted by high energy particles the entanglement-induced symmetry is broken and we can see evidence of quark structure. But when the entanglement-induced symmetry is broken, the proton is no more. The proton, when it exists, is a unity, and the fact that it can be destroyed is not sufficient to say that it is impermanent in the Madhyamaka sense.

#### ***B.4. Intermediate conclusion***

From these case studies, we would conclude that certain entities do, indeed, persist, unless we adopt one of the following possible alternative conventions: (1) *Any eventual change of any sort, intrinsic or extrinsic* entails annihilation of the old entity and creation of the new. This extreme mereological essentialism informed by Leibniz' laws—that any change entails a new entity—is implausible in light of what we have

discussed about the essential properties involved in the identity of an entity in Chapter Three and Chapter Seven. However, we must also recall how many, if not all, essential properties are essential only in relation to a particular domain, while in other domains those properties are relational. These issues relate to the topics of supervenience and emergence, to which physics may contribute, and to which we turn next. (2)

Alternatively, a different view of time may entail, suggest or at least allow momentariness, continual impermanence or persistence. It may be that time itself is momentary, and *everything* is new each moment, as a presentist may suggest that there is something *objectively* different and special about the present. In this case, nothing persists from one time to the next, since time itself does not persist and all entities must be indexed to their time—the *entity-time* is what exists, not the *entity* by itself, as indicated by the adverbial solution discussed in *Chapter Five: Metaphysics of Change*. This possibility relates to the problem of the dimensionality of the world, whether it is 3D or 4D, whether objects exist through time, or whether time itself persists. Hence, a notion of the nature of time is necessary to ground this discussion. Relativity has much to contribute in order to decide which perspective corresponds to the world as physics describes it, and we will turn to it after our discussion of structuralism and emergence. Without a presentist view of time itself, adopting a theory of time embodied as a flow of future into present and past, justification of the persistence of objects through time would be substantially easier.

### ***C. Structuralism, supervenience and emergence***

We discussed these topics in several contexts in this dissertation,<sup>311</sup> and they also have relevance to persistence. The question was expressed by Heraclitus: if the constituents of an entity change over time, does the same entity persist? One way in which it may do so is through a structural realist-informed view similar to some forms of supervenience,<sup>312</sup> and another is through emergence. As discussed in Chapter Five, Haslanger notes that for there to be an entity which persists “there are distinct times  $t$  and  $t'$ , and there is an  $x$  such that  $x$  is wholly present at  $t$  and  $x$  is wholly present at  $t'$ ” (1994, 341). The question for this section is whether it is possible for the same entity to be wholly present if all of its constituents are exchanged for other instance-tropes of the same constituent-type. The entity in question may be our lonely rock, and the constituents would be its atoms that are composed of the elementary leptons, quarks and gauge bosons that are annihilated, while new ones that are identical are created in their stead. But recall that quantum particles are indistinguishable, hence it is not possible to identify which particle is present. However, it is possible to know that a particle was annihilated and another just like it (or the ‘same’ one) is created. Since ‘same’ and ‘different’ lose their meaning for quantum particles of the same type (by same type is meant with the same state-independent properties, e.g. charge, mass, spin and other conserved quantum numbers) we can just say that a particle was annihilated and then recreated. Recall from *Chapter Seven: Physics of Dependence* that there is no violation of conservation

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<sup>311</sup> See also footnote 303 at the beginning of this chapter.

<sup>312</sup> Supervenience which allows for changes to the constituents without attendant change to the supervening structure would qualify, but some define supervenience to require different supervening structures for any change of a constituent, which is a form of mereological essentialism.

principles, hence conserved quantities are retained, and therefore the choice between ‘annihilation and creation’ or ‘transformation from one form to another’ to characterize this situation is moot.

Through all of this quantum foam chaos, the properties of our rock (assuming it has only stable isotopes, which is quite plausible) will not change from one moment to another. The question is whether the rock is the same rock with an electron-positron pair missing from its constitution for a moment, being replaced by a photon pair, for a moment—would that essentially change the rock?. Hence, it comes down to how we define the rock: It seems to be inessential to the nature of the rock to require that it have a particular constitution. I propose that all intrinsic rock-properties supervene on a number of different constituent varieties—hence a multiple realization sort of supervenience from many constituent constructions, each viewed as non-essential to the one essential supervening structure. This view is embodied in the phenomena of decoupling discussed in the previous chapter.

For a large range of substances, from a reductive point of view an entity’s intrinsic properties (its chemical and physical properties) will supervene on the micro-properties such as the type of molecule (e.g. SiO<sub>2</sub> in silica), rest mass of the substance (the total number of molecules, independent of temperature, relative velocity and other energy factors), and structural arrangement (e.g. tetrahedral ordering with specified bonding arrangement of Si and O atoms). Given the same chemical composition and structure, etc., a number of things may change and the rock can have the same intrinsic properties. Those irrelevant changes should, it seems, include the number of electron-positron pairs. From the Physics Pluralism point of view, the entity’s essential and

intrinsic properties in domains of classical mechanics are those which characterize it as a unity in relationship to certain mechanical and dynamic phenomena, and those physical properties are decoupled from the detailed nature of micro-properties for those phenomena.<sup>313</sup>

One way to look at existence and persistence is to consider an ‘object’ *to be identical with* its structure, and object’s structure persisting as being the same as the object persisting. This is the generic structural realist position. Another view is emergence based on the decoherence programme interpretations of quantum mechanics, as previously mentioned. It is not clear how to justify the conclusion that an entangled system is the ‘same’ as the object made of its constituents before or after the entanglement event, or any kind of spontaneous symmetry breaking—there is statistical causal determinism connecting the entangled to the decohered state, but violations of local realism in the system entail a view of the unitary object becoming composite and then becoming unitary again, which is somewhat puzzling. Yet, it is not clear how to avoid the conclusion either: We can identify the unity and the constituents and then the unity in a causal sequence. Again, this identity problem seems to be more a matter for convention than physics—it pertains to relevance, pragmatics, usage and philosophical stances rather than physics. Such successive entanglement and decoherence would be justification for both a presentist view of lack of persistence as well as for 4D-stages perdurance.

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<sup>313</sup> See Howard (2007) for distinctions between intertheoretic reduction, supervenience and emergence.

## **D. Relativity**

### **D.1. Special Relativity**

Special relativity, which is in a domain without consideration of gravity or other accelerating frames, is based on two postulates:

(R) *Principle of relativity* (Galileo): No experiment can measure the absolute velocity of an observer; the results of any experiment performed by an observer do not depend on his speed relative to other observers who are not involved in the experiment.

(U) *Universality of the speed of light* (Einstein): The speed of light relative to any unaccelerated observer is  $c = 3 \times 10^8 \text{ m s}^{-1}$ , regardless of the motion of the light's source relative to the observer. Let us be quite clear about this postulate's meaning: two different unaccelerated observers measuring the speed of the *same photon* will each find it to be moving at  $3 \times 10^8 \text{ m s}^{-1}$  relative to themselves, regardless of their state of motion relative to each other. (Schutz, 1985:2).

(V)

An alternate statement of (R) is:

(R') [*Principle of relativity* (Galileo):] The laws of nature are the same (or take the same form) in all inertial reference frames. (Friedman, 1983:149).

The Relativity Principle is generally considered to be “theoretical and conceptual” (Born 1924, 225), although none of its empirical predictions have ever been violated by any experiment, and the second (U) is explicitly considered an empirical fact, and also has never been violated. There seems to be an inconsistency between the two, which is resolved by the Lorentz transformations (Friedman 1983, 149-159). The relevance to persistence is a result of the following principle that is derived from those two postulates:

(S) *Relativity of simultaneity*: judgments of the simultaneity of events will vary according to the state of motion of the observer. (Norton, 2010a).

(T)

This means that if I am in one inertial frame and you are in a different one traveling with non-zero velocity relative to me, then our judgments of which events are simultaneous will, in general, be different..

The result of these principles that are relevant to this dissertation is the concept of the block universe, which represents spacetime as a fixed whole, a 4D structure existing in its entirety. This "...suggests the flow of time is an illusion: the entire universe just is, with no special meaning attached to the present time" (Ellis 2006, 1797). A conclusion of universal determinism and fatalism has been suggested from this result obtained from special relativity, as mentioned previously (see footnotes 307 and 308 for references).

While there does seem to be sufficient justification from special relativity for believing that objects are 4D, they may exist in each moment as 4D-stages which correspond roughly to the presentist view as we have described it. Incorporating classical and quantum indeterminism to the 4D-stages view would obviate the fatalistic conclusion, and allow change and even lack of persistence, as presented by George Ellis and discussed below. As summarized by Balashov and Janssen (2003, 328-9, fn.1) "The advocates of the [4D *stage* theory] (see, in particular Sider, 2001 and Hawley, 2001)<sup>314</sup> have argued that, among other advantages, their theory offers the best unified solution to the paradoxes of material constitution and coincident entities and to the problem of vagueness." In domains of classical mechanics (even if the domain is considered merely pragmatic), relativity would not pertain, hence the major justification for the 4D view of time and persistence does not pertain. Yet, even if we are discussing relativistic domains, whether we have the view that (1) objects do not persist for more than a moment; or that (2) objects perdure in four dimensions but there are 4D-stages that do not persist for more than a moment, there seems to be little justification in the physics for deciding on which view is more appropriate, hence is left largely as a matter for semantics and convention, and not physics. The only justification in the physics that I can find is that there seems to

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<sup>314</sup> Both of these were discussed in Chapter Five.

be some back-time communication, i.e. communication from the present to the past, at least for very small intervals of time. This communication has been inferred from the delayed-choice EPR-Aspect experiments exploring the quantum measurement problem. With such a back-time communication, one must either think that there are more times than just the present, or that the global present has a non-zero finite duration.

George Ellis and Rothman (2009) argues for a present time as the divider between the determined past and the undetermined future: The present is when the immediate future becomes the determined past. While locally the present is defined as a point of time, global time has a duration, since the present is defined by decoherence, and different systems decohere at different times. He finds justification for temporal asymmetry in domains of Newtonian classical chaotic systems, special relativity and general relativity, even though much temporal asymmetry supervenes on the time-symmetric classical physics. Even apparently classical systems can exhibit indeterminacy. For example, a breaking wine glass is an instance of the impossibility to predict the future position of each shard, and also the impossibility to postdict from where the resulting placement of such shards initially came from. Such a simple example shows how no time-symmetric equation can describe how those shards can get back into the glass. However, I would argue that this is not a classical system—the wine glass is in a quantum-atomic structure with symmetry properties that are broken by the crash, and the indeterminance from that situation entails the particular results which become the configuration of shards. Another simple example of our failure to postdict is a block resting on a table: Was it just put there, had it sat there for years, was it placed there or

did it slide there and come to rest (and if the latter, from which direction)? We cannot postdict this situation.

Ellis views the global block universe as arising from energy-scaled averaging of local effects. Thus, he promotes the view of the *evolving block universe* in these domains. The 4D-stages of objects can then be understood as objects that exist in sequences of the present moment that evolve from the future into the past. We will first briefly mention how Ellis deals with this idea in domains of general relativity, and then follow with his integration of classical and quantum physics.

### ***D.2. General relativity***

“In this case [in domains of GR], the present is again represented as where the indeterminant nature of potential physical events changes to a definite outcome, but now *even the nature of the future spacetime is taken to be uncertain until it is determined at that time*, along with the physical events that occur in it.” (George Ellis, 2006:1813).

Leaving quantum gravity to a later section, below, the central feature of general relativity is that spacetime is not considered as a passive metrical container for events, but as a dynamic, interactive substance, the gravitational field. Thus a distribution of matter-energy will generate spacetime manifolds, and different manifolds will influence any matter-energy within it in different ways. Ellis continues:

A further major feature is that because spacetime is curved, unlike the special relativity case, *in particular solutions of the Einstein equations there are in general geometrically and physically preferred spacelike surfaces and timelike world lines*, related to the specific physics of the situation. These represent broken symmetries in the solutions to the Einstein field equations: the solutions have less symmetry than the equations of the theory. (1813).

In general relativity, as with special relativity, time has a relational nature without our Newtonian conception of simultaneity. One way of dealing with the situation is to do away with the notion of time altogether, as promoted by Rovelli:<sup>315</sup>

GR inherits from SR the melting of space and time into spacetime. Therefore, the relational nature of space revealed by GR extends to time as well. It follows that in GR there is no background spacetime and therefore in particular no time along which things happen. GR teaches us that we must abandon the idea that the flow of time is an ultimate aspect of reality. The best description we can give of the world is not in terms of time evolution. The dynamics of GR itself cannot be cleanly described in terms of evolution in time. (Rovelli, 2006:34).

Thus, general relativity is typically invoked as further justification for a non-presentist, non-flow type of time, but one more relating to events, hence McTaggart's B-series (our event-relational series) without an A-series (our present-relational). Yet time arises in thermodynamics and organic processes. Ellis has a different view which attempts to show how time in classical domains emerges from collapse of entangled states, thus supporting the view that what pertains to domains of quantum physics does not necessarily entail everything that pertains in classical domains, i.e. the pluralist view. We discuss Ellis' ideas in more detail in the next section, where he shows how the domains relate and integrate. Thus, in relativistic domains there is support for a 4D view of time, hence a 4D view of persistence, i.e. perdurance, either 4D-worm or 4D-stages, while in non-relativistic classical domains either a 3D presentist or 3D persistence may pertain.

### ***D.3 Emergence of classical domains***

Setting the stage for the integration of those domains, classically one can say that “the transition from the present to the past does not take place on specific spacelike surfaces; rather *it takes place pointwise at each spacetime event*” (Ellis 2006, 1813).

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<sup>315</sup> He is ignoring cosmology's acknowledgement of the preferred frame of reference determined from the cosmic microwave background radiation and quantum gravity considerations, discussed below.

Hence, we must index time to space, giving us ‘here-now’ rather than simply ‘now’.

“But...it is more convenient to consider the *evolution as taking place along timelike world lines*” (1813-14). However, there is a potential arbitrariness in the choice of world lines which would entail indeterminism. There are two choices: (1) arbitrary world lines; or (2) world lines “associated with a symmetry breaking that leads to the emergence of time” (1814). Ellis promotes the latter case. There are some models of cosmology in general relativity (Robertson-Walker) where, if matter is present, solutions form a plausibly unique physical evolution that is invariant under the spacetime symmetries.

“Then one might propose that the evolution of time is associated with these preferred timelike world lines and perhaps associated spacelike surfaces, being an emergent property associated with the broken symmetries represented by these geometrical features in curved spacetimes” (1814). We still have the problem of choosing among world lines. The evolution can be described along arbitrary families of world lines.<sup>316</sup> “A key result then is that no unique choice for these world lines needs to be made in the standard GR situation with simple equations of state; the ADM theory<sup>317</sup> says that “*we locally get [the] same result for the evolving spacetime, whatever world lines are chosen*” (1815). Note that temporal evolution is local, and in some sense arbitrary, and relate more with convenience and pragmatism than objective determination—although specific models such as the Friedmann-Robertson-Walker solution to the Einstein equations may generate a uniquely determined time variable. In our local world, with a relatively constant gravitational field, with a relatively flat spacetime curvature due to a modest sized stress-

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<sup>316</sup> “...corresponding to the freedom of choice of the shift vector in the ADM formalism” Arnowitt et. al, 1962 and Misner et. al 1975:520-528.

<sup>317</sup> Arnowitt, Deser and Misner; see Arnowitt et. al, 1962 and Ellis (2006, 1814).

energy tensor of Earth's mass, there seems to be no arbitrariness. We use descriptions that are natural to our domains.

Thus in the classical GR case, we get a consistent picture: things are as we experience them. Time rolls on along each world line; the past events on a world line are fixed and the future events on each world line are unknown. Spacetime grows as in the Newtonian picture, but now even the spacetime structure itself is to be determined as the evolution takes place... The metric tensor determines the rate of change of time with respect to the coordinates, for this is the fundamental meaning of the metric...A gauge condition<sup>318</sup> determines how the coordinates are extended to the future. Conservation equations plus equations of state and associated evolution equations determine how matter and fields change to the future, including the behaviour of ideal clocks, which measure the passage of time. The field equations determine how the metric evolves with time, and hence determine the future space-time curvature. The whole fits together in a consistent way, determining the evolution of both spacetime and the matter and fields in it, as is demonstrated for simple equations of state by the existence and uniqueness theorems of general relativity theory. (Ellis 2006, 1815).

However, the conventional formalism (i.e. ADM mentioned above) assumes that the micro-world is deterministic, but the QM description is not. Thus, “most models are *not* deterministic; irreversible unpredictable processes and emergent properties will take part in determining space time curvature” (1815). Ellis attempts to formulate time from a combination of general relativity and quantum mechanics, to which we now turn.

Many systems may be idealized as closed, such as the insulated container and room in our previous examination of thermodynamics and entropy, but there are no really closed systems to be found in the real world—they are idealizations that enable us to understand the world in segments that may then be integrated if and when needed. Merely pragmatic domains may be considered such idealizations, and are models of the true theories that also have ontic domains. As mentioned, if we are just concerned with simple mechanical or dynamic phenomena for many purposes, e.g. of a rock being propelled into the air, it would be ludicrous to go outside merely pragmatic domains of

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<sup>318</sup> Essentially, a measuring device.

classical mechanics or dynamics. However, there are many domains where different theories and models must be integrated. In a paper that ends with some speculation, Ellis and Rothman (2009) describe the indeterminance of quantum domains being “amplified”, just as in Schrödinger’s Cat, for example: Timing of radioactive decay controls the timing of firing a rocket engine—actually a rocket with two opposing engines that can propel the rocket in opposing directions—in otherwise empty space. With successive decays, opposing engines fire alternately. Wherever the rocket goes, spacetime is modified, and this would therefore be decidedly indeterminant. Hence, quantum indeterminance is “amplified” into domains of classical physics—of Newtonian, special relativity and general relativity domains. This modification of his *evolving block universe* is the *crystallizing block universe*, and it also has allegiance to the present as the time when the indeterminant future is *crystallized* into the determinant past. However, while in the evolving block universe the present was an infinitesimal moment, for the crystallizing version the global present has some temporal duration: Crystallization is formed through decoherence of entangled systems, and though it does happen instantaneously in each wave function collapse, it does so at different times in different systems in different local presents. All classical phenomena therefore exhibit such becoming of the future into the past during the finite durational global present, giving us an arrow of time. Providing an arrow of time—which is time-reversal invariance—for ensembles is contra Aharonov et. al. (1964), but it is supported by other theoretical models such as GRW, mentioned previously. This description provides a way in which domains of different theories may show how 4D-stages of objects may ‘become’, i.e. how the stages evolve.

#### *D.4 Quantum gravity*

In one sense, at least until recently, it could have been justified to think that quantum gravity (QG) was not (yet) science, since there is (probably) neither empirical verification of any of its predictions nor were there soon to be any, due to the extreme scales which concern it (Rovelli 2007). However, substantial progress has been made recently, and perspectives are rapidly changing. The reasons for these changes include “The explosion of empirical confirmations and concrete astrophysics, cosmological and even technological applications of general relativity on the one hand, and the satisfactory solution of most of the particle physics puzzles in the context of the particle physics ‘standard model’ on the other” (Rovelli 2007, 1288). Unification of these two, and/or extension of each into further domains, remain as a major focus of advancing physics. Since QG has much to say about the nature of space and time, at least in its domains, it is worthwhile briefly examining its relevance to our questions.

QG has grown out of the concern that our two best clusters of theories—QM and GR—utilize contradicting notions of time, space and observation, all somewhat fundamental to physics understanding. Hence, in another sense, QG is merely (!) an attempt to design a theory that is consistent with both of those highly verified theories, thus the evidence which supports those theories can be co-opted to QG. It was also thought that many different consistent QG theories would be generated, and due to the (presumed) lack of ability to generate evidence they would all remain within the representational ecosystem of possibilities without any empirical survival stress necessary to determine the fittest necessary to overcome the underdetermination objection to realism. However, since no consistent theory has yet been devised this has not been as big an issue as originally thought.

QM formalisms generally consider time as an external variable, and QFT specifically uses a fixed background spacetime that is explicitly non-dynamical. The non-dynamic nature indicates that spacetime does not participate in the equations of motion, but is merely a background coordinate system to arbitrarily mark all the activity. Neither of these two perspectives are consistent with GR, which utilizes Riemannian geometry to describe a spacetime that is not just affected by the gravitational fields resulting from local energy density, but actually is the gravitational field, a “classical, deterministic dynamical field”, the metric field (Rovelli 2007, 1288). Additionally, as we have seen, the cosmic microwave background radiation provides a universal spatial frame of reference, and the time of the initial inflation of the universe (at least according to some GR models) provides an origin time to which everything can be referenced. These cosmological coordinates make us question the global relativity on which the special-relativistic QFT theories are based.

QG should be able to describe phenomena which neither GR nor QM separately can describe. These include evaporation of black holes, the birth of the Universe and any phenomena at very high energies or on the small scale called ‘the Planck scale’, which is  $\sim 10^{-33}$  cm, about  $10^{18}$  times smaller than a neutron. Since these phenomena are on the extremes of even imaginable measurement, we must ask why this might be relevant to any philosophically significant endeavor. The answers are several-fold. First, again, a consistent conceptual framework would provide further confidence in the results of GR and QM, even if no further verification is obtained to confirm that what we have created is the only consistent QG. Hence, even if the consistent QG would simply break down into GR and QM in domains of those two theories and the un-separated QG would never

be directly utilized (if its direct domains are inaccessible to measurement) we would still obtain significant philosophical utility. Yet, it is also likely that such a QG would provide us with quite new ways of understanding space and time. Second, recent suggestions have been made that QG effects may soon be observable, or may already have been observable but remain un-interpreted by QM or GR. These phenomena include propagation of high energy cosmic rays, anisotropies of the cosmological microwave background radiation and anisotropies in cosmological density generally (Rovelli 2007, 1297).

This is all very interesting, but how might it pertain to the question at hand, which is whether phenomena have inherent nature or are relational, whether they are independent, unitary and permanent or dependent, composite and impermanent, and specifically in the context of this chapter the latter of these three components of inherent or relational natures. These all have to do with space, time and matter, hence QG is relevant to our conception of those in a fundamental sense, which is relevant in other domains if we have any allegiance to fundamentalism, as I have portrayed it here (hence is connected to the unification process described above). This alone makes the search for QG important and relevant. However, if we utilize a pluralist epistemic framework such as the one being promoted here, we must ask if QG is relevant. Certainly our understanding of the issues in phenomena of QG domains would be enhanced, and these would include, as mentioned, the very small, the very energetic and the very large. The latter includes the universe as a whole. First, we should realize that while Newtonian time is a universal independent variable that grows monotonically, in GR domains time is neither universal—it is a local notion determined by the local gravitational field—nor

independent. “In a sense, any partial observable variable can be chosen as the independent one in GR...For instance, in a closed cosmology the volume  $\alpha$  of the universe and the proper time  $t_c$  since the Big Bang, along a galaxy worldline, are often used as independent variables”, although they may not be used in all cases. “This weakening of the notion of time in classical GR is rarely emphasized...a single solution of the GR equations of motion determines a spacetime, where a notion of proper time is associated to each timelike worldline. In the quantum context, on the other hand, there is no single spacetime, as there is no trajectory for a quantum particle, and the very concept of time becomes fuzzy” (1317-18). The reason why the “weakening of the notion of time” in GR is not emphasized is that we can still have a temporal interpretation in classical GR, since a solution to the dynamical equations of the gravitational field (the Einstein equations) generates a local spacetime. However, this may break down in QG: “it may be impossible to describe the world in terms of a spacetime, in the same sense in which the motion of a quantum electron cannot be described in terms of a single trajectory” (1290). Thus, time may simply be a useful notion in an approximate understanding of physical reality.

I have not made any conclusions from what we know so far about possible QG theories. However, it does seem that a consistent and empirically verified QG could further support the view that phenomena are relational. We may find further support for the idea that even spacetime and the uncoupled space and time themselves—which are not necessarily phenomena—are relational. However, we may also find support for the final granularity of space, time and matter in strings or loops at the Planck scale, and that could be a fundamental inherent nature to all things.

## ***E. Conclusion***

In this chapter we examined whether all phenomena exhibit persistence vs. the idea that phenomena exhibit momentariness as promoted by Abhidharma or impermanence without momentariness as promoted by Madhyamaka. In Chapter Two we interpreted Madhyamaka arguments as denying discrete changes, consistent with its anti-reductionist and anti-atomist critique of other components of inherent nature and relationality, while promoting a continuous impermanence and continuous change. Quantum domains, however, do exhibit discrete values of dynamic variables and discrete changes, while classical domains exhibit continuous values and changes. As with the other two components, unitary vs. composite and independent vs. dependent, from the point of view of Physics Pluralism we have determined that not all phenomena must be considered to be impermanent. Indeed, some phenomena and some objects in some domains persist through time, at least as far as physics can determine: There are different locally apparent persistence, momentariness or impermanence characteristics found in different local ontic domains, and each is equally valid. There is global ontic relationality in that properties vary as phenomena vary among domains, and there is global epistemic relationality in terms of our explanatory schemes when we compare domains.

If we apply a 4D-stages view from our *Chapter Five: Metaphysics of Change*, i.e. that objects are four-dimensional yet have momentary temporal parts or stages, then there seems to be little difference between this latter and the momentary view, and if we make the stages continuous then we can have a continuous impermanence view. Hence, if we consider an object in *this* time to be an instantaneous temporal stage of its four-dimensional existence, then one should say that the object *as a whole* perdures in time

while each temporal part or stage is momentary, or as continuous stages flow. This variation of perspective seems to be more a semantic convention than anything substantial, i.e. we have found no particular justification from the physics to decide between the options of momentariness-presentism or continuous impermanence-presentism and 4D-stages perdurance. From the normal view of objects persisting in time, however, we must admit that some objects exhibit no changes in their essential and intrinsic characteristics, even over quite a long time.

In reference to the nature of time itself in regards to the general presentist view that places special emphasis on the present, Ellis' crystallizing block universe view incorporates relativity and quantum mechanics with an objective distinction of the global present as the moments when entangled phenomena lose their coherence, thus solidifying the past into a determined stasis while leaving the further future open.

## CHAPTER TEN. CONCLUSION

A fundamentalist perspective in philosophic discourse, philosophy of science and modern physics might be characterized as promoting the view that the terms, concepts and theories which we use should apply throughout all contexts. By this perspective there are universal answers to many questions of analytic philosophy, just as there are (or should be eventually if we ever discover them) fundamentally true theories of science that apply to everything, and that no other theories are true. In Chapter Six we have instead argued for a pluralistic understanding of the nature of physical, non-organic phenomena—Physics Pluralism. We justified this view with a non-fundamentalist model-theoretic semantics introduced in Chapter One and applied throughout Chapters Three through Five in combination with the semantic conception of scientific theories, justified and supported by Physics Pluralism by techniques and findings of contemporary physics developed over the past 40 years, as analyzed in Chapters Seven through Nine.

In Chapter Two we explicated an interpretation of Madhyamaka Buddhist philosophic views that no phenomena have inherent nature, which we deconstructed into the idea that no phenomena are causally independent, mereologically unitary or temporally persistent. We extended this interpretation into two areas: First, we have promoted a positive thesis which has been found to be consistent with some interpretations of Madhyamaka that all phenomena are relational. That there can be a positive Madhyamaka thesis is controversial, although Ruegg (2000) and my own reading<sup>319</sup> support the idea that there is one, and it is summarized in the statement by Nāgārjuna MMK24:18 that *sūnyatā* is dependent arising, which we have renamed relationality. Nāgārjuna's other statements that he holds no views is then interpreted to

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<sup>319</sup> Also at least suggested by Oetke (1991), if not fully endorsed.

mean that he holds no views concerning substantialist, inherent nature. We were then able to decompose relationality into different mutually interdependent components: causal dependence, mereological composition and temporal impermanence.

If Mādhyamikas applied a fundamentalist understanding, then they would argue that all phenomena, regardless of context, have no inherent nature and are relational. However, we find a fundamentalist view entirely anathema to Madhyamaka arguments, where the notion of different contexts is frequently mentioned in order to make us aware of the way in which things seem to be different when we look at them in different ways. The idea of contextualization, brought over from model-theoretic semantics and incorporated with the semantic conception of scientific theories, when combined with concepts from the effective field theories programme and condensed matter physics, including decoupling and symmetry and symmetry breaking, provides us with an understanding of the way in which many domains of philosophic discourse, physics theories and physical phenomena are essentially and necessarily domain-specific. Hence, it is not just how we talk about phenomena—the discourse and the theories—which are semantically and epistemically context-sensitive, but also the way phenomena ontically are. We therefore found numerous instances of global semantic, epistemic and ontic relationality, i.e., when comparing results among domains, even though we found instances of local inherent nature within particular domains. Due to the reliance on contextualization in Madhyamaka arguments, we determined this finding to be quite consistent with Madhyamaka.

Our Madhyamaka understanding discussed in Chapter Two concerning causal independence or dependence is that no causally independent phenomena can be known or

interact, since to know of something requires interaction and interaction cannot occur if something is causally independent. Hence, in this view at least all that we know, and for all intents and purpose everything that we know to be existent must be causally dependent. However, neither cause(s), effect(s) nor causal relationship(s) may be independent, hence we cannot justify saying that an independent entity caused an independent effect through an independent power. We found in Chapter Three that causal independence pertains to the presence of intrinsic properties that are not modified by interaction, are not relational, and are had by an entity in virtue of itself alone regardless of the presence or absence of anything else in its own possible world. We saw in Chapter Seven that there are state-independent properties such as mass, charge and spin that qualify as intrinsic properties of entities, and are conserved quantities. However, those properties interact with other entities, with the background vacuum quantum field and with the spacetime manifold, depending on circumstances and the domain, and are the result of relational interactions described within different domains. Hence, at least some properties which are intrinsic and independent in some domains must in other domains be considered interactive and relational. I express this as local inherent nature and local relational nature, respectively, hence when comparing across domains we find what I call global relationality. I have identified such global relationality with ultimate *śūnyatā*. In Chapter Seven we also discussed productive theories of causality, essentially that something new can be produced. We discussed how Nāgārjuna argued against such theories and preferred rather a dependence theory of causality that embodies interdependence or mutual dependence of one thing on another. Nāgārjuna's view has been interpreted to coincide with Hume's regularity theory of causality, essentially that

one thing follows another and that regularity is causality. According to this interpretation of Hume, regularity is the terminus of explanation, in that nothing further can be determined. In footnote 57 in Chapter Two I pointed out how that was not actually Hume's view, but regardless we found it insufficient to modern physics: further explanation is called for. While a productive theory of causality was still rejected by physics we did determine as more compatible a different dependence theory called the conserved quantities theory of causality. We also found this theory consistent with Nāgārjuna's view. The conserved quantities theory explains how certain conserved quantities such as mass, charge and spin are passed from one entity to another, from cause to effect. Perhaps further or even a final terminus may be determined in higher energy domains of the standard model of particle physics and quantum gravity, yet that research is still in progress in those developing theories. The general approach to causality as 'conserved quantities being exchanged' may be viewed as a universal theory of causality that is good in at least those domains that have been examined. Thus, the general conserved quantities theory of causality is a general principle of relationality that corresponds with *sūnyatā*, yet how it is implemented or instantiated in each domain may indeed be different, custom-designed to the domain under consideration. Thus, causality can be seen as a flexible pluralist concept within an overall general principle of relationality.

Our Madhyamaka understanding of composition is that since the normal furniture of our world of composite objects has no inherent nature, no coherent reductionist basis can be found to build such objects from parts that have inherent nature. Thus, Mādhyamikas reject the atomistic reductionism of Abhidharma philosophy. In Chapter

Four we analyzed similarly eliminative Western philosophies that accept a conventional existence of composite objects while rejecting their ontological existence, yet accepting the ontological existence of atoms. However, we found those arguments insufficiently justified. In particular, they ignored electromagnetic bonding that unit atoms into larger objects, and also ignored or at least gave insufficient attention to both the domain-specificity of scientific theories and even the domain-specificity of philosophical discourse. In Chapter Eight we found more support and precise definitions of the nature of ontic domains in terms of symmetry and spontaneous symmetry breaking that provide further ammunition for the pluralist view. Hence, we have unitary objects in some domains and composite objects in other domains, even of the ‘same’ object, yet still consistent with the global, cross-domain nature of semantic, epistemic and ontic relationality. In Chapter Eight we did find some relational features of elementary particles in some domains that provides interesting correspondence with the *conclusion* of *neither-one-nor-many* (e.g., EM or quantum fields as relational parts), even while that Madhyamaka *argument* cannot be utilized in the context of modern physics.

The Madhyamaka interpretation of change over time is that all phenomena are impermanent. Many phenomena exhibit change that makes impermanence undeniable. However, for some phenomena, such as objects not involved with obvious interactions, persistence is hard to deny. However, Madhyamaka denies all persistence due to implicit reliance on Leibniz Laws in combination with mereological essentialism, thus any change in any property of an object entails a new object. While changing relational properties are frequently included in this process, even if we are restricted to intrinsic properties the view is that there will at least be ‘subtle’ changes that entail impermanence—even though

the macroscopic object seems to not be changing and conserved quantities remain unchanged, there will be microscopic changes. We found this argument contrary to the anti-reductionist intension of Madhyamaka, and were not able to resolve the apparent tension. In Chapter Five we found that concerns about the problem of change in contemporary Western philosophy were resolved by invoking a 4D-stages view of the existence of entities through time, yet found presentism—which is more ostensibly consistent with Madhyamaka views—to be consistent with the 4D-stages view. However, in application of a pluralist view in Chapter Nine we found that some entities persisted in some domains while the same entity in other domains, and other entities, were impermanent. This situation was interpreted as a demonstration of global relationality, yet I argued that some things persist. We found that many of the arguments by Madhyamaka are arguments against discrete situations and for continuity in space, time and matter, which we interpret in this context as promotion of continuous change. However, consistent with the Abhidharma view that things are discretely momentary (a view denied by Madhyamaka) is denied, discrete change is undeniable in quantum domains, even though we cannot take this feature over into classical domains.

Madhyamaka arguments for the universality of relationality for all phenomena should, by this analysis, be understood as classic arguments applying archaic views of the physical world. *Neither-one-nor-many* in particular should be understood as inappropriate to any modern physics understanding. However, a more general relationality applied to modern physics and modern philosophy of science represented by Physics Pluralism may be considered a coherent view that even designates its own relationality to be relational. This feature may be seen from the idea that some objects exhibit non-relational inherent

nature within certain domains but the properties that are locally inherent are relationally dependent on the phenomena that defines the domain, and different phenomena define different domains in which the object exhibits relational nature. I consider this to be a modern example of the Madhyamaka śūnyatā of śūnyatā, the emptiness of emptiness, the relationality of relationality, as described by Nāgārjuna:

(MMK 24:18-19)

Whatever is dependently co-arisen; that is explained to be emptiness.  
That, being a dependent designation, is itself the middle way.

Something that is not dependently arisen, such a thing does not exist.  
Therefore a nonempty thing does not exist. (Garfield, 1995:304)<sup>320</sup>.

There is relationality in the physical world, relationality in our explanatory schemes designed to understand the world, and relationality in our semantic conventions used to discuss the world. Those three types of relationalities also are intimately related to each other. How we designate a category in which to identify kinds of objects (e.g. the quartz rock or merely the rock) determines how we are going to talk about the object, yet I argue (contra some Madhyamaka interpretations) that our discourse does not change the ontological character of the entities that are discussed. Rather, the nature of the entity is determined by its causally interactive nature in a particular domain, and this may entail that some properties are inherent, at least in that domain. However, some of those inherent properties within a domain may be inherently relational, and some may be globally relational when compared between domains. Additionally, the causally interactive phenomena being examined determine a theory-system which defines the explanatory scheme used to understand the meaning of those properties, phenomena and object within their different domains of discourse. .

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<sup>320</sup> My format changes. See Garfield 1995:304-308) for explication of these verses

May any merit that may have accidentally been gained from this research be dedicated to benefit all beings who wander in samsara without appreciating the journey.

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