A Platonic Defence of Realism in Quantum Theory

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy

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Contents

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Until I started on this venture four years ago, I did not really understand how much an author wishes to show her gratitude to those who have helped in various ways throughout the long process. How many helpful conversations have I had with people at numerous international conferences, invited and attended lectures, or during and after presentations for the Interdisciplinary Forum or the Science Communication Unit? How many times has my wife, Ryoko, inspired me during our daily fiery philosophical conversations; and what about the intensity of shared inquiry with the members of the Platonist group The Prometheus Trust? In what way has something I read many years ago slipped unconsciously into my way of thinking that has only now found its expression in a brief sentence in my thesis? How often has someone, academic and office staff, in the philosophy department, and also representatives from the Graduate School and the Faculty of Arts assisted me in so many vital ways? And what about those few souls who are so close with me that our entire way of life permeates my thoughts and approach to the philosophical problems I have addressed? To the many unnamed but deserving people, forgive me if I am forced to mention only those who have most directly assisted me in the development of my thesis.

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Abstract

A Platonic Defence of Realism in Quantum Theory

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In this thesis, contrary to the common assumption that quantum theory is positivist and antirealist, I argue that it is best understood as being Platonic. There has been a constant confusion of terms whereby realism has been equated with materialism and determinism, so that the denial of these metaphysical notions has led to the false conclusion that quantum theory is antirealist. However, there are many different uses of the terms 'realism', 'antirealism' and 'idealism'. When such confusion has been clarified and we have taken seriously the philosophical views of the founders of quantum theory coupled with appropriate metaphysical reasoning, we can understand how the new physics still presupposes and implies the truth of essential aspects of Platonism. Two important examples are that physics (classical and quantum) presupposes the notion of a unified, hierarchically ordered universe, and that what is most real or fundamental in physics is the ideal. The ideal laws of physics must have some sort of existence (or being) prior to their discovery, and the best explanation for their ontological status and our access to them is to be found in Platonic realism.

The basic realist assumption that we discover nonphysical objective truths has rarely in the contemporary literature been given a serious metaphysical defence. The ontological and epistemological difficulties permeating the underlying assumption that an apparently physical, finite, and perpetually changing sentient creature can have access to nonphysical, eternal, and constant truths (whether in the mathematical laws of physics or morality) are almost ubiquitously ignored. Such a denial unavoidably leads to irresolvable conceptual dilemmas, which become obvious in the philosophical and empirical foundations of quantum theory. We are thus justified in demanding a philosophical defence, and I argue that only a properly understood Platonic metaphysics is capable of such a formidable task.

I challenge many naïve implicit assumptions in both contemporary analytic philosophy and the common experience of the experimental physicist who completely relies upon the pioneering work of the great physicists, from the founders of modern science four hundred years ago to Einstein, Planck, Heisenberg, Bohr, Schrödinger, and Pauli among others. It is only through understanding that such eminent pioneers were necessarily involved with deep metaphysical questions while developing the new physics that we can begin to appreciate and come to understand the various conceptual difficulties in quantum theory. It is a reasonable presumption that without such philosophical understanding, fundamental advances in the sciences will not be possible and pure research will dwindle. And without pure research, applied research will sooner or later be essentially nonexistent, or completely trivial.

Preface

The eminent pioneering physicists that are the focus of my interdisciplinary thesis were not professional philosophers, and although they made important philosophical arguments and assumptions, which we must take seriously, they were unable to offer the proper philosophical clarification necessary to understand the metaphysical foundations upon which they were unfolding the new physics. It is one of the main goals of my thesis to offer conceptual clarification of the fundamental issue of realism versus antirealism in quantum theory. One may object that the only worthwhile way to think philosophically about conceptual issues in physics is if one is a trained physicist. But the physicists are almost never trained in philosophy and, in any case, having a PhD in physics or philosophy is no guarantee whatsoever that such an educated person will actually be original or discover anything important. It is hypocritical for the philosophers to ignore the philosophical thinking of physicists just because they do not have PhDs in philosophy, especially since philosophers believe that they can speak intelligibly about any subject whatsoever without a PhD in the relevant disciplines. We have philosophy of psychology, of science, of biology, of law, of mathematics etc., and it is very unusual for such philosophers to have a second PhD in the discipline which they are studying philosophically. I am not saying that a philosopher also should be a specialist in mathematics to discuss intelligibly the philosophy of mathematics, for she need only understand the most important principles of mathematics and know very limited specific details. Indeed, as A. E. Taylor writes, 'what the philosopher needs to know, as the starting-point for his investigation, is not the specialist's facts as such, but the general principles which the specialist uses for their discovery and correlation.'[1] But, similarly, the physicist does not need a PhD in philosophy in order to be able to contribute something worthwhile to philosophy of science or even to philosophy in general.

However, I am not committing the fallacy of arguing from authority; just because Werner Heisenberg repeatedly says that Plato was correct, it obviously does not necessarily follow that therefore Plato must have been correct. Independent arguments are always

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[1] A. E. Taylor, 1936, p. 48.

required. On the other hand, every day everyone (including scientists) must to some degree submit to various sorts of authorities on matters about which we have little or no technical competence.[2] If we did not accept the testimony of others so often then we would have to test everything for ourselves, which is impossible. We can surely doubt what we hear on the news, but that is often because we know other information from some other source, which we have had to accept without verifying for ourselves. Engaging in first-hand verification of everything would be 'a wasteful procedure'[3] and is in fact impossible. But we do need to be able to analyze critically the information that is given to us even though we may not be technical experts in the relevant field. Appropriate application of critical philosophical reflection and clarification enables the philosopher with sufficient technical background knowledge to assist the experts in a particular field. Philosophers need not have a PhD in physics in order to make significant contributions to the discipline from within a certain conceptual domain, and physicists need not have a PhD in philosophy to be able think metaphysically. My argument is not that Platonism must be true because several eminent physicists think it is. Rather, I am making the reasonable claim that given that many eminent pioneering physicists have either explicitly or implicitly endorsed Platonism (or compatible beliefs) then we are not justified in dismissing Platonism *a priori* and in fact have good grounds for considering the possibility via independent arguments that these physicists just may be correct.

If a majority of philosophers of the last century have been guilty of abjuring metaphysics while themselves holding untenable metaphysical assumptions at the foundations of their own work, the majority of physicists have been equally guilty of ignoring the perplexing philosophical problems inherent in quantum theory and relativity and instead have been merely aiming at utility, the application of the mathematical formalisms that somehow or other produce the desired results—microwave ovens, nuclear missiles, etc. By contrast, the greatest pioneering theoretical physicists seldom cared about the applications, at least until the dawning of the atomic bomb. But without the deep thinking philosopher-

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[2] See Polanyi, 1966, p. 64 & Price, 1969, p. 119.
[3] Price, 1969, p. 117.

physicists leading the way, then pure research would eventually come to end. Without pure research, applied research would soon lose its fruitfulness and technological applications would eventually dwindle to nothing more than a recycling of old ideas. It is easy to neglect the metaphysical aspects of physics when one has merely instrumental aims of getting research grants for project-oriented goals of applying some technique in the service of corporate financial ambitions, but without those metaphysically and indeed mystically-minded pioneering physicists, quantum theory would never have been born and our high-tech industry would never have existed. Peter Atkins makes the following important observation:

> It has been said that around 30 percent of the manufacturing economy stems from the application of quantum mechanics: that is not bad for a theory that we do not understand and suggests that there would be an extraordinary surge in the economy should we ever understand the theory properly, for understanding always enhances application.[4]

It is the aim of this thesis to contribute towards such understanding, to elucidate and clarify various conceptual difficulties in quantum theory in order to bring deeper understanding both to the physicists and the philosophers (and tangentially to corporations, governments, and the general public).

Various technical terms and concepts are unavoidable, but I have endeavoured to write as plainly as possible, while offering clear exposition of relevant terms and concepts when required. Many articles in contemporary philosophy are unnecessarily convoluted and incomprehensible to anyone who is not a specialist in the particular area in question. This cumbersome obfuscation often seems intentional, as if hiding the fact that the writer has nothing of any substantial merit to offer. Despite my intention of writing as plainly as possible, the arguments that I will be offering and concepts that I will be clarifying are subtle and complex, and I have been greatly inspired by the cogent arguments and straightforward clarity of writing by Christopher Norris. For the most part I am in

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[4] Atkins in Baggott, 2004, Foreword. Cf. Gibbins: 'One must of course admit that through nuclear weaponry, the transistor, and now the microchip, our system of communication, indeed our technoculture as a whole, has come to be based on and threatened by an ultimately quantum-mechanical technology.' (Gibbins, 1989, p.1.)

fundamental agreement with Norris' realism, although I argue that because of a misconception of Plato and Aristotle he has not been able to provide an epistemological account of our access to nonphysical objective truths. Once we have understood the essence of Platonism, then it seems clear that Norris too is a Platonic realist in essential relevant respects. From my perspective, that is the highest compliment I can offer. Of course, as already mentioned, I have also been influenced by the styles and philosophical approaches of Peter Rowlands and Stephen Clark, as well as Dominic Dickson's visionary interdisciplinary projects and presentations and Mike Houlden's inspiring ability to clarify for non-specialists the extraordinary beauty and hair-raising implications of nonlocality.

Clark also reminds us that when doing professional philosophy we need not restrict our reading 'to those few thinkers that have, for whatever reason, achieved canonical status.'[5] That does not mean that we should consider only non-philosophers when writing philosophy, but when the 'canonical thinkers' are *wrong* and *disallow* fundamental questions even to be raised, especially when such questions were forced upon us by the experimental results in physics, then there is no choice but to engage with other thinkers, whether or not they are professional philosophers. Unfortunately, as Errol Harris notes, although the new physics ushered in by relativity and quantum theory 'has revolutionized science, it has as yet had little effect on philosophy and social order.'[6] While this is true, Norris aptly questions whether or not philosophers should take lessons from quantum theory.[7] If the lesson is that we should be antirealists, then perhaps we should not accept such lessons but instead help the physicists understand the inherent difficulties with this metaphysical worldview and how it is at odds with the realist assumptions implied by the success of physics. There is deep metaphysical confusion at the foundations of quantum theory and, as Palle Yourgrau aptly notes, 'the final philosophical account of the nature of quantum reality (or unreality) has yet to be written. Not only are we not there yet; no one seems to know where we're going or how we will know when we get there.'[8] A

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[5] Clark, 1990, p. vii. Norris (2002-C, p. 43) makes a related point.
[6] Harris, 2000, p. xi.
[7] Norris, 1999.
[8] Yourgrau, 2005, p. 153.

'final' account may not even be possible, but I do think that I have helped show the futility of antirealism while bringing our attention back to a realistic understanding of physics, even though I support a non-materialistic realism, specifically Platonic realism.

INTRODUCTION

General Overview

In this thesis, contrary to the common assumption that quantum theory is positivist and antirealist, I argue that it is best understood as being Platonic. I have needed to defend some controversial points in this thesis, beginning with a detailed critique of several false assumptions that are generally associated with analytic philosophy. I then argue for the necessity of an interdisciplinary approach followed by a chapter on the inextricable relationship between physics and metaphysics and another chapter on the role of faith. Through a combination of historical, sociological, and philosophical analysis, these first four chapters cast aside many misconceptions that would otherwise make it impossible to offer conceptual clarification of the metaphysical foundations of quantum theory (and all of physics). Chapter Five begins the main arguments of the thesis, where I show that the founders of the Copenhagen interpretation, who are usually assumed to have been positivists and antirealists, are actually overwhelmingly Platonic realists, while in Chapter Six I acknowledge and argue against those few antirealist comments made by Bohr and Heisenberg. Finally, in Chapter Seven I show how quantum theory presupposes and implies the essence of Platonic realism.

As a very basic description, we can say that realists believe we discover truth whereas antirealists believe we merely invent truth, whether as a socially or individually constructed fiction. There has been a constant confusion of terms whereby realism has been equated with materialism and determinism, so that the denial of these metaphysical notions has led to the false conclusion that quantum theory is antirealist. Materialism (or physicalism, which I take to be synonymous[9]) basically states that all that exists or is real

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[9] It may be possible to develop further distinctions between what is 'material' and what is 'physical', but such subtleties will have no effect on my main arguments and for my purposes I am assuming that they are essentially identical in meaning in so far as they both refer to the all the 'stuff' in the cosmos. As the focus of my thesis is on realism versus antirealism in quantum theory, there is nothing to be gained by trying to go beyond this commonsense definition of physicality (or materiality), which refers to every material entity, from rocks and trees to microwaves and twenty-eyed aliens. It may correctly be pointed out that my definition is circular, in the sense that by 'stuff' I just mean 'material' and by 'material' I mean 'stuff', but I am doubtful that anyone is capable of a non-question-begging definition. Whatever physical stuff actually is, if you put enough of it together and smash it against you at high enough speeds, it will probably hurt.

must be physical, and determinism, in its simplest form, assumes that any particular outcome or effect could not have been otherwise. However, there are many different uses of the terms 'realism' and 'antirealism', and also ambiguities concerning the notions of 'materialism' and especially 'determinism', which I deal with in more detail in Chapter Three. When such confusion has been clarified and we have taken seriously the philosophical views of the founders of quantum theory coupled with appropriate metaphysical reasoning, we can understand how the new physics still presupposes and implies the truth of essential aspects of Platonism.[10] Two important examples are that physics (classical and quantum) presupposes the notion of a unified, hierarchically ordered universe, and that what is most real or fundamental in physics is the ideal. One key example is that the laws of physics must have some sort of existence (or being) prior to their discovery and the best explanation for their ontological status and our access to them is to be found in Platonic realism.

I have chosen to focus mostly though not exclusively on quantum theory for four reasons: (1) it is the most powerful scientific theory in history; (2) it is usually assumed that the chief architects of the Copenhagen interpretation were positivists and antirealists, the opposite of what I argue; (3) its founders were profoundly metaphysical by necessity of the results of empirical and theoretical research; and (4) due to several unnecessary assumptions about the goals and permitted methodology in philosophy, most philosophers have ignored or belittled the metaphysical reflections of these pioneering physicists, to the detriment of both academic philosophy and fundamental thinking in physics.

This interdisciplinary thesis is intended to be of benefit to philosophers, physicists, and mathematicians, at least those who are concerned with trying to understand the deeper metaphysical foundations and implications of quantum theory and of physics in general.

Due to the continuing (and sometimes practically unavoidable) parochial confines of the

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[10] Joshua Knobe in the USA apparently has been leading the way in 'experimental philosophy', in returning to the Socratic spirit of actually asking people what they think instead of merely pontificating, which often results in cultural and gender bias. (See Wilson, 2005.) In a similar way, in this thesis I consider what the founders of quantum theory actually believed in conjunction with independent philosophical arguments and some relevant historical and sociological analysis.

administrative structure of universities, my thesis must primarily be aimed at appeasing the philosophers and, consequently, several of the side routes that must be followed up and defended, while hopefully interesting to the physicist, may leave her wondering what all the fuss is about. When the thesis is revised for publication, I will be able to make it more appealing to the general physicist. Nevertheless, as it stands, I provide important historical, sociological, and especially philosophical understanding of how the 'strangeness' of quantum theory is alleviated when understood via Platonism (although one may still think that Platonism is strange too). But, as I discuss in later Chapters, Erwin Schrödinger believed that all knowledge is rooted in the soul, and Heisenberg claimed that the search for the One has played a similar role in both science and religion. Clearly, these great physicists were comfortable with such fundamental Platonic assumptions.

Besides the occasional mention, I am not concerned with mathematical equations themselves. Of course physicists cannot dispense with mathematics, although Aristotle did not think it was absurd to do so,[11] but it is equally misguided to pretend that we can dispose of metaphysics and hope to make fundamental progress in science. Many of the greatest pioneers in physics have admitted the necessity of metaphysics, and my thesis aims to help clarify some of the conceptual difficulties in quantum physics, which often have their roots in the apparently polar positions of realism and antirealism. Most of the philosophical debates surrounding realism and antirealism in physics and in broader contexts stem from the metaphysical beliefs, arguments, and thought experiments of Niels Bohr, Heisenberg, Wolfgang Pauli, Albert Einstein, Max Planck, and Schrödinger among others, even though most philosophers have not taken these physicists seriously as philosophical thinkers. It is the philosophical beliefs of such eminent pioneering physicists that I am most concerned with in this thesis.

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[11] I discuss this point again in Chapter Two. For example, see Koyré, 1968-B, pp. 36-37; Heisenberg, 1974; Whitehead, 1953; Burtt, 1925; and Rowlands, *Physics: The Quest for Unification*. Whenever I cite Rowlands and give a title, that means I am quoting from one of his written lectures. But all the material from these lecture notes has been incorporated and expanded in his forthcoming book *Zero to Infinity: The Foundations of Physics*, published by World Scientific, forthcoming this winter 2007, at which time such references will be publicly accessible. I am fortunate to have had access to his cutting-edge research and his historical understanding of the history of science and its intimate relation to philosophy and theology.

We will need to address many questions, including the following:

(1) What is quantum theory? (Introduction)

(2) What is Platonism? (Introduction)

(3) What are the strengths and weaknesses of analytic philosophy, especially in relation to fundamental questions in physics? (Chapter 1)

(4) Why is an interdisciplinary approach necessary? (Chapter 2)

(5) What is the relationship between metaphysics and physics? (Chapter 3)

(6) What is the role of faith in physics and in reasoning? (Chapter 4)

(7) Which realisms are presupposed and implied by quantum theory? (Chapter 5)

(8) What are the differences and similarities between antirealism and idealism in quantum theory, and why does antirealism fail? (Chapter 6)

(9) What are the most important reasons for claiming that quantum theory (and physics in general) implies and presupposes Platonic realism (Chapter 7)

Despite the interconnected importance of these essential questions, some will require more explanation and argumentation than others. Each of these questions contains almost innumerable sub-questions and debates and sometimes requires much prior work in order even to attempt to answer the question, so we must be able to focus on what is most relevant. Inevitably, however, the act of focusing forces us to ignore other important issues. A similar problem arises in experimental physics where artificially closed systems need to be constructed in such a way that allows manipulation of only a few variables at the expense of ignoring the infinite complexity of the whole system of the universe in which each experimental arrangement is a part. But once we begin to ask fundamental metaphysical questions it is easy to become overwhelmed by the endlessness of the task, in a similar way as attempting to account for every conceivable variable in an experiment is impossible. Each essential concept needs to be clarified, but the act of clarification requires relying upon other concepts that are equally problematic and difficult to define. Even the most ardent metaphysician must reach a point where she realizes that she simply cannot define or clarify every concept. The most important example that we will encounter throughout the thesis is the concept of 'unity'. It seems impossible to define 'unity' without begging the question because we must rely upon the prior possibility of

unity in order to be able to offer a definition, clarification or argument for (or even against) the concept of unity.

If unity were an absolute impossibility, then I could not write this thesis. There would not be any way of unifying my thoughts or expressing them in any meaningful way in language, nor could anything exist in any way whatsoever. It is not the fault of the metaphysician that she cannot define absolute unity, nor is it necessary for physicists to try to define unity itself, which *qua* physicist they cannot do anyway, even though the concept of unity is presupposed by everything they do. Indeed, it is the search for the ultimate unifying laws or principles that drives physics forward, even though we can never ultimately succeed in grasping unity itself. I will reiterate this and related points throughout the thesis, approaching them from different angles and in various contexts because (1) they are crucial to my essential arguments and (2) these metaphysical notions and ways of thinking are denied *a priori* by some contemporary philosophers.

Perhaps the physicist would not be too disappointed that we cannot define with unambiguous precision this most essential concept of unity. After all, physics 'works', so who cares about mere linguistic definitions? But the physicist also needs to be able to define concepts, both mathematically and linguistically, while the contemporary analytic philosopher often seems to expect that all concepts should be able to be defined, and some even have the odd position that what cannot be defined cannot have any existence. Indeed, there are some influential philosophers who have argued that questions of realism versus antirealism are meaningless and that all metaphysics in general is a waste of time and should be purged from philosophy. Consequently, an entire chapter on analytic philosophy is required before we can proceed with addressing many of our essential questions listed above. Of course, defining concepts as clearly as possible is essential in philosophy and physics, but the point that will be made clear in Chapter One is that clarifying concepts is logically an infinite task; there is no end to analysis, and so at some

point we must agree with Alfred Whitehead's caveat: 'Clarity always means "clear enough."'"[12]

[12] Whitehead, 1948, p. 93. But "clear enough" for whom? This question will relate to Bohr's claim that we need to give a complete description of the experimental arrangement, which I discuss in Chapter Seven.

Realism in Brief

I argue that a return to realism in physics is essential, although it is probably more accurate to say that we simply need to recognize or remember that realist assumptions have always remained at the foundation of physics, despite the bizarreness of quantum reality. An essential point to keep in mind at the outset is that the foundations of physics have never been congenial to materialism and have always aimed at unification, simplicity and the abstract. The abstract natural laws are viewed by antirealists as being fictions constructed from the phenomena, while the realist believes that we discover them. Since these laws themselves have no physicality yet underpin all physical reality, then realism entails that materialism is false.

I discuss realism in detail in Chapter Five and antirealism and idealism in Chapter Six, so here I will mention only the most essential realist assumption, which the antirealist simply denies. The realist believes in a mind-independent reality, or as Norris says, verification-transcendent truths.

> Most crucial to any version of the realist case is that which asserts the existence of objective or verification-transcendent truths. In other words, there exist many features of reality that lie beyond our knowledge or present-best powers of understanding, but which nonetheless obtain quite apart from what we happen to think or believe.[13]

It seems helpful to think of realism in general as positing 'verification-transcendent' truths that exist (or have being) whether or not we happen to believe or know them or are even able to imagine them. Among other problems, however, we must consider the meaning of the verb 'to exist' because existence involves change and so whatever apparent 'truths' we may discover cannot be the sorts of objective, eternal, unchanging truths physicists seek. Thus, as I shall argue, these discovered truths that obtain apart from our current thoughts and beliefs must have being, which is to say that they must be what they are without changing, which was a common assumption in Platonism capable

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[13] Norris, 2000-A, p. 63.

of clearer exposition in ancient Greek than in modern English.[14] For example, we are forced to say that something 'has being' in order to denote its timelessness and unchanging nature, but such phrasing is awkward in normal conversation. Following Norris' suggestion, it may first be better for the realist to argue for *belief*-independent truths rather than mind-independent truths, although, with important qualifications and clarifications, I will also argue for the latter. Nevertheless, it would seem that only the former is required to vindicate realism.

Michael Dummett is apparently the first to have published the term 'antirealism' in 1978, and I have never read Bohr or Heisenberg using the term to refer to their beliefs about quantum theory. Dummett characterizes realists as people who believe that statements possess an objective truth-value independent of our means of knowing it, whereas antirealists believe that 'statements of the disputed class are to be understood only by reference to the sort of thing which we count as evidence for a statement of that class.'[15] In other words, for antirealists, ontology is subservient to epistemology, or, more accurately, ontology is simply nonexistent—what we *know* is what reality *is*. Understood in this way, Heisenberg and Bohr can *sometimes* be seen to be antirealists, but not nearly to the degree that has been so easily assumed.[16]

If I do not state explicitly 'quantum antirealism' or 'general antirealism', then the context should clearly indicate my intention. However, antirealism in quantum theory is not straightforwardly identical to relativism or the general postmodern denial of all truth claims. Quantum antirealists raise some legitimate concerns for realists, but I will not be seeking a compromise between realism and antirealism. Norris has already argued

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[14] See Donald Zeyl's discussion in his Introduction to his translation of Plato's *Timaeus*, 2000, pp. xxix-xxxii.

[15] Dummett in Rorty, 1991, p. 3.

[16] Eddington makes a good case for not being too concerned about this notion of reality because it is 'one of those indeterminate words which might lead to infinite philosophical discussions and irrelevancies.' (Eddington, 1929, p. 28.) That is not to say that the notion of reality is irrelevant or that attempting to analyze its meaning is futile; rather, when attempting to say *exactly* what we mean by the term, we can quickly find ourselves traversing many irrelevant trails, which I will not do here. In Chapter Three I discuss the notions of 'nature' and 'reality' in relation to the Heisenberg uncertainty principle.

successfully against such a project when he showed several problems in Response-Dependence approaches, which need not concern us here.[17]

[17] Norris, 2002-A; 2002-B; 2003.

What is Quantum Theory?

Peter Gibbins states that quantum mechanics is '*deeply* mysterious...because it subverts the classical picture of the world, of which classical mechanics and electromagnetic theory are refinements.'[18] The classical picture, of course, was one of mechanistic materialism, and it has usually been assumed to stem from Newton, which is false. As I mention again in Chapter Four, Newton was not a mechanist but was primarily a theological thinker who believed that 'the ultimate causes of things were abstract rather than mechanical.'[19] This anti-mechanical view has never been popular amongst those physicists who are more concerned with the technical application of the principles discovered by the great pioneers, but for the past four-hundred years it has been the most fruitful in fundamental physics. One of the most important legacies of quantum theory is that it has shown us the 'impossibility of describing fundamental physics in any kind of 'concrete' terms.'[20] 'The intrinsically abstract nature of quantum mechanics,' Rowlands concludes, 'is thus no problem for physics, as many people believe, but evidence for its truly fundamental nature.'[21]

Unfortunately, this rejection of materialism, which has falsely been conflated with realism, has left the impression that quantum theory is the 'most important fundamental theory of science that is truly anti-realist both in its mathematical formalism and in its orthodox interpretation.'[22] Despite the mystery (or because of it), philosophers and physicists (and lots of people who have seen the movie *What the Bleep Do We Know?*[23]) use the phrase 'quantum physics' quite casually, as if they and their listeners or readers all know what that means. However, Gibbins notes that despite its extraordinary predictive power, 'philosophers and physicists are in total disagreement about what, again if anything, quantum theory tells us about the way the quantum world is.'[24] Yet, as Heisenberg reminds us, 'it is in quantum theory that the most fundamental changes with

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[18] Gibbins, 1989, p. 2. Original emphasis.
[19] Rowlands, 2003, p. 16.
[20] Rowlands, *Physics: The Quest for Unification.*
[21] Rowlands, *Physics: The Quest for Unification.*
[22] Baggott, 2004, p. 118.
[23] See Arntz et al, 2004.
[24] Gibbins, 1989, p. x.

respect to the concept of reality have taken place.'[25] We can cite some obvious aspects of quantum theory, which I do below, and that will be sufficient for my purposes, but it seems impossible to pin it down concretely. I suppose this lack of concreteness is apropos since the theory itself belies materialism.

Another thesis could be written on what exactly quantum theory is supposed to be, just as a plenitude of books have been written on Platonism (and there is still no general agreement after 2,400 years), but my goal is to show that, whatever quantum theory actually is, its founders were essentially not antirealists or positivists but, rather, Platonic realists. Jan Faye notes that although it was commonly assumed that the Copenhagen interpretation was subjectivist and positivist, today 'anyone who has studied Bohr's essays carefully agrees that his view is neither.' However, what Faye has glossed over is that the common consensus in academia remains fixed on the antirealist aspects of his thought to the exclusion of the realist elements. But, as Faye continues, 'there are, as many have noticed, both typically realist as well as antirealist elements involved in it, and it has affinities to Kant or neo-Kantianism.'[26]

Planck was the first to understand that the allowed energy levels of an electron are discontinuous and determinate—'you never have half a photon'[27]—and the amount permitted is proportionate to Planck's constant (6.62×10^{-34} Joule-seconds) multiplied by the frequency. This is probably the most significant aspect of quantum theory, setting it apart from classical assumptions: energy is discontinuous, and when electrons move into higher or lower states of energy, they can only do so when the energy level reaches a certain point. There can be energy levels 1, 2, 3, for example, but not 1.5 or any other fraction in between; in other words, energy comes in discrete packets and is not

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[25] Heisenberg, 1958-A, p. 28.
[26] Faye, 2002. Kant was certainly influenced by Platonism, and since I cannot address every possibility in this thesis, I will set Kant aside except for a few remarks. For example, in his review of T. K. Seung's *Kant's Platonic Revolution in Moral and Political Philosophy*, J. Ward quotes Seung as saying that "Platonic ideas 'provide the ultimate goal for all [Kant's] maneuvers; they give the unity and integrity to all his works. The spirit of criticism is only a dutiful handmaiden to his grand Platonic vision." (J. Ward, 1996, p. 281. However, Brittan claims that in arguing against Hume, Kant wanted a 'fully realist, or *material*, interpretation of Newtonian physics.' (Brittan, 1978, pp. 125-126, original emphasis), which would seem to put Kant at odds with Platonism.
[27] Gibbins, 1989, p. 55.

continuous. It is this aspect that prompted the phrase 'quantum jump'. Beyond this, it is difficult to say for sure what else composes quantum theory exclusively, for it is possible to contest each further aspect as belonging only to a particular interpretation.

Nowadays we refer to the old and new quantum theories. The old quantum theory essentially includes Planck's explanation for black-body radiation (as just mentioned above) in 1900, Einstein's explanation of the photoelectric effect in 1905, Bohr's model of the atom (optical line spectra) in 1913, and de Broglie's explanation of the particle/wave character of the electron in 1923, which seems to me to be a sort of a transition to the so-called 'new quantum theory'. This 'new' phase was inaugurated by Heisenberg's matrix mechanics and a year later Schrödinger's wave mechanics. They seemed to be in contradiction until Schrödinger proved that they were equivalent.[28] Gibbins observes that the physicists usually refer to quantum theory as consisting of a 'user-friendly blend' of Heisenberg's and Schrödinger's approaches, but what the 'contemporary mathematician calls quantum mechanics is an abstraction from both due to John von Neumann.'[29] Despite all this confusion surrounding the meaning of quantum theory, there seem to me to be at least nine prominent features, which could, of course, be contested or added to, but such clarification is sufficient for our purposes here:

1) Discretely quantized energy
2) Schrödinger's equations (time independent and time dependent)
3) Heisenberg matrix mechanics
4) Heisenberg uncertainty principle
5) Wave-particle duality
6) Principle of complementarity
7) Nonlocality
8) Pauli exclusion principle
9) Irreducibly statistical laws

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[28] Information for the old and new theories is taken from the Computational Physics website, The University of Groningen, the Netherlands.
[29] Gibbins, 1989, p. 24.

Physicists can argue about whether or not other aspects should be included in quantum theory, but these points all contribute to the 'strange' non-classical implications when we search for a physical description, and so this list, however incomplete or contestable, will suffice for our purposes. There are different interpretations of quantum theory, including the Copenhagen, hidden variables, and many-worlds, but my focus will be on the former because it is the standard view and it is supposed to be positivist and antirealist. So, what is the Copenhagen interpretation? It was mostly but not exclusively the result of the views of Bohr, Heisenberg, and Pauli, which, despite their internal disagreements, was 'founded on the dual wave-particle properties of quantum entities.'[30] However, there is still no one 'single consistent interpretation of the theory,'[31] and the founders themselves never used the phrase 'Copenhagen interpretation.'[32] Einstein disagreed with the Copenhagenists about their view that quantum theory was complete and consistent,[33] (and a recent experiment is being hailed by some physicists as vindicating his belief).[34] In fact, however, this issue is mostly metaphysical in nature, as all experiments need to be interpreted, and each interpretation rests upon prior metaphysical commitments.

Copenhagen followers still tend to believe that other interpretations, such as hidden variables, are incompatible with quantum theory. Gibbins makes the following important points:

> The dispute between the two interpretations has philosophical significance not merely for the philosophy of physics but in philosophy generally. For in defending the maximal completeness of quantum mechanics one can be led, as Bohr was, to develop a rudimentary philosophy of the limits of explanation and even the limits of language. The dispute has extraphilosophical [sic] significance since someone who rejects the possibility of hidden-variables theories will frown on research into such theories while his opponents will try to encourage it.[35]

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[30] Baggott, 2004, p. 105.
[31] Gibbins, 1989, p. 47.
[32] Faye, 2002.
[33] See Heisenberg, 1974, p. 159; Einstein, 1954, p. 323.
[34] Afshar et al, 2007 & Rowan University, 2007 (discussing the same experiment). However, this experimental conclusion is heterodox, as the majority of physicists would not agree with it.
[35] Gibbins, 1989, pp. 9-10. Original emphasis.

Some of the important purposes of my thesis should here be obvious. In showing how quantum theory is realist (though not materialist), there will be important philosophical implications. Yet, by seeing that prejudice against hidden-variable alternatives is rooted in metaphysics and not necessarily in experimental data, we can open the way to such empirical and theoretical research. An objection that such an approach will not provide any more empirical accuracy than already given by the standard view is nullified (or at least attenuated) by the fact that string theory, which is one of the new dominant investigative routes, has not provided even one experimentally confirmed result, even after so many years, which raises the question of whether or not it is a scientific theory or mostly metaphysics. It may prove fruitful in the future—and we may also discover hidden-variables.[36] An interesting point that seems to be overlooked on this topic is that the hidden variables are usually assumed to represent physical entities, thus apparently vindicating a materialist realism, yet these variables need not be physical. Just because something is not physical (or at least not crudely and obviously physical) it does not follow that its parameters cannot be definite and independent of our minds and measuring apparatuses.

But Bohr did in fact argue that there was no mind- or measurement-independent quantum world; or, a bit more accurately (but just as ambiguously), he claimed that no quantum particle has any intrinsic properties until measured. He seems to have been led to this belief because all relevant physical descriptions describe the quantum system *plus* the macro measuring apparatus as a whole—they cannot be separated and therefore there is no independent reality to be claimed about the quantum world. All these points have earned him the reputation of being an antirealist. He also provided the qualitative counterpart to the uncertainty relations by proposing his principle of complementarity, (which he also wanted to extend to other disciplines).[37] Basically, all the apparent mutually contradictory notions in quantum theory, such as wave-particle duality or the

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[36] Cf. Norris: 'Von Neumann's apparent mathematical proof against the possibility of a hidden-variables theory has been argued to be conceptually flawed; Bell, like Bohm, thought that nonlocality was a small price to pay in comparison with the various conceptual dilemmas imposed by the orthodox theory.' (Norris, 2002-A, p. 40.)

[37] See Baggott, 2004, p. 105 and Gibbins, 1989, p. 56.

uncertainty relations, are simply two sides of the same coin, which could not exist without each other.

Perhaps more generally, the Copenhagen interpretation aims to set limits on what can be known, not just in physics but in the other sciences and philosophy as well. Nevertheless it is, as Gibbins says, difficult to state exactly what the Copenhagen interpretation is. With the following final remark I will end my discussion of what constitutes the standard interpretation of quantum theory, although I consider certain aspects in detail throughout the thesis.

> The Copenhagen interpretation is not about whether or not quantum systems are waves, or particles or both or neither. It is a philosophy of physics, a philosophy which confronts the limitations of *representations* that physics may employ, a philosophy of physics-as-a-cognitive-activity. It is deep. That is, it is extraordinarily unclear as to what the Copenhagenist philosophy of physics asserts.[38]

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[38] Gibbins, 1989, p. 48.

The Essence of Platonism

That we should return to the Platonic tradition in relation to modern physics is not surprising since it had a fundamental influence on the beginning of modern science through Copernicus,[39] Kepler,[40] Galileo[41] and Newton,[42] and, as I make evident

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[39] Burtt, 1925, p. 43. And the foundations of modern medicine are also dependent on to Plato to a significant extent. In the second century CE, Galen of Pergamum, the 'leading medical authority of antiquity—rivalled only by Hippocrates...[who had] unparalleled influence well into the modern period' (Lindberg, 1992, p. 125) was influenced by Aristotle but he esteemed Plato and Hippocrates as his classical heroes. 'Galen in his principal anatomical work more than once exhorts his reader: "Follow Plato and me."' (von Staden, 1995, p. 62.) For example, Galen adopted Plato's tripartite division of the soul to correlate with 'the three basic physiological functions defined by Erasistratus.' (Lindberg, 1992, p. 127.)

[40] Burtt, 1925, pp. 58-59; Pauli in Jung & Pauli, 1955; Spencer, 2006; Kepler, 1997; T. Taylor, 2006, p. 6; Koyré, 1968-B. In a recent textbook, Peter Bergethon writes that Kepler was even 'one of the pioneering biophysicists.' Although we may not accept his astrological rules today, his assumption that 'biological behaviour can be understood via an understanding of the physical rules governing our universe is the fundamental assumption of this book and modern biophysical chemistry.' (Bergethon, 1998, p. 10.) It is quite amazing to see Kepler quote Proclus on the Title Page of 3 out of the 5 Books that comprise *The Harmony of the World*. In fact, in Book IV he quotes Proclus in full for 5 straight pages (pp. 298-302), and, besides having such Platonist beliefs as the foundation of his entire scientific thinking, he also hopes that relying on the Proclus will remove from him 'the blame for rejecting Aristotle in both directions.' (Kepler, 1997, p. 302.)

[41] For example, 'the Neo-Platonic background of mathematical and astronomical development of the times had strongly penetrated the mind of the Italian scientist [Galileo], as in the case of so many lesser figures.' (Burtt, 1925, p. 71.) Heisenberg also reminds us that Galileo paid no attention to the authority of Aristotle but instead followed the teachings of Plato and Pythagoras, and tried to 'find mathematical forms corresponding to the facts obtained by experiment,' thus arriving at his law of falling bodies and inaugurating the 'beginning of modern exact science.'(Heisenberg, 1974, p. 173.) The myth that Francis Bacon had been the father of modern science persisted into the 19th century 'due to a coalition of literary men who knew nothing about physics and of physicists who knew nothing about history or philosophy,' (Benn, 1882, p. 71) which is another example of the importance of bringing together history, philosophy, and physics.

It is interesting that in his very brief review of Koyré's *Metaphysics and Measurement: Essays in Scientific Revolution* (1968-B), L. Laudan (1969) claims that (a) Koyré has not clarified sufficiently the metaphysical principles of which Platonism consists; (b) the Renaissance resurrection of Neoplatonism was a 'violent departure from, and corruption of,' Plato's own philosophy; and (c) Kant, Newton, and every mathematical physicist would, on Koyré's account, 'emerge as a disguised Platonist.' Laudan is correct only about (a), which I have remedied in this thesis while still showing that Koyré was essentially accurate. There has been immense scholarship on the Neoplatonic tradition since 1968, and the claim that such philosophers violated Plato is nonsense (and it is a claim that is only rhetorically evoked by Laudan, as he provides no evidence whatsoever). Finally, faulting Koyré for the implication of his position entailing that all mathematical physicists must be Platonists is misplaced and misses the point completely. It is exactly the point of this thesis to show how all physicists, including self-professed positivists such as Stephen Hawking, necessarily hold beliefs that make them at least mathematical Platonists. No doubt Koyré could have been more explicit and careful when explicating his meaning of Platonism, but it has only been recently that our scholarship has opened the way to such important developments, as I am attempting here. However, it does not follow that Plato was the great 'architect of science' who single-handedly orchestrated all the great mathematicians and astronomers of his day, as Zhmud (1998) goes to great lengths to remind us. But Zhmud has missed the point of the importance of the dialectic and Plato's emphasis on eternal, unchanging mathematical laws and their Ideas that are ontologically prior to them.

throughout the thesis, several contemporary physicists have either explicitly returned to this tradition or endorsed a metaphysical perspective that is highly compatible with it. I am not just trying to show interesting parallels with modern physics and the Platonic tradition, as some writers have tried to do with quantum theory and Eastern philosophy.[43] My purposes are far deeper, for I will show how mathematical Platonism is essential for modern science. For example, Paul Shorey defended Plato against those who had fashionably proposed that Plato was unscientific, and he shows how Plato's desire for the soul to gaze upward actually referred to 'the study and contemplation of abstract mathematical relations and principles in their application to solids in motion.' Shorey continues:

> It is easy for a hasty modern reader to mistake that [star-gazing] for a rejection of observation and fact and a proposal to deduce the phenomena of astronomy *a priori*. But Plato is not thinking of that. He is in some sort predicting the mathematical astronomy of to-day. That is of course not the whole of our modern astronomy. But it exists and is a fulfilment of Plato's prophecy.[44]

If it is a difficult challenge to clarify the essence of quantum theory, then finding agreement between philosophers and classicists as to what unambiguously and definitively constitutes Platonism seems to be impossible. After almost twenty-five centuries we are still arguing about what the term 'Platonism' means. Identifying the essence of Platonism is as important as it is difficult and controversial, but Lloyd Gerson has already made significant progress in this respect. Much of what I am calling Platonism is indebted to his painstakingly detailed and formidably argued recent work, discussed below. I also refer to various contemporary scholars, but the main three ancient Platonists I draw from are Plato, Plotinus, and Proclus.[45] I offer further references in the

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[42] For example, see Hutton, 2005; Koyré, 1968-A, p. 159; Oderberg, 1986. 'Newton's absolute space and time are aspects of the abstract system, not the measurement process applied to individual events.' (Rowlands, *Theology and Modern Physics*.) And Proclus too believed that 'space is immobile, indivisible, and immaterial body,' (Schrenk, 1989, p. 87.)

[43] For example, McFarlane, 2002.

[44] Shorey, 1927, p. 172.

[45] Plotinus is widely considered to be one of the greatest 'pagan' philosophers, but recent scholarship has also elevated Proclus to be 'spokesman of mature Neo-Platonism.' (Siorvanes, 1996, p. x.) As classicist Kevin Corrigan notes, Proclus is 'perhaps the greatest systematizer of all time...[and his *Elements of Theology*] condenses the whole of Neoplatonic metaphysics into 211 propositions (each deduced from its predecessors as in Euclidean geometry).' (Corrigan, p. 235.) Besides the huge original corpus of Plato,

footnotes of this section, but I do not want to spend all my time qualifying what I am *not* talking about and why I am not talking about it, nor do I wish to become entangled in the disputes popular amongst those interested solely in the history of ideas. That A believed B to have said C about D whereas E thought that F disagreed with A is a fruitful sort of intellectual challenge that often produces important conclusions, including ones relevant to my research, but, in embracing what is good about the *approach* of analytic philosophy, I want to develop my own arguments and consider whether or not the views of the ancients are actually helpful for my goals.

I could simply stipulate that the sort of realism I am defending in relation to quantum theory relies precisely upon the same sort of essential or fundamental aspects of Platonism as outlined by Gerson without actually worrying about any historical continuity. However, even though my arguments stand or fall on their own regardless of total, partial, or no historical continuity with the Platonic tradition, it is nevertheless a remarkable fact that a scholar of Gerson's stature has been able to argue convincingly for a set of essential metaphysical assumptions underlying all aspects of Platonism that I have been able to show are also the same essential implied and explicit assumptions of modern physics. Not only were the founders of modern science Platonic realists, but the pioneers in quantum theory (and relativity) also shared these same fundamental metaphysical assumptions.

However, as the title of my thesis states, I am arguing that quantum theory is *Platonic*, which is an *adjective* used to describe the *general* metaphysical presumptions and implications of modern physics. Many of the physicists discussed in this thesis either explicitly adopted a Platonic outlook with respect to physics and mathematics or they held views that implied this metaphysics. Thus, one of the main arguments I develop (especially in Chapter Five) is that the founders of the Copenhagen interpretation were unambiguously *abstract realists*, which is to say that they were at least mathematical

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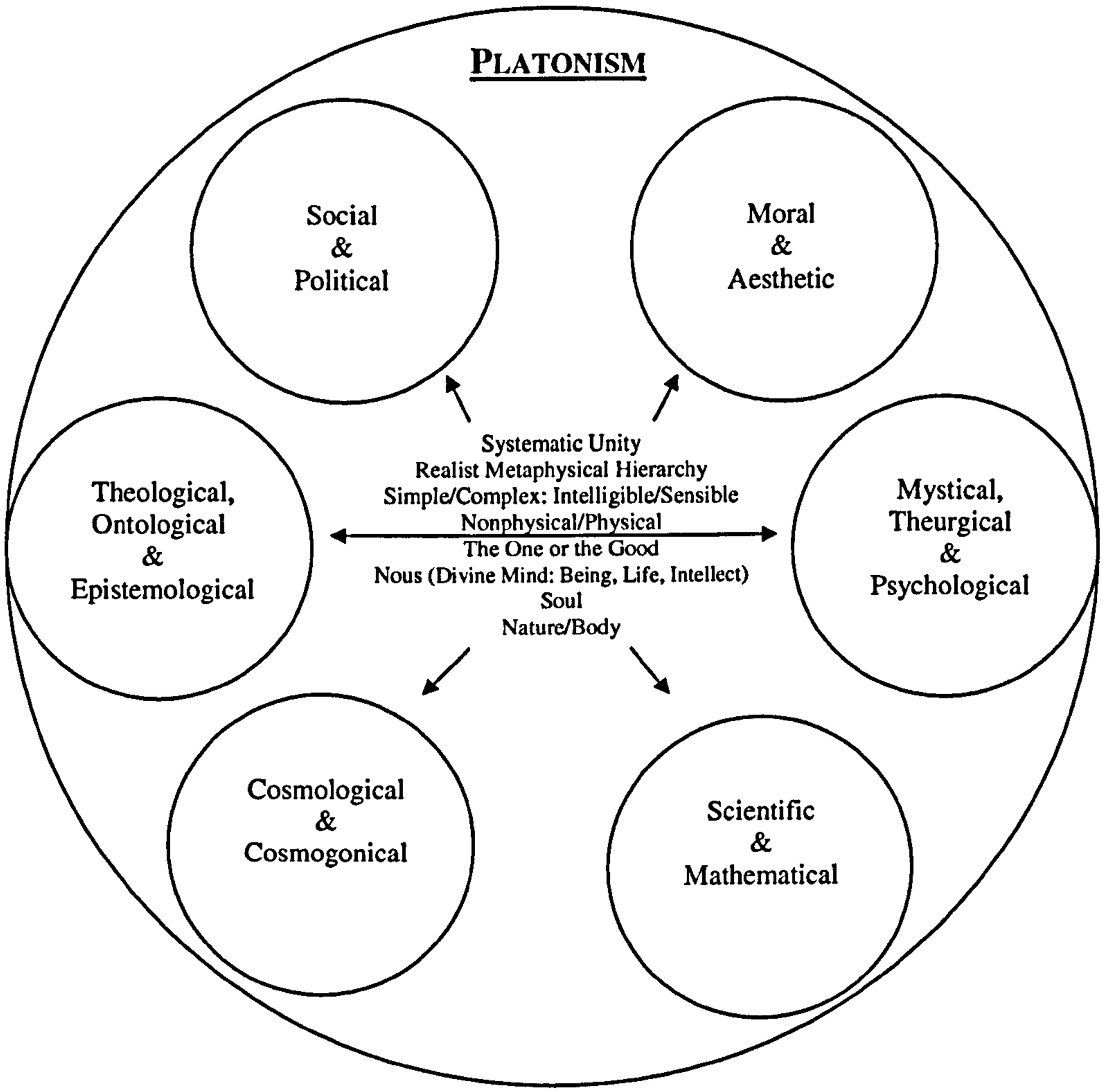
Plotinus, and Proclus, which I am not providing here, the following secondary sources are a sample of helpful relevant literature: Siorvanes, 1996, Lowry, 1980; Rosán, 1949; Lloyd, 1982; Whittaker, 1928; Bos and Meijer, 1992; Blumenthal's essay 'Plotinus and Proclus on the Criterion of Truth' in eds. Huby and Neal (eds.), 1989; Werner Beierwaltes' essay 'Image and Counterimage? Reflections on Neoplatonic Thought with Respect to its Place Today' in Blumenthal & Markus (eds.), 1981; Clark, 1994, 1997.

Platonists. Mathematical Platonism entails that nonphysical mathematical objects and their relations having more being or in some sense are more real than the physical world that obeys these mathematical laws, and their greater reality means they are closer than physical phenomena to absolute truth.[46] Being a mathematical Platonist is enough to support my claim that quantum theory is Platonic, although I have important additional reasons as well, which I discuss below. The following diagram may be helpful in making our way through the various aspects of Platonism.



[46] 'The Classical Greek for truth, αλήθεια, also stood for reality. Platonism kept the strong association of truth with real-being....Platonists subscribed to the division into reality *vs* appearance but moved reality to the transcendent "far side" (επέκεινα). Realism implies transcendence. If something real is to be independent, it must transcend all justifications and beliefs about it. For Proclus the One and Good is not cut-off but is that which imbues realities with their independence.' (Siorvanes, 2000, p. 60.)

I have developed the central points of the diagram based on the work of Gerson and Lucas Siorvanes,[47] while the diagram itself and its system of classification are my own. I am not going to discuss the many diverse aspects of Platonism that are not relevant to the thesis but instead focus only on what is of most importance for our purposes. The top central metaphysical principles permeate and provide the metaphysical foundation for all aspects of Platonism, and the bottom central outline provides the hierarchical divisions from the absolute simplicity, unity, and goodness of the One all the way down to physical bodies in motion.

Perhaps the first point to note in understanding the relevance of the above diagram to the arguments in my thesis is that the term 'Platonism' is not limited to the corpus of Plato. 'Aristotle tells us that Plato "followed the Italians (i.e., the Pythagoreans) in most things" and Plotinus tells us that Plato was not the first to say the things that in fact we today widely identify as elements of "Platonism," but he said them best.'[48] Moreover, the term 'Neoplatonism' can cause much confusion when it is not understood that such philosophers simply considered themselves to be Platonists, which allowed them to extrapolate, interpret, and add to the continual development and unfolding of this tradition.[49] Similarly, there are many different sects and branches in the various religions, often with mutually exclusive claims being made under the same umbrella religious category, yet there are also certain fundamental principles that, for example, Christians share but Buddhists reject, thus allowing us to make broad but vital distinctions between the two religions despite various internal doctrinal discrepancies and inconsistencies. Similarly, as Gerson argues, Aristotle, for example, was really a Platonist

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[47] See Gerson, 2005-A & 2005-B for the top centre metaphysical assumptions that permeate and are the foundations of all aspects of Platonism. See Siorvanes, 1996 for the lower centre outline of the hierarchical division, from the absolute simplicity, unity and Goodness of the One all the way down to physical bodies in motion.

[48] Gerson, 2005-A, p. 256.

[49] It is generally accepted that Neoplatonism is a designated period that began with Plotinus (204-270 C.E.) and ended in 529 C.E., a few decades after the death of Proclus (C. 411-485), when Emperor Justinian suppressed the philosophers. The International Society for Neoplatonic Studies (http://www.isns.us/) is a superb resource for contemporary Neoplatonic books, journals, and articles, as well as for primary texts. Ralph Waldo Emerson makes an interesting claim: 'Plato is philosophy, and philosophy Plato – at once the glory and the shame of mankind, since neither Saxon nor Roman have availed to add any idea to his categories' (Emerson, 2000, p. 421). However, that is not quite true because many philosophers have indeed developed the Platonic tradition to a great extent in original and inspiring ways.

despite having important disagreements with Plato because he had believed in the same fundamental metaphysical principles as outlined above in the top centre of the diagram, such as the intelligible preceding the sensible, even though his own philosophical work seems to have placed more emphasis on expounding the latter.[50] In a similar way, the relevant beliefs of the founders of quantum theory can also be construed as Platonic even though (like Aristotle) they would not have accepted all aspects of Platonism. Thus, we can distinguish Platonic elements in the metaphysical commitments of thinkers ancient, medieval, and modern.

As my diagram exemplifies, one could maintain a belief in scientific and mathematical Platonism while rejecting, say, political and social Platonism, as Schrödinger did (although I doubt that he really understood what was meant by political Platonism.[51]) And Einstein, for example, would probably have rejected theurgy (or working on the Gods[52]) even though he clearly believed in moral and aesthetic Platonic assumptions as well as scientific and mathematical Platonism. Thus, although Schrödinger, Einstein, and Heisenberg, for example, held metaphysical presuppositions that were clearly Platonic, they were not necessarily (and probably were not) total Platonists in the sense of embracing every aspect of Platonism listed above. Moreover, there have been several distinct manifestations of Platonism throughout history, which, despite sharing fundamental assumptions, such as outlined by Gerson, are not always identical in all other details.

I will show how quantum theory is Platonic in the following way. First, in the final chapter, I show how all of physics, obviously including quantum theory (and its Copenhagen interpretation) presupposes the truth of cosmic unity and the metaphysical hierarchy of the simple and intelligible preceding the complex and sensible. I also show how Platonic metaphysics allows us to make sense of the role of the observer in the universal hierarchy. Second, in Chapter Five, I show how the Copenhagenists (as well as

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[50] See Gerson 2005-A, pp. 269-276 and Gerson 2005-B.
[51] For Neoplatonists in general, 'metaphysics, the cosmos and the human condition are connected. What constitutional government (*politeia*) is to the state, a sense of justice is to the soul, and order is to the cosmos.' (Siorvanes, 1996, p. 9.)
[52] See Sheppard, 1982.

Einstein, Schrödinger, and Planck) were all 'abstract realists', which is a wider category embracing mathematical Platonism. They were also scientific Platonists, which, on my account, entails that not only is mathematical Platonism (which is a deeper account of structural realism, which is itself an aspect of abstract realism) true but the entities of the best scientific theories are very likely to be highly similar to the corresponding entities in physical reality. In other words, the physical world is in perpetual Heraclitean flux, though still consisting of real entities even though they are constantly changing, but the abstract mathematical relations and laws of physics are ideal though more real than physical reality, and so there must always be some sort of discrepancy between ideal theories and physical measurements.

Throughout the thesis I clarify how various aspects of Platonism further contribute to a defence of realism in quantum theory, such as Socrates' motivation to fight to discover the truth about what is presently unknown. Thus, by showing that (a) physics presupposes the metaphysical assumptions underlying all aspects of Platonism, (b) both the Copenhagenists and their opponents (such as Einstein and Planck) were mathematical and scientific Platonists, and (c) various other (though only briefly discussed) aspects of Platonism have been presupposed by physicists, I am more than justified in claiming that quantum theory is Platonic. Furthermore, since realism has often been associated with materialism, then defending a specifically Platonic realism is unavoidable. And there is one more important aspect of Platonism that is implied by the entire scientific enterprise (when properly seeking truth and not misapplying scientific principles deceitfully for profit, etc.), something so practically fundamental which ultimately relies upon the assumptions of Platonic realist metaphysics that it hardly needs any defence. I am referring to following the argument wherever it leads in the pursuit of the unknown, which is continuously stressed by Socrates in the Dialogues.[53]

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[53] As also noted by Harris, 2000, p. 24, and Polanyi, 1964, p. 14. In this thesis I am not at all concerned about the arguments aimed at making distinctions between the historical Socrates and Plato. See Cohn, 2001 for such a discussion.

Platonism, however, has often been supposed to be a form of idealism[54] when in fact it is realist. I discuss this point further in Chapter Six, but here we can note Whittaker's distinction between ancient and modern idealism. Ancient idealism assigns greater reality to the unchanging whereas modern idealism claims that there is no definable reality beyond the appearances of things in consciousness,[55] which appears to have more in common with antirealism, although not necessarily. But is Platonism really realist? Yes, it is *extreme* realism, the only sort that is capable of accounting for nonphysical objective truths, the physical universe, and the sentient creature who comprehends both. Consider here Gerson's remarks.

> What was beyond dispute, however, is that Platonism is firmly committed to the existence of an intelligible, that is, immaterial or incorporeal realm, that is ontologically prior to the sensible realm. Thus, Platonism is a form of explanatory realism, in principle similar to theories that posit neutrinos or the unconscious to explain certain phenomena.[56]

As I discuss in the final chapter, the principle of absolute or divine Unity, the One, what Newton called 'IT',[57] must be posited if we are to offer a realist explanation for how anything exists at all where the interactions between physical entities can be understood via mathematical representations of physical laws that are responsible for the constant relations between the phenomena. As Clark notes in a different context, Platonism is an older realism,[58] which, of course, is what some scholars now call ancient idealism. Some people prefer to call Platonic realism an idealist-realism, which falsely suggests a compromise between the two positions, which is especially problematic (if not impossible in principle) if one accepts contemporary notions of idealism and materialist realism.[59] But as classicist Kevin Corrigan notes, in *Ennead* I, 1, 7 Plotinus 'spells out his

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[54] For example, Whittaker, 1928, p. 13; Goswami, 1993, pg. 57, 61; Norris, 2002-A, p. 137-138.
[55] Whittaker, 1928, p. 40.
[56] Gerson, 2005-A, p. 263. See also Santillana, 1957, pp. 24–25.
[57] Oderberg, 1986.
[58] Clark, 1995.
[59] Cf. Roberto Poli: 'Another problem is the relationship between the realms of the real world and the ideal world. Until a way to coordinate forms of reality and ideality is found, it will be impossible to understand the unreasonable effectiveness of mathematics, as well as the ability of values to become dimensions of reality.' (Poli, 2001, p.279.)

own peculiar idealist-realist, but definitely Platonist, version of perception.'[60] Thus, it is not uncommon to think of idealist-realism, but it is much less confusing and more accurate simply to say 'Platonic realism' or, simply, 'Platonism' for convenience.

Given that quantum theory is so poorly understood at the conceptual foundations, providing a metaphysical framework within which one can begin to grasp various apparent paradoxes is clearly an important step. Second, as I discuss in the final chapter, some philosophers have attempted to argue against the notion of unity while some physicists have been suggesting that the laws of physics are not stable, yet both views are incoherent and, if truly believed and applied, would make science impossible. It is the general Platonic notion of pervasive unity and the more specific notions of mathematical and scientific Platonism that counters such ill-conceived positions, which if permitted to spread will continue to hinder our understanding of physics and thus impede future technological progress. Third, as I discuss briefly at the end of Chapter Six, antirealism in academia and society in general is often derived from misinformed and misunderstood assumptions about the supposed antirealism in quantum theory, and by showing explicitly how quantum theory necessarily presupposes realism we help put an end to such misleading beliefs.

Finally, and probably most importantly, if Platonic realism is true, then the pre-eminent unifying principle known as the One, which Platonists have identified as the ultimate nature of reality, must be supreme Good. The metaphysics that the Platonists put forward thus entails that the universe is intelligible, beautiful, and good, and humans need to transform themselves in order to follow these ultimately real moral/spiritual realities. As the ancients would say, 'we should become like God'.[61] However, because the Platonic

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[60] Corrigan, 2005, p 67.

[61] Cf. Harris: 'Contemporary physics, we have observed, has abolished the classical materialism and has made it impossible any longer to maintain the sharp separation between the physical object and the observer. It has established the internal character of the physical relations and the unity of the physical universe. Philosophically considered, the essential nature of the whole so revealed requires a dialectical structure that leads inevitably to religious conclusions.' (Harris, 2000, p. 270.) I think Harris is correct, except that I would use the word 'spiritual' instead of 'religious'. Biblically, the term 'religious' (*threskos*-θρησκος) meant to be 'careful of the externals of divine service', whereas 'spiritual' (pneumatikos-πνευματικος) was used variously but a key meaning was to denote 'things that have their origin in God [but higher in the scale of being than man in his natural state], and which, therefore, are in harmony with His

tradition is so little understood today, and because there are several prejudices in analytic philosophy concerning this tradition, including a distrust of interdisciplinary studies (that actually take the philosophical thoughts of the leaders in other disciplines seriously on their own terms), metaphysics, faith, and the style of philosophical writing that is necessary to begin even to approach an understanding of Platonism or the metaphysical way of thinking of Einstein and Heisenberg, I have had to spend my time in this thesis developing and defending the first three motivating factors, which together are more than good enough reason to claim that quantum theory is Platonic realist.

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character.' (Vine, 1952.) Such a view, where there are grades of reality that have more being when closer to the One (or God) is, as I will show throughout the thesis, an essential assumption of Platonism and physics.

CHAPTER ONE: Analytical Philosophy – Time to Bow Out?

Introduction

What exactly is analytic philosophy? 'As in the case of chicken-sexing, it is relatively easy to identify analytic philosophy and philosophers, though difficult to say with any precision what the criteria are.'[62] Analytic philosophers generally believe that the 'linguistic turn' (which means ignoring experience and focusing solely on language) coupled with symbolic logic can 'turn philosophy into a scientific discipline.'[63] The irony, of course, is that while pretending to be emulating the sciences, such philosophers have generally ignored both the philosophical thinking of the greatest pioneering physicists and the metaphysical implications of the most powerful scientific theory in history.[64]

After a brief historical background of this tradition we will be in a better position to appreciate the five main false assumptions embedded in analytic philosophy that are impediments to my thesis because they are incompatible with the metaphysical assumptions and implications of modern physics. These assumptions include: (1) the history of philosophy is irrelevant; (2) metaphysics should be eradicated; (3) the linguistic turn provides the only way for proper philosophy; (4) the relation between nonphysical consciousness and matter is not a serious philosophical question;[65] and (5)

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[62] Audi, 1999-B.
[63] Rorty, 1999.
[64] Although the number of diverse dissenters is growing (See Adams & Spencer, 2005, 2006), analytic philosophy is still dominant in 'Western' philosophy departments. Many of the unquestioned assumptions of analytic philosophy limit its applicability to such an extent that it is not only generally useless for most other disciplines but only a handful of specialists seem to know the insider's jargon well enough to participate in discussions. (See Hadot, 1995, 2002, and Spencer 2005.) This insularity prohibits the reflective physicists (and other 'outsiders') benefiting from the logical acumen of philosophers.
[65] Solso (2003) points out the interesting statistic that in 1950 there were about 23 articles published on consciousness, whereas in 2000 there were approximately 11, 480. Thus, while there is now growing interest in the role of consciousness, it was mostly neglected by philosophers at the time when quantum theory was first unfolding. Second, despite important exceptions, the general consensus in philosophy, psychology and psychiatry is that consciousness, if it exists at all, is merely an epiphenomenon resulting from neurological complexity. Yet, many pioneering physicists, as I discuss later, have thought of consciousness as being immaterial and prior to physical reality. Moreover, there remains a pervasive prejudice against the style in which such questions about the nature of consciousness may even be asked, a fact that is difficult to reference because nonconforming papers do not get published or taken seriously.

there are logically and physically separate atomic facts. And even more fundamentally, I also discuss the limited applicability of the nature of analysis itself. By undermining such assumptions, the metaphysical door opens for both the philosopher and the physicist to take seriously the deep and perplexing questions and paradoxes embedded in quantum theory.

In general, this chapter defends Harris' view that 'what is overtly styled the philosophical revolution of the present day—the 'analytical' movement led by Russell, Moore, Wittgenstein and Carnap—has gone diametrically in the opposite direction [to the twentieth-century revolution in physics].'[66]

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[66] Harris, 1983, p. 37.

A Brief History

Gottlob Frege is generally considered to be the 'grandfather of analytical philosophy'[67] who, despite being a Platonist (at least a logical/mathematical Platonist), helped prepare the way for logical positivism and analytical philosophy. Sociologist Randall Collins reveals the irony that 'Frege's Platonism, when broadened into an epistemology, gave rise to the imperious claims of logical positivism,'[68] while at the same time opening 'the path for Wittgenstein and the recognition that a language or symbol system contains multiple levels.'[69] Here we can see how, by neglecting their own history as well as the history of philosophy and science in general, analytic philosophers have been able to utilize key ideas from Platonism while at the same time pretending to despise Platonism and the history of philosophy in general. Needless to say, such philosophers are not too keen about having these issues exposed.

Dummett argues that contrary to the standard view concerning the development of so-called 'Anglo-American' philosophy, Russell and Moore were at best only 'great uncles' for the analytic philosophy movement because the real impetus came principally from the German philosophers.[70] Dummett seems to be correct here, as concerns the beginnings of the movement, but Russell, Moore, Wittgenstein, and Quine were among the most important developers of this movement. Collins seems to offer a balanced perspective: 'Modern logical philosophy comes from the convergence of two lines, German and British. Russell, who brought them together, was the product of a British network going back several generations.'[71]

Analytic philosophy took deep root in North America and the UK and has had tremendous influence on the development of aspiring young philosophers, especially by strongly discouraging them from thinking metaphysically. But the speculative metaphysical thinking of the ancient philosophers was in principle the same sort of

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[67] Dummett, 1996, p. 14.
[68] Collins, 1998, p. 703-704.
[69] Collins, 1998, p. 704.
[70] Dummett, 1996, p. ix.
[71] Collins, 1998, p. 705.

thinking that occupied the minds of the founders of quantum theory, even though their methodologies were less philosophically developed.

However, it might be argued that positivism played a vital role in the development of relativity and quantum theory, which would already indicate the importance of philosophy for physics.[72] But the positivists were actually *anti*-philosophy. In *The Unity of Science*, Rudolph Carnap writes that 'the Viennese Circle Does Not Practice Philosophy' and that they '*pursue Logical Analysis, but no Philosophy.*'[73] Carnap was explicit in his dismissal of philosophy, which is highly significant since he and his comrades were to have such an important influence on the development of analytic philosophy. The obvious question to me is: if they admittedly did not do philosophy, then why didn't they get out of philosophy departments?[74] In no way am I being naively partial or merely polemical. My question is simply a logical corollary from the positivists' own admission that they do not practice philosophy. If I champion the fact that I do not practice medicine, despite having a medical degree, then it is entirely consistent to refuse to refer to me as a medical doctor when I myself do not. Similarly, it seems highly inappropriate to say that the positivists were philosophers, when, by their own admission, they did not do philosophy.[75]

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[72] Collins (1998, p. 722) notes the antirealism of some of the early positivistic physicists. I cannot give a detailed analysis of all the various aspects of positivism and empiricism, but I do discuss and clarify the most relevant points with respect to my goals. For a more detailed discussion of positivism, see Hacking, 1983, and Collins, 1998.

[73] Carnap, 1995, p 29. (Original emphasis).

[74] Spencer, 2007, p. 106, and Adams & Spencer (2007) raise this question.

[75] Consider the following hypothetical scenario. Medical doctors practice an art and rely on the sciences. They use various scientific technologies, whether x-rays or the latest pharmaceuticals, yet they also require intuition, sensitivity, and empathy—at least ideally. Some people would argue that such characteristics fall outside the realm of science and into psychobabble nonsense. Imagine a small group of x-ray technologists who claim that they will save the medical profession from such non-scientific nonsense because it is the x-ray technology that tells us whether or not a patient has a broken collarbone, tuberculosis, or a serious dental problem. Empathy, sensitivity, and intuition are not required, nor is it necessary to ask the patient what she feels about her own body or state of mind because all such things are nonsense when compared with the precision of scientific measurements. Then imagine that these x-ray technologists claim that they do not practice medicine and refuse to engage with typical medical questions, such as asking the patient how she feels or where it hurts, and instead will reduce all medical practice to x-raying. Then these technologists take over the medical schools and ban all those who practice the 'old fashion' nonsense art of medicine. The coup is complete. This is exactly what has happened in academic philosophy, whereby a minority of logical positivists, who excelled in devising and implementing important logical tools, overran traditional philosophy. They expunged the most meaningful and important philosophical questions and

Heisenberg, for example, one of the chief founders of quantum theory, is usually called a positivist,[76] and at some points he does sound like one when saying that we derive empirical laws only from observations, but his apparent positivism was really a denial that atoms are actual physical objects.[77] It is not that atomism (or materialism) and positivism are identical, but his rejection of materialism and reliance on mathematical rather than pictorial representation of the subatomic realm has often been seen as being positivist. However, the positivists had no concern about whether or not the mathematical laws were actually true aspects of reality, yet Heisenberg unambiguously believed in the nonphysical reality of such mathematical laws of physics. He was rejecting materialism and the parochial limitations of positivism, which does not necessarily lead to empiricism. But he also admits that there were (or appear to have been) elements of positivism in relativity and quantum theory, for Ernest Mach had some influence on both Einstein and Heisenberg, yet he adds that Mach's influence should not be overestimated.[78] This caveat is important because Mach was anything but a straightforward positivist. After all, Schrödinger claims that Mach's views were very close to the orthodox dogma of the Upanishads,[79] and Philipp Frank notes that despite his positivism, Mach has also been 'proclaimed as a champion of the idealistic philosophy in modern science and as a leader in the struggle against materialism.'[80] Stanley Jaki adds that 'Mach could even speak of Buddhism as a religion most germane to science.'[81]

Moreover, as I discuss in Chapter Five, Heisenberg was essentially a realist and was mostly against the parochialism of positivism, although I do not mean to suggest that the positivists had no influence on Heisenberg whatsoever. My point is that he was not a positivist because he refused to accept their self-defeating, anti-philosophical parochial limitations. Both Bohr and Heisenberg agreed with the positivists that we should attempt

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modes of thinking in much the same way as our hypothetical x-ray technicians overthrew the medical doctors.

[76] For example, Baggott writes that Heisenberg took 'a fairly uncompromising positivist stance' (Baggott, 2004, pp. 103-104).

[77] Heisenberg, 1971, pp. 122-123.

[78] Heisenberg, 1974, p. 18.

[79] Schrödinger, 1964, p. 37.

[80] Frank, 1941, p. 212.

[81] Jaki, 1978-A, p. 159. For a critique of Mach's views and how Einstein ended up rejecting him, see Yourgrau, 2005, pp. 34-35, 37, 49.

to give the most accurate and precise clarification of whatever we are talking about, insofar as we are able, but such demands are not the sole province of the positivists: the desire for analytical precision goes back at least to Plato.[82] Moreover, Heisenberg states bluntly that 'the Copenhagen interpretation of quantum theory is in no way positivistic'.[83] He also calls positivism a 'pointless philosophy'[84] and rightly claims that the 'insistence on the postulate of complete logical clarification would make science impossible.'[85] Indeed, we cannot even unambiguously define what we mean by 'matter' or 'energy' without immediately falling into circular reasoning.

Contrary to one of their own central tenets, the positivists sought the *unity* of the sciences, even though such a concept has no physical reality and is purely metaphysical. As Comte put it, 'the first characteristic of the positive philosophy is that it regards all phenomena as subjected to invariable natural *laws*.'[86] Finally, Mach's empiricism (or whatever metaphysical view he held), an important ingredient of positivism, sought 'the comprehension of as many facts as possible by the simplest possible system of propositions.'[87] Ironically, and as we shall see in detail in Chapter Seven, the seeking of unity, simplicity, and invariable natural laws makes the positivists appear to be straightforward mathematical and scientific Platonists. Yet, the positivists abhorred the Platonists, which adds to the confusion about why the analytics and positivists ignored the deep metaphysical thinking of the physicists such as Bohr, Heisenberg, Pauli, Einstein and Schrödinger.[88] This irony is exacerbated by the fact that Frege himself was a

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[82] Mark Daniels notes that 'This view [that ancient philosophy was a waste of time] was eventually overcome by Gilbert Ryle who found that Plato's later dialogues were actually 'doing' analytic philosophy and were thus of some interest after all!' (Daniels, 2006.) Of course, we do not need Ryle to tell us that Plato is worth studying and that he sought logical clarification of ideas and terms so far as possible. 'The method of making distinctions to solve philosophical problems is ubiquitous. Reading Plato should suffice to convince one that the method goes right back to Socrates.' (Mortensen, 2000, p. 342.)

[83] Heisenberg, 1958-A, p. 145.

[84] Heisenberg, 1971, p. 213. For further criticisms of positivism, see Jaki, 1978-A, 1978-B, and Medawar, 1984, p. 66.

[85] Heisenberg, 1958-A, p. 86.

[86] Comte in Hacking, 1983, p. 47.

[87] Frank, 1941, p. 215.

[88] Cf. Hacking notes that Kuhn also seemed to be a realist in many ways and believed that theories should be 'simple in structure and organize facts in an intelligible way.' (Hacking, 1983, p. 13.) Interestingly, Collins notes that 'the last notable act of the *Encyclopedia*, and hence of the Vienna Circle's organizational core, was to commission Thomas Kuhn, a physicist turned historian, to write *The Structure of Scientific Revolutions*.' (Collins, 1998, p. 730.)

Platonist.[89] But the positivists tried to reject metaphysics and believed that 'concepts such as "mass," force," and "atom" are merely convenient fictions for simplifying observations,'[90] but they still unwittingly adhered to several key Platonist ideas.

As Collins convincingly argues, the founders of analytic philosophy were essentially mathematicians and those such as Russell and Wittgenstein were actually 'hostile to philosophy.' They ended up in the attention space of philosophers because that is where the most interest was to be found concerning meta-mathematics. Russell then tried using his mathematical logic to purge all of philosophy from 'meaningless' metaphysics.[91] Unfortunately, Russell's prejudices impaired analytic philosophers' ability to comprehend the depth of the implications of quantum theory. And his pessimistic belief that all life, and every action, thought, and feeling, ends up being meaningless because all things are destined for 'extinction in the vast depth of the solar system', may, as Ervin Laszlo writes, 'be the chimeras of an obsolete view of the world.'[92]

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[89] For example, Yourgrau, 2005, p. 35. Cf. Dummett: 'On Frege's view, thoughts and their constituent sense form a 'third realm' of timeless immutable entities which do not depend for their existence on being grasped or expressed,' (Dummett, 1996, pp. 22.23), which sounds like straightforward Platonic realism.
[90] Collins, 1998, p. 722.
[91] Collins, 1998, pp. 696, 711-713.
[92] Laszlo, 2004-A, p. 15. (see also Russell, 1903.)

Five False Assumptions

In his 1998 APA (American Philosophical Association) sponsored address at the XXth World Congress of Philosophy, Robert Audi outlined several major problems facing academic philosophy today: (1) Philosophy is weak in undergraduate education in the US and elsewhere; (2) Philosophers are not engaging with the public sufficiently; (3) diminishing research support (often because of (2); (4) & (5) concern an insufficient balance between philosophical grounding and highly specialized or interdisciplinary work, and too little engagement with or even study of other fields; and (6) a provincialism manifested in, for example, 'stereotyping the views or methods of other philosophers or in positive indifference to alternative perspectives.'[93] My critique engages with some of these problems while delving into more depth concerning specific prejudices of the analytic tradition. Indeed, Norris writes that 'it may be argued that analytic philosophy of science has taken a number of wrong turns as a consequence of its becoming so far out of touch with developments elsewhere.'[94]

But I should note that although the assumptions I critique are usually associated with analytic philosophy, it is likely to be the case that there are a few philosophers who consider themselves to be 'analytic' but who do not necessarily hold all of these assumptions. Or, there may be philosophers who hold one or all of these assumptions yet maintain that they are not analytic philosophers. Hence my critique is more specifically aimed at a particular set of assumptions that have hampered fruitful dialogue between deeply reflective physicists and philosophers concerning fundamental conceptual difficulties in quantum theory. Nevertheless, it is generally the case that such assumptions are more likely to be held by analytic philosophers and so aiming my criticisms at analytic philosophy in general (and recognizing the possibility of exceptions) is clearly warranted. It is also the case that the assumptions that I critique may be useful in other philosophical contexts, perhaps in the philosophy of language, but these assumptions are still antithetical to reflecting deeply about fundamental philosophical issues in quantum theory, and, therefore, they must be criticized and set aside in this thesis.

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[93] Audi, 1999-A, pp. 139-140.
[94] Norris, 2000-B, p. 107.

(1) The first assumption that I will consider is that the history of philosophy is irrelevant, which was vociferously championed by Carnap and culminated in Quine, who 'made a point of reading as few of the canonical texts as possible, and he recommended this practice to his students at Harvard.'[95]Yet, ironically, *all* the founders of analytic philosophy have now passed into the *history* of philosophy and so by Quine's own demands we should not study them. However, the meaning of 'history' is ambiguous. Strictly speaking, the sentence prior to this sentence you are currently reading is now a part of history. Each moment that passes becomes part of history, so it seems that Quine was not being analytically precise when he dismissed the history of philosophy because he never clarified what he meant by 'history'.

It therefore strikes me as being one of the bigger hypocrisies in the history of philosophy for analytic philosophers to develop a whole research program dedicated to the history of analytic philosophy.[96] Dummett writes that 'it is important to analytical philosophy that it understands its own history, seeing itself in the context of the general history of philosophy during the nineteenth and twentieth centuries: especially is this true at a time when it is undergoing profound changes.'[97]

How can we justify studying the history of analytic philosophy while neglecting the importance of the history of philosophy in general? Perhaps Quine's followers are unaffected by this glaring inconsistency because apparently the reason we should not study the ancient philosophers is because they were wrong about everything—each and every one of them.[98] But only by actually reading the ancients and understanding their arguments in detail could Quine possibly have had rational grounds to disagree with

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[95] Rorty, 1999.

[96] Norris too disapproves of the fact that 'one distinctive feature of work in the broadly 'analytic' tradition is its tendency to treat philosophical issues as if they spring fully formed at each moment and can therefore be addressed with a minimum of reference to episodes in their own formative prehistory.' (Norris, 2002-A, p. 18.)

[97] Dummett, 1996, p. 1.

[98] As was confessed to me by the head of a predominantly analytic philosophy department in Canada, the history of philosophy is really to be understood as being a bunch of dead ideas. Thus, a philosopher's ideas are only relegated to the history of philosophy if they are no longer relevant. But if this is true, then questions raised in quantum theory entail that the thoughts of the ancient Platonists are relevant to modern science (and in many other areas), and so, rather oddly, Platonism should not be considered as part of the history of philosophy.

them. But, as Richard Rorty states, he emphatically made a point of *not* reading the ancients, and therefore could only have proclaimed dogmatically that they were wrong.[99]

Moreover, saying that the history of physics is irrelevant to current scientific research, as Quine proclaimed, is erroneous for several reasons. First, physics graduates today must be knowledgeable about relativity, which is more than a hundred years old now. If Quine were correct that the history of physics is irrelevant to modern physics, then we should not study this theory but should concern ourselves only with the current number of dimensions postulated in string theory. Quine, for example, probably would have replied that the 'history of physics' refers only to those theories that have been rejected and no longer constitute part of the body of accepted scientific theories. But such a view would be disastrous to physics. Copernicus revived a 'dead' theory from the past, and at various points it was believed that particle theories were replaced by wave theories and vice versa. And atomism has been rejected, revived, and rejected.

Moreover, we can only know that some theory was in fact proven to be wrong in the past, which will help us from making the same mistake again, if we actually study the history of physics. It seems to be true that many experimental physicists do not need to know the history of physics or even whether or not Planck's constant is merely a fiction or a symbol of a true aspect of reality, but *some* physicists, notably the pioneers, need to think and be knowledgeable about such issues. Rorty admits that in seeking tenure he realised that 'there was little percentage in being historically minded,'[100] which is very important because it may help to explain why there has been such resistance to taking seriously the metaphysically-inclined physicists who were influenced by ancient philosophy and tended to think in such ways as those philosophers.

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[99] Ryan Nichols writes that 'many of the best contemporary analytic philosophers have not made detailed historical studies of the views they oppose (or for that matter, any historical studies at all), and some, as we have witnessed, express a thinly veiled contempt for such projects.' (Nichols, 2006, p. 34.)
[100] Rorty, 1999.I deleted an obvious typing error in the original, where he has written 'in being in being '.

(2) The second unnecessary assumption is that metaphysics should be eradicated, an ideology propagated by Carnap, Russell, Wittgenstein, and Quine etc.[101] There are many possible areas to explore in criticising these anti-philosophy 'philosophers', so I will narrow the focus to only a few essential points. First, Russell has admitted that he 'cannot admit any method of arriving at truth except that of science,'[102] which, despite aiming to eradicate the need for philosophy (and art and moral reasoning) is a metaphysical statement leading to a similar problem as the paradox of positivism: there is no scientific experiment that could ever prove the statement that the only method of arriving at truth is that of science. Thus, this statement itself is metaphysical and, therefore, by its own demands, cannot be true or even have any meaning because it is not a scientifically proven statement. Even the act of defining what the sciences and their methodologies are belongs to philosophical inquiry. Einstein aptly rebuked Russell in a review of his book, *An Inquiry into Meaning and Truth*: 'In view of these endeavours I am particularly pleased to note that, in the last chapter of the book, it finally turns out that one can, after all, not get along without "metaphysics." The only thing to which I take exception there is the bad intellectual conscience which shines through between the lines.'[103]

Einstein had good occasion to be intimately acquainted with Russell's anti-metaphysical views. Russell reminisces:

> While in Princeton, I came to know Einstein fairly well. I used to go to his house once a week to discuss with him and Gödel and Pauli. These discussions were in some ways disappointing, for, although all three of them were Jews and exiles and, in intention, cosmopolitans, I found that they all had a German bias towards metaphysics, and in spite of our utmost endeavours we never arrived at common premises from which to argue. Gödel turned out to be an unadulterated Platonist, and apparently believed that an eternal 'not' was laid up in heaven, where virtuous logicians might hope to meet it hereafter.[104]

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[101] For example, Yourgrau, 2005, p. 28, and Collins, 1998, p. 713.
[102] Russell, 1997, p. 189.
[103] Einstein, 1954, p. 24.
[104] Russell, 1968, p. 224.

Yourgrau writes that 'the failings of an entire century are crystallized in the fact'[105] that Russell could not find any common ground upon which to engage in deep discussion with two of the greatest physicists and the greatest logician of the last century. His inability to relate to them was essentially because of *his* bias *against* metaphysics and especially against Platonism. Thus, philosophy, including philosophy of science, would develop in directions that placed it squarely against developments in modern physics, as Harris has argued extensively. It is also important to note that Pauli and Einstein generally had very different views about the interpretation of quantum theory, yet they seemed to be in agreement about *how to think* about such issues.

If we criticize the physicists' attempts at philosophical reflection and dismiss them because they are not analytical enough, then we have admitted that physicists do not need to think analytically (in the philosophical sense) in order to do physics. Hence, since the physicists have such tremendous success with their science and apparently have not needed to be able to do philosophy (when we define philosophy as being nothing more than analytic philosophy) then quite clearly analytic philosophy is useless for the development of physics. Even though I disagree with Hawking's positivism, he is correct to dismiss philosophers who have followed Wittgenstein as being incapable of participating in discussions with the physicists about the nature of reality.[106] Hawking paraphrases Wittgenstein as saying that 'the sole remaining task for philosophy is the study of language.' He then adds, 'What a comedown from the great tradition of philosophy from Aristotle to Kant!'[107] As we have already noted, not only is philosophy, defined as analytic philosophy, irrelevant to physics, but a plausible argument can be made that analytic philosophy is even irrelevant to *philosophy* since many of its founders

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[105] Yourgrau, 2005, p. 13.

[106] Biologist W. H. Thorpe has an appropriate comment: 'It is hardly too much to say that if scientists had taken [Wittgenstein's *caveat* that 'there may be no deep structure'] seriously, subatomic physics, to say the least, would have dwindled and died.' (Thorpe, 1978, p. 2.)

[107] Hawking, 1988, p. 175. Hawking's not so subtle stab at Plato (and all philosophers after Kant) is most certainly aimed at Penrose, who is a Platonist. Hawking also says that 'in the nineteenth and twentieth centuries, science became too technical and mathematical for philosophers, or anyone else except for a few specialists.' (Hawking, 1988, pg. 174.) Clark has an apt rebuttal: 'The weird assumption that only those with "scientific" training can actually think is as obvious a piece of self-serving ideology as that of any ancient priesthood....Misplaced animism may be an intellectual sin, but so is misplaced mathematization.' (Clark, 1990, p. 31.)

were anti-philosophical. It may be more accurate, however, to say that they were anti-metaphysical, but that really just amounts to the same thing because, as already noted, for Russell, only science can bring us to truth, so philosophy seems to be rather useless, except perhaps as elucidating pseudo problems, showing them to be nonsense. But, as Winston Barnes notes, Wittgenstein's 'notion of elucidatory nonsense is one that only a very subtle mind in a very stupid moment could have conceived.[108] Elucidatory nonsense is still nonsense. As I discuss in Chapter Three, metaphysics, which includes ontology and epistemology, is the essence of philosophical thinking, and so dismissing its ineluctable importance is to be anti-philosophical. And attempts at mere reconstruction, rather than assisting with deep metaphysical speculations and clarifications, have ended up drawing the justified charge from physicists, such as Dominic Dickson, who have said that such philosophers are merely 'arriving after the show trying to tell us what we did.'[109]

(3) The third assumption concerns the so-called 'linguistic turn'. As Dummett notes, in essential agreement with Rorty on this point, the analytics believe that a comprehensive philosophical account of thought can only be obtained through a philosophical account of language.[110] However, 'no justification for the linguistic turn is offered in [Frege's *Die Grundlagen der Arithmetik* of 1884]: it is simply taken, as being the most natural way of

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[108] Barnes quoted in Harris, 2000, p. 61. Of course, Wittgenstein admittedly did not care at all about what other philosophers thought and did not even give any references in his PhD 'thesis'. (See Wittgenstein, 1918, Preface.) And see Goldstein (1999) for a scholarly and entertaining article arguing that Wittgenstein should never have been awarded a PhD. Wittgenstein seems to have been more interested in creating a personality cult centred on him, while using Russell and Moore then treating them badly and usurping (if not plagiarising) them. (Collins, 1998, pp. 735-736.) It is not without many good reasons that Norris and Roy Bhaskar claim that Wittgenstein has had the most harmful influence on academic philosophy in the last century. (Bhaskar & Norris, 1999.)

[109] Dickson made this apt comment during the discussion after my invited lecture 'Platonic Implications of the Metaphysical Assumptions Presupposed by Science', presented for the Science Communication Unit Lecture Series, Department of Physics, University of Liverpool, March 30, 2004.

[110] Dummett, 1996, pp. 4-5.

going about the philosophical enquiry.'[111] I find it significant that arguably the most important assumption of analytic philosophy had no supporting arguments.[112]

It strikes me as being obviously false to assume that all of thought can be expressed in language. However, setting aside possible arguments for or against this assumption, it is even more clearly wrong to assume that what cannot be expressed in language cannot really be thought or experienced, which is the logical corollary of the above assumption.[113] It is this assumption that is most damaging because it disallows any sort of philosophical probing into deeper questions beyond what can be expressed directly through language. Imagine trying to explain the feeling of biting into a lemon to someone who has never eaten one. It does not matter how many descriptive metaphors and similes or detailed physiological explanations one uses, language will never fully capture the experience (or any experience), and so there exist aspects of reality beyond what can be analyzed linguistically. Similarly, if language fails us when trying to think about and describe subatomic events, then analytic philosophy will be of no value whatsoever to the physicists reflecting on the paradoxes and conundrums they face. Thus, the linguistic turn has rendered analytic philosophers incapable of reflecting about quantum theory. As Hacking notes, 'attempts at scientific reduction – reducing one empirical theory to a deeper one – have scored innumerable partial successes, but attempts at linguistic reduction have got nowhere.'[114]

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[111] Dummett, 1996, p. 5. And this fundamental assumption pervades all of positivism and analytic philosophy. For example, M. Black in Carnap writes that 'the analytic method adopted by the Viennese circle culminates in the judgment that there are no distinctive philosophical problems. Speculative philosophy must be transformed into a new methodology, the analysis of linguistic forms.' (M. Black in Carnap, 1995, p. 13.)

[112] Moreover, as Dummett notes, 'Frege indeed so far reacted against 'theories of truth' as to declare truth to be indefinable.' (Dummett, 1996, pp. 15-16.) I think Frege was correct to argue that truth is indefinable, but there are *many* fundamental concepts that are not definable in a non-question-begging way, such as the concept of 'unity.' Let the analytic philosophers study their own history to see how their founder declared such an essential notion as truth to be indefinable, gave no justification for the linguistic turn, and was even a Platonist. And Henry Le Roy Finch writes that 'No concept in Wittgenstein's later philosophy is more difficult to understand and has given rise to more differences in interpretation than the concept of forms of life. The expression occurs only five times in the Philosophical Investigations, and nowhere does Wittgenstein attempt to define it. Yet it is of fundamental importance and has to be understood along with the concept of language-games, with which it is closely associated.' (Finch, 1977, p. 89.) Not only could Wittgenstein not define one his most important concepts, he did not even bother trying.

[113] It is not necessary for my purposes to pursue the intricate distinctions between thinking and experiencing.

[114] Hacking, 1983, p. 50.

(4) The fourth assumption, which is also criticized by Norris, holds that any appeal to constitutive acts of consciousness should be ruled out because they supposedly involve a retreat to naïve psychologism, and that the logico-semantic approach is apparently sufficient.[115] But denial of 'constitutive acts of consciousness' is antipodal to advances in modern science, where the observer has often been recognized as playing a central role. And current research is not taking us further away from such an understanding. For example, based on quantum theory, well-known physicist Amit Goswami has recently argued for a Platonic understanding of primordial immaterial consciousness as the basis for physical reality, [116] and the Platonist Roger Penrose and (more qualified Platonist) Stuart Hameroff argue that quantum coherence may be possible in the brain, given the high degree of isolation provided by microtubule walls.[117]

Since in Chapter Seven I argue in detail for the importance of giving an account of the role of consciousness and the observer, as necessitated by the postulates of quantum theory and by independent argument, all that needs to be noted here is that, regardless of one's conclusion, such questions are embedded in the assumptions of quantum theory and so we need to be open to analyzing them philosophically. Unfortunately, analytic philosophers often do not want to consider such metaphysical questions. Or, if some of them do, their style of writing and method of analysis would still preclude taking the deep questions seriously or at least limit the way in which such questions can be explored. Most certainly, the majority of analytic philosophers have basically ignored the philosophical reflections of the pioneering physicists, especially as concerns the role of consciousness.[118]

(5) The fifth false assumption of analytic philosophy is that the world can be broken down into independently existing states of affairs, where a statement about X has no

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[115] Norris, 2000-B, p. 116.
[116] Goswami, 1993. For example, pp. 57, 61, 82.
[117] Penrose, 1999, p. 125-139; Hameroff & Neimark, 2002.
[118] For more detailed information and abstracts from numerous interdisciplinary conferences considering questions related to consciousness and physics, see the Center for Consciousness Studies, The University of Arizona, Tucson. www.consciousness.arizona.edu/ and David Chalmers' page at http://consc.net/chalmers/

relation to a statement about Y. Harris correctly notes that 'Ayer's pronouncement that "if two states of affairs are distinct, a statement which refers to only one of them does not entail anything about the other" is totally belied. There can be no atomic facts and no atomic propositions.'[119] The reasoning behind this false assumption is partially related to the fourth false assumption because both the fourth and the fifth assumptions neglect the fact that quantum theory tells us that the entire universe is holistically interconnected. But as Norris has argued, those who follow the Copenhagen interpretation of quantum theory (which includes most physicists) tend dogmatically to exclude hidden variable theory alternatives, such as championed by Bohm. And even Bohm agrees with Bohr about the interconnected holistic nature of reality:

> Thus, one can no longer maintain the division between the observer and the observed (which is implicit in the atomist view that regards each of these as separate aggregates of atoms). Rather, both observer and observed are merging and interpenetrating aspects of one whole reality, which is indivisible and unanalysable.[120]

You cannot logically separate observer from the observed, but the logical atomism of Russell, Wittgenstein, and Ayer etc., is utterly opposed to nonlocality, which appears to be a fact of nature.[121] And physicists as diverse as Planck,[122] Schrödinger,[123] Bohr, Bohm and Ian Barbour have recognized that studying individual parts will never give us an understanding of the whole, and it is the whole that we are ultimately seeking. For example, Bohm says that 'the present approach of analysis of the world into independently existent parts does not work very well in modern physics.' He argues that 'both in relativity theory and quantum theory, notions implying the undivided wholeness of the universe would provide a much more orderly way of considering the general nature

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[119] Harris, 2000, p. 101.
[120] Bohm, 1980, p. 9.
[121] Baggott, 2004; Nadeau & Kafatos, 1999; Rowlands 1992; Gibbins, 1989; Norris, 2002-A, p. 40. However, metaphysical interpretation is always necessary. And, it is good to keep in mind how deeply unsettling this concept is to reflective physicists. For example, particle physicist, Mike Houlden, exclaimed in a joint lecture we presented to the Math Society, University of Liverpool, Dec. 2005, 'thinking deeply about this issue [of nonlocality] makes the hairs on the back of my neck stand up!' (Houlden, 20 June 2006.)
[122] Planck, 1931, pp.25-26.
[123] Schrödinger, 1967, p. 30.

of reality.'[124] Harris explains further that in quantum theory, 'physical entities thus have come to be viewed as wholes of integrated and interdependent parts, rather than as separate and isolated particles.'[125]

One may wish to object that even if quantum theory implies physical inseparability among entangled quantum states and with the observer (indeed with the entire universe), it does not follow that we cannot logically have distinct, atomistic *linguistic* parts, and therefore there is still a place for logical atomism even if physical atomism fails. But this objection fails immediately, for the logical and linguistic symbols that are placed in such a way as to make some sort of meaningful utterance are themselves logically inseparable because only together do they form the whole system. Moreover, if the sentences are not purely fictions but represent anything in the physical world, then the sentences too must logically be inseparable. If they represent abstract but real nonphysical relations, then they too are interconnected with all other relations and their common source. Even more technically, the letters and symbols and the means of uttering or writing them are all physical phenomena and so also subject to quantum physics, which says that they must all be interconnected.

Bohm goes on to say how in the East there has, in general, been more attention paid to philosophy and religion and that they made the greatest attempts to seek the immeasurable (such as Bohm's undivided wholeness), whereas in the West we have been more concerned with measuring.[126] In general, Bohm is correct, but he has by-passed entirely the Platonists who not only had the same desire for the immeasurable undivided wholeness, the One or the Good, but also as far as possible aimed to uncover the rationality of the physical universe, which brought about the birth of modern science.

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[124] Bohm, 1980, pp. xi-xii.
[125] Harris, 2000, p. 99. Even well-known futurist, Alvin Toffler, notes that the same sort of integrated holistic approach in business is replacing the outdated 'smokestack' economy based upon Cartesian mechanical assumptions. 'The new model of production that springs from the super-symbolic economy is dramatically different. Based on a systemic or integrative view, it sees production as increasingly simultaneous and synthesized. The parts of the process are not the whole, and they cannot be isolated from one another.' (Toffler, 1990, p. 81.) If businesses and the sciences are ultimately based upon such a holistic, interconnected approach, then analytic philosophers who hold on to their outdated assumptions and insular methodologies are bound to make themselves obsolete.
[126] Bohm, 1980.

Finally, consider the etymological root of 'analysis', which is found in the Greek word analusis (αναλυσις)[127] and originally meant 'a loosening, releasing; dissolution, death.'[128] Such historical meanings may surprise (or upset) the contemporary analytic philosopher, but they would not be out of place for Bohr. Heisenberg recollects Bohr's idea of complementarity applied to biology, where complete knowledge of a cell's molecular structure could only be achieved through methods that kill the cell, and therefore 'it is logically possible that life precludes the complete determination of its underlying physico-chemical structure.'[129] Dissection kills the cell in a similar way that over analysis can result in the 'death' of deep understanding of underlying unity and of interdisciplinary research. Such a conclusion seems inevitable, for if your goal is to understand life but your methods of study kill the organism and thus put an end to life, then you can never study life itself. Similarly, if in philosophy your goal is to study X but your methods force you in to ever-increasing minutely detailed arguments, then they are taking you further and further away from understanding X. I think that, rather ironically, a simple argument can show that there must be a limit to the power of analysis.

Any theory, T, must rest upon a set of axioms (or assumptions), A, whether explicit or implicit. We must ultimately be able to give an account of the veracity of A, but if we use T to prove A then we have begged the question because we have to assume the truth of A in order to rely upon T in the first place. Thus, we can only prove T by resorting to another explanation or theory, T_2. However, T_2 will rest upon a set of axioms A_2 and those axioms will ultimately need to be proven. But any attempt to prove A_2 will lead to the same problems we face in trying to prove A, and this process of external proof must in principle have no logical end, and thus analysis is in principle limitless. If there is no limit, then there can be no definite conclusion. As Whitehead said, we stop when we think things are clear enough. The problem is that when we dislike our opponent's conclusion, we simply need to say that he has not clearly defined his terms etc., in the

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[127] Ayto, 1990.
[128] Liddell and Scott, 2004.
[129] Heisenberg paraphrasing Bohr in Heisenberg, 1958-A, p. 105. Bohr (1958, p. 9) makes this same point.

attempt to destroy rather than to build understanding, which relates to Audi's concerns mentioned above.[130]

If you think it financially prudent to be considered a part of the analytic camp, then, as Dummett notes, you need to be quoting from the most important writers in the field and writing in a style that appeals to such philosophers in order to be consider to be at least part of that tradition.[131] Gödel did not follow this advice and was systematically ignored by the philosophers. I here briefly want to consider Gödel because although not technically a physicist or a philosopher, he was an intellectual giant of the last century[132] and contributed to physics by arguing for the ideal nature of time based on the principles of relativity,[133] and the implications of his theorem about the incompleteness of mathematics are only now starting to be more fully appreciated (and not as stubbornly and fearfully ignored) by physicists and philosophers.

> It should also be obvious that the more advanced is a physical theory the more mathematics it contains and the more advanced is the mathematics. From this the ground for connecting Gödel's theorem with physics readily follows. For insofar as Gödel's theorem states that no non-trivial system of arithmetic propositions can have its proof of consistency within itself, all systems of mathematics fall under

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[130] Clark makes a similar point: 'Undergraduate students of philosophy (and some of their elders) believe that the task of a philosopher is simply to criticize, and to find fault with arguments even for conclusions that no-one has any serious interest in rejecting. I do not share this view. Analytical criticism, even destructive criticism, is often a good thing, but the real aim of philosophy is not to destroy, but to understand and explore.' (Clark, 1986 p. ix.)

[131] Dummett, 1996, pp. 4-5.

[132] Yourgrau, 2005, p. 56; Collins, 1998, p. 727-728.

[133] Gödel offered 'unsuspected cosmological solutions to the field equations of general relativity...In the possible worlds governed by these new cosmological solutions, the so-called rotating or Gödel universes, it turned out that the space-time structure is so greatly warped or curved by the distribution of matter that there exist timelike future-directed paths by which a spaceship, if it travels fast enough—and Gödel worked out the precise speed and fuel requirements, omitting only the lunch menu—can penetrate into any region of the past, present or future.'(Yourgrau, 2005, p. 6).

But, as Yourgrau continues, if the time travel is actually possible, at least in principle, then, as Gödel pointed out, 'if we can revisit the past, then it never really "passed". But a time that fails to pass is no time at all. Einstein saw at once that if Gödel was right, he had not merely domesticated time: he had killed it...In a word, if Einstein's theory of relativity was real, time itself was merely ideal.... But now something truly amazing took place: nothing. Although a few physicists bestirred themselves to refute him and, when this failed, tried to generalize and explore his results, this brief flurry of interest soon died down. Within a few years the deep footprints in intellectual history traced by Gödel and Einstein in their long walks home had disappeared, dispersed by the harsh winds of fashion and philosophical prejudice'[133] (Yourgrau, 2005, p. 7).

> this restriction, because all embody higher mathematics that ultimately rests on plain arithmetic. Then it follows that there can be no final physical theory which would be necessarily true at least in its mathematical part.[134]

As Jaki further notes, it is not that Gödel showed a final theory of everything is impossible; rather, we can obtain a temporary theory that incorporates all other known theories but we can never know that we have actually discovered the final theory.[135] To believe that we can ever actually have the final theory of everything is incredibly misplaced arrogance, without relying upon Gödel to help prove this point. As Medawar notes, the goal of scientists' work is asymptotic, 'for there can be no apodictic certainty in science, no finally conclusive certainty beyond the reach of criticism. There is no substantive goal; there is direction only, that which leads toward ultima Thule, the asymptote of the scientist's endeavors, the "truth".'[136] However, the possible confusion is that Medawar's statement that there can be no certainty is itself a statement of certainty. This certainty of the uncertainty (or better stated, rejection of absolute certainty) in science is a metaphysical certainty. We can be metaphysically certain that the laws of physics, whatever they are, must pre-exist the physical world, despite the fact that we will never know all of them in absolute detail and so can never be certain that we have the final truth.

But if the physicists feared Gödel's reasoning, why did the philosophers turn away? Yourgrau provides the answer: 'More than most academic philosophers, [Gödel] engaged in philosophy in a manner of which Parmenides and Plato would have been proud: asking fundamental questions about the nature of time, being, death, God and the world of transcendent forms, or "ideas."'[137] Yourgrau shows clearly how the philosophers ignored Gödel because he refused to pay homage to their masters and instead was a Platonist who actually thought in the same sort of way as the ancients.[138]

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[134] Jaki, (on line essay, no date given, but 2003 or later), *A Late Awakening to Gödel in Physics*, p. 4.
[135] Jaki, *A Late Awakening to Gödel in Physics*, pp. 9-11.
[136] Medawar, 1984, p. 5.
[137] Yourgrau, 2005, p. 165.
[138] Yourgrau, 2005, p. 168.

Summary

The five false assumptions that would impede the sorts of questions I am pursuing and methodology that I am using in this thesis are the following:

1) The history of philosophy is irrelevant;
2) Metaphysics should be eradicated;
3) The 'linguistic turn' entails that a comprehensive philosophical account of thought can only be obtained through a philosophical account of language;
4) Discussing seriously the nature of consciousness and its relation to physical reality results in naïve psychologism;
5) The physical and logical worlds can be broken down into independently existing states of affairs where a statement about one does not entail anything about any other.

Polanyi stresses that freedom of inquiry is essential to the sciences,[139] and so to philosophy and any discipline. But analytic philosophy has had too many prejudices (especially during the time of the development of quantum theory) regarding the role of consciousness, atomic facts, metaphysics, and the important role of ancient philosophy. It also demands an esoteric writing style that excludes philosophically inclined physicists (among others), and it has false assumptions about philosophy only being allowed to discuss the role of language rather than seriously considering ontological questions about

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[139] Polanyi, 1964, p. 62.

the nature of reality. Therefore, we 'must refuse to limit the philosophical enterprise to this linguistic propaedeutic.'[140]

> For such useful work as [analytic philosophy] may have done, let us applaud it as it bows out, and let us get back to work as genuine philosophers attacking problems that seriously affect our life and thought, seeking illumination that (as may now be generally admitted) competent metaphysical speculation can afford.[141]

[140] Harris, 2000, pp. 65-66.
[141] Harris, 2000, p. 66.

CHAPTER TWO: An Interdisciplinary Approach

Introduction

There is abundant conceptual confusion in modern physics and an interdisciplinary approach is necessary if there is to be any hope of sorting out these numerous philosophical and theoretical difficulties.[142] This philosophical confusion is not just an afterthought to physics; it begins at the foundations. As Rowlands notes, many of Newton's contemporaries who accepted the instrumental value of his mathematical laws nonetheless rejected his qualitative thinking that underpinned it.[143] Similarly, by ignoring the philosophical (and sometimes mystical) aspects of the thoughts of the pioneering physicists, we have found ourselves unable to understand modern physics at the foundational level and have unfortunately assumed that quantum theory is antirealist. Jim Baggott acknowledges that 'students are likely to blame themselves for failing to understand quantum theory.' 'This is a great pity,' he continues, 'because this non-understandability can, in fact, be traced to the anti-realism of the Copenhagen interpretation. The theory is, quite simply, not *meant* to be understood.'[144] It is not really that quantum theory is not meant to be understood; rather, it is not possible to understand it from a materialistic, straightforwardly naïve realist perspective; in other words, our commonsense fails.

In this Chapter, I first discuss the relationship between physics, philosophy, and classics, showing how various relevant physicists believed in the necessity of an interdisciplinary

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[142] A recent study in the UK has shown that 'interdisciplinary research is pervasive throughout higher education. Around four-fifths of researchers report that they are engaged in at least some interdisciplinary work.' (Research Assessment Exercise, 1999.) My experience as founding president of the Interdisciplinary Forum (IDF) at the University of Liverpool (www.liv.ac.uk/idf) indicates that this statistic is accurate, and it is my intention that this thesis will help to foster interdisciplinary research in general and especially between physics and philosophy. Of course various physicists and other scientists are already collaborating on such border-crossings, but the Research Assessment Exercise (RAE) is still biased towards discipline-specific research. Dickson, a physicist at Liverpool, is a welcome exception, and his Science Communication Unit and theatrical production, *Big Bang*, have made great progress towards integrating the arts and sciences in original and inspiring ways. Nevertheless, his polymathic abilities and original projects have yet to be integrated properly by mainstream researchers. There is still much work required to bring about the administrative changes necessary to understand and properly utilize interdisciplinary research, especially between the arts and sciences. (Cf. Snow, 1998.)

[143] Rowlands, *Theology and Modern Physics*.

[144] Baggott, 2004, Preface. Original emphasis.

approach. I also discuss how beauty plays a vital intersecting role between the three disciplines and how through studying ancient philosophy we learn how to pose questions of principle, which is so important to foundational, pioneering thinking in physics. In the next section I show how these pioneering physicists could not avoid being logically inconsistent in some ways yet were still rational, while on the other hand they sometimes held views that were not rationally consistent either, and we can begin to sort through such conceptual confusion. Finally, I discuss some difficult challenges of interdisciplinary research

Physics, Philosophy, and Classics

Throughout the history of the development of European universities, the process of generating new specializations has been the driving point of creativity in academia, since such differentiation allows for combining new ideas.[145] Mathematical science was also the originator of interdisciplinary pressures that influenced the development of the major schools of modern philosophy,[146] a trend which culminated in the development of positivism and analytic philosophy, as already discussed in Chapter One. Of course, historically there has always been a mutual influence between philosophy and the sciences, so why is it so difficult now to get philosophers to take physicists seriously as philosophical thinkers? Besides the reasons already mentioned, another important factor to discuss here is that physicists are not and apparently cannot be as systematically rigorous and consistent as the philosophers demand. But before I purse this point in the next section, I first want to outline briefly the importance of an interdisciplinary perspective, especially one that necessarily incorporates philosophy, physics, and classics, in order to foster greater understanding in all three disciplines.

Schrödinger and Heisenberg had some fundamental disagreements about the interpretation of quantum theory, but they agreed on the necessity of interdisciplinary research. Heisenberg said that the sciences are compelled to engage with philosophy 'if we wish to make fundamentally important advances and to understand them.'[147] And Schrödinger said that specialization was an 'unavoidable evil' but that 'all specialized research has real value only in the context of the integrated totality of knowledge.'[148] Heisenberg is acknowledging that philosophy is fundamentally important for making advances in the sciences, for it is impossible to understand our scientific research without reflective and at least somewhat systematic thinking. Schrödinger is making a related

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[145] Collins, 1998, p. 668.
[146] Collins, 1998, p. 695.
[147] Heisenberg, 1974, p. 209.
[148] Schrödinger,1952, p.7. The following simple analogy may help support Schrödinger's view. I can have knowledge about how to drive a car to a certain destination and I do not need to know about cartography or how to build car engines, design oil rigs or even how to change a tire, but *somebody* has to know how to do all these things. My knowledge of how to drive relies upon a virtually endless complex web of integrated knowledge and there must always be people at the borders of each knowledge-specific domain who are capable of understanding and moving between the different regions. These are the interdisciplinary workers.

point that while specialization is unavoidable, it becomes meaningless unless we reintegrate in original ways that which we have separated, as mentioned above with respect to the development of European universities. It seems almost banal trying to offer arguments for the importance of interdisciplinary pursuits because it is so obviously necessary in everyday research. However, although a scientist or philosopher may admit this point, the majority in either discipline are still apt to ignore one another in their daily work. Thus, the fact that so much conceptual confusion permeates quantum theory is a direct result of physics and philosophy having drifted so far apart, a fact that is acknowledged by physicist Mendel Sachs. Although physics would not be possible without mathematics, Sachs says it is unfortunate that physicists turned their allegiance away from the philosopher to the mathematician because 'the dogmatic *approach* remained in physics in our own time primarily because physics stayed apart from philosophy and its critical attitude.'[149] Indeed, the authors of standard quantum mechanical textbooks are 'quite justifiably anxious to get off the philosophical material and on with the physics.'[150]

A philosophical interpretation, however, is required not only after the data have been collected but also at the beginning of the experimental and theoretical process. Physics cannot begin to develop in any fundamental way without an interpretation, and given that any interpretation is ultimately based on metaphysics, whether implicitly or explicitly, then physicists should hope that they have the correct (or at least the best or most reliable) metaphysical assumptions.[151] Stathis Psillos echoes this point: a non-scientist would simply see a pointer moving on an ammeter, but the physicist would tell us that this pointer is indicating an electric current of some intensity moving through a wire. 'Observation in science is not just the act of reporting a phenomenon (whatever that means!). It is the interpretation of a phenomenon in the light of some theory and other

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[149] Sachs, 1988, p. 40. (Original emphasis.)
[150] Gibbins, 1989, p. 48.
[151] Cf. Baggott: 'Quantum theory directly challenges our understanding of the nature of matter and radiation, and the process of measurement at their most elementary levels, and we cannot go forward unless we adopt some kind of interpretation, some way of trying to make sense of it all. As we will see, this interpretation has to be based on some philosophical position.' (Baggott, 2004, p. 97.)

background knowledge.'[152] I have argued elsewhere (against the antirealist) that relevant technological devices, such as Geiger counters and x-ray machines, are actually aiding and expanding our perceptual capacities rather than *creating* those entities that we are observing, such as electrons and broken bones.[153] This point does not belittle the importance of the role of interpretation, but it does prevent the antirealist from making the logical mistake of claiming that just because we need to interpret data our interpretations are, therefore, *creating* the entities represented by the data, which I discuss further in Chapter Six.

But many physicists have attempted to sidestep the interpretative difficulties and problematic philosophical assumptions by resorting to an instrumentalist approach in practice. This is an understandable and perhaps unavoidable approach for many (if not most) physicists who simply apply the equations, constants, and laws that have been provided for them in order to achieve some practical end, and they appear to be able to do so without worrying about whether or not Schrödinger's cat is dead or on vacation in Spain. But such worries are both physically and metaphysically valid and thus they are genuine worries that *some* researchers need to be thinking about.

Imagine if in response to the question, 'how or why or in what way can we explain the fact that things fall toward the earth?' we responded by saying it does not matter why or how because things just happen to fall toward the earth and we need not inquire any further. Surely, for many 'practical-minded' people, such a question *was* irrelevant. Thankfully some 'impractical' natural philosophers thought about these questions and sought answers. Physicists today are also very fortunate that Proclus was an 'impractical' philosopher. We tend to take mathematics for granted, even though it is neither intuitively obvious nor possible to show why or how mathematics can be applied to the physical world without rigorous metaphysical explanation. Ian Mueller notes that the intellectual climate in which Proclus' taught in the fifth century C.E. was 'generally unscientific—or even antiscientific.'

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[152] Psillos, 1999, p. 31.
[153] Spencer, 2007-A.

Proclus has to argue against people who disparage mathematics because it doesn't teach anything of moral significance (*to kallos*) or of practical value in the "real" world. We might well accept the first charge and reject the second. Proclus argues in the reverse way: mathematics familiarizes us with order, symmetry, and definiteness, three preeminent characteristics of *to kallos*; and mathematics ought to be studied for its own sake, or, if an external motivation is needed, in order to purify the soul for higher apprehension.[154]

Mueller, however, failed to mention here that Proclus also recognized that mathematics can be applied to the physical world: 'Mathematics also makes contributions of the very greatest value to physical science.'[155] The translation of *to kallos* as 'moral significance' could also be a bit misleading without knowing that the literal meaning is 'beauty',[156] but what is beautiful—orderly, symmetrical, and definite—is also good and therefore moral. We may wish to reject the reasons Proclus defends mathematics, but we need to be grateful to Proclus' 'impracticality.' But was he really so impractical?

The mathematicians and physicists seek and discover symmetry, order, and harmony—essential characteristics of beauty, which I discuss more in Chapter Seven, but here we need only understand that, as Rowlands writes, 'symmetry (or analogy) has been the driving force of much of theoretical particle physics, as it was, previously, of classical physics, and physicists seem to *expect* to find symmetries in nature.' [157] Heisenberg reflects: 'But what was there in the beginning? A physical law, mathematics, symmetry? In the beginning was symmetry! This sounded like Plato's *Timaeus*, and I was reminded of the day I spent on the roof of the theological college in the summer of 1919.'[158] Finally, Polanyi quotes Paul Dirac '...It is more important to have beauty in one's equations than to have them fit experiment,'[159] while Bronowski writes the following:

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[154] Mueller in Proclus, 1970, pp. xxvi-xxvii.
[155] Proclus, 1970, p. 19 (Chapter VIII. 22.)
[156] Peters, 1967.
[157] Rowlands, 2003, p. 3.
[158] Heisenberg, 1971, p. 133.
[159] Dirac quoted in Polanyi, 1964, p. 12. Theologian Keith Ward argues that the 'highest truth of all lies in the apprehension of an objective reality of supreme beauty and goodness.' (K. Ward, 1996, p. 101.) He is (apparently unwittingly) holding a generally Platonist position, which claims that the realist's demand of objective truth must be nonphysical and simple, and that the highest of such truths (after the One itself) is supreme beauty and goodness.

> When Coleridge tried to define beauty, he returned always to one deep thought: beauty, he said, is 'unity in variety'. Science is nothing else than the search to discover unity in the wild variety of nature—or more exactly, in the variety of our experience. Poetry, painting, the arts are the same search, in Coleridge's phrase, for unity in variety. Each in its own way looks for likeness under the variety of human experiences.[160]

Coleridge's point is essentially what Proclus meant by the dialectic: 'Dialecticians must seek the dissimilarities in kindred things and the similarities in divergent things.'[161] Of course there is a great multiplicity of differing phenomena in the universe, but a genuine plethora of absolute differences is not possible. If it were possible, then we could not know that fact nor know anything at all. The variety of phenomena are in some way related, there is a unity that binds all things together, and it is the goal of physics to unveil specific aspects of this unity in as precise terms as possible. As Proclus writes elsewhere, 'Symmetry, therefore, is necessary to the union of the things that are mingled, and to an appropriate communion.'[162] But we must not assume that beauty is only in mathematics. Pauli notes the historical debate concerning beauty, which he compares to the quantitative thinker who considers the *parts* to be essential versus the qualitative thinker who considers the indivisibility of the *whole* to be fundamental.

> We already find this contrast, for example, in antiquity in the two corresponding definitions of beauty: in the one it is proper agreement of the parts with each other and with the whole, in the other (going back to Plotinus) there is no reference to parts but beauty is the eternal radiance of the "One" shining through the material phenomena.[163]

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[160] Bronowski, 1961, p. 27. And Coleridge, of course, had 'an enthusiasm for the Neoplatonists, whose writings were being translated by Thomas Taylor.' (Beer, 2007.) But what happens when we seek explanations for the beauty and rationality of the cosmos? I am not going to enter into the motley of confusions surrounding the intelligent design discussion except to say that accepting that there is an intelligent design in the universe, as Einstein and so many other physicists have believed, clearly does not necessarily mean that one must be a creationist in the sense of believing that the earth is 6000 years old. Barr has written recently that 'if the ultimate laws of nature are, as scientists can now begin to discern, of great subtlety and beauty, one must ask where this design comes from. Can science explain it? That is not possible...science really has no alternative to offer to the Argument from Design' (Barr, 2003, p. 106). For an atheist rebuttal inspired by Dennett, see Robert Crease, 2005. But see Francis Bitter, physicist and geophysicist specializing in magnetism, who argues there is design in the cosmos, which indicates a Creator. (Bitter, 1963, p. 23.)

[161] Proclus, 1987, p. 528.

[162] Proclus, 1816, p. 198, BK III, Ch VI.

[163] Pauli in Jung & Pauli, 1955, pp. 205-206. I.e. *Ennead* I, 6 (1).

Plotinus is surely correct that Beauty cannot be *reduced* to order, symmetry, and definiteness. We could, after all, organize a very orderly bank robbery or commit genocide with definiteness and care, but most of us would not want to say that such activities are beautiful. However, the proper execution of an orderly bank robbery by a group of thieves still relies upon intelligence, trust, commitment, and a symmetry or harmony between the participants, which are all beautiful and desirable characteristics that have been directed to an ugly end.[164] But the word *kalos* originally had connotations of physical *and* moral beauty simultaneously, which may seem a bit odd to us today because we usually make distinctions between such notions, and it is not often that we speak of moral beauty at all. But to speak personally, *ceteris paribus* I am more attracted to a symmetrical face, but I would think that the person with a less symmetrical face is more beautiful if her soul was good and the former was less good. In such a metaphysical hierarchy, Beauty comes after the Good and symmetry after Beauty. Symmetry is only possible because of Beauty and so it seems reasonable to agree with Proclus that symmetry presupposes Beauty. Perhaps Bohr's notion of complementarity could fruitfully be applied to both notions of Beauty, showing their interdependence. As Clark writes, 'analytical philosophy, perhaps, is not very likely to awaken us to beauty,'[165] and as beauty is such an important aspect of mathematical physics, again, analytic philosophy would seem to have little to offer to the physicists and mathematicians.

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[164] The fact that we can utilize such beautiful characteristics in the service of ugly or evil actions leads us to questions outside the bounds of our goals, but it is worth this brief mention here because the applications and goals of the sciences sometimes have been and still are put into the service of ethically dubious if not outright criminal actions. The Nazi medical crimes come straight to mind, as well as the pharmaceutical cartel. But the point is that just as the group of thieves must rely upon good and beautiful characteristics if they are to be successful in their immoral pursuits, so to scientists whose concern is merely for profit, fame, or immoral goals must also rely upon the eternal laws of physics that, for the Platonist anyway, imply a Divine Mind.

[165] Clark, 1995.

Heisenberg offers further reasons for studying ancient philosophy and the classics:

> Whoever delves into the philosophy of the Greeks will encounter at every step this ability to pose questions of principle, and thus by reading the Greeks he can become practised in the use of the strongest mental tool produced by Western thought...I believe that in the work of Max Planck, for instance, we can clearly see that his thought was influenced and made fruitful by his classical schooling...The connections between the different branches of science have become much more obvious in the last decades than at any previous time. There are many signs of their common origin, which, in the final analysis, must be sought somewhere in the thought of antiquity.[166]

First, Heisenberg notes that by studying the ancient philosophers we learn how to think systematically and how to pose questions of principle, which is essential for the sciences. Further, if we are to seek the common origin of the sciences, which we must do if we hope to understand how, say, biology, chemistry, and physics are interrelated, then, if Heisenberg is correct, we would do well to look for this common origin somewhere in the thought of the ancient Greek philosophers. With this view in mind we can read what Proclus scholar James Lowry writes: 'There is no major idea in the whole of Greek philosophy which cannot be found in this small treatise [*The Elements of Theology*].'[167] Even if this claim is slightly exaggerated, it is still true that a major portion of ancient thought is contained in this text by Proclus. Thus, if we take the physicists seriously and seek the common origin of the sciences, then the work of Proclus would be highly relevant.[168]

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[166] Heisenberg, 1958-B, pp.53, 63, 64. Pierre Grimes has suggested to me that it would be of great benefit to do an in-depth study showing exactly how Plank's thought was shaped by his classical training, but such an important undertaking would require another thesis

[167] Lowry, 1980, p. 25.

[168] See Whittaker, 1928, p. 8 for his claim that ancient Greek philosophy in general was scientific in spirit.

Rationally Inconsistent Physicists

Eddington writes that

> the energies of the orbits in hydrogen are calculated by classical laws; but one of the purposes of the calculation is to verify the association of energy and period in the unit *h*, which is contrary to classical laws of radiation. The whole procedure is glaringly contradictory but conspicuously successful.[169]

In this section I will discuss how it could be that such contradictoriness in physics can still allow for such magnificent success. To begin, we must admit that while it is essential to take seriously the philosophical views of physicists, it is admittedly very difficult to place them in one particular and completely exclusive philosophical camp.[170] For example, Arthur Fine has argued persuasively against the common view that Einstein rejected (or did not understand) the new quantum theory because he had grown conservative or even senile. Rather, Fine claims that Einstein was actually 'more radical in his thinking' in hoping to replace the concepts of classical physics, which Bohr had wanted to keep.[171] Fine's historical approach shows how difficult it is to say exactly what Einstein actually meant by what he said. Einstein appears to have been a straightforward realist, but Fine argues that Einstein's so-called realism has a deeply empiricist core that makes it a realism 'more nominal than real.'[172] However, Nadeau and Kafatos write that the Einstein-Bohr debate 'eventually revolved around the issue of realism, and it is this issue that Einstein felt would determine the correctness of quantum theory,' and they claim that 'Bohr was the winner on all counts.'[173] The authors who made this misplaced pronouncement about Bohr being the 'winner' also claim that the terms antirealism and idealism do not really apply to Bohr. However, I (mostly) agree with them that idealism 'properly applies to the so-called realists who assert the existence of an ideal system with

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[169] Eddington, 1935, p. 192.
[170] I watched this problem unfold when Rowlands presented a Royal Institute of Philosophy Stapledon Lecture at the University of Liverpool's philosophy department (06 February 2006). Rowlands talked about why physics works, and several philosophers kept trying to pigeonhole Rowlands into being a realist (in the naïve, narrow sense), antirealist, instrumentalist, etc. Physicists aim to be rational although they can never be totally logically consistent in every respect.
[171] Fine, 1996, p. 24.
[172] Fine, 1996, p. 108.
[173] Nadeau and Kafatos, 1999, p. 65.

properties that cannot be simultaneously measured'[174] and that Bohr was actually 'brutally realistic in epistemological terms.'[175]

Part of the difficulty in this interdisciplinary thesis is the fact that on the one hand I am claiming that we need to take seriously the philosophical views of physicists, but on the other hand I have to admit that their views are often far from being philosophically clear. (Of course, many professional philosophers are often even less clear). Einstein, for example, has said that science may be defined as 'methodological thinking directed toward finding regulative connections between our sensual experiences,'[176] but he also opposed empiricism and positivism using phrases such as 'senseless empiricism' and 'sterile positivism'.[177] Heisenberg quotes Einstein from one of their conversations:

> I have no wish to appear as an advocate of a naïve form of realism; I know that these are very difficult questions, but then I consider Mach's concept of observation also much too naïve. He pretends that we know perfectly well what the word 'observe' means, and thinks this exempts him from having to discriminate between 'objective' and 'subjective' phenomena. No wonder his principle has so suspiciously commercial a name: 'thought economy.' His idea of simplicity is much too subjective for me. In reality, the simplicity of the natural laws is an objective fact as well, and the correct conceptual scheme must balance the subjective side of this simplicity with the objective. But that is a very difficult task. Let us rather return to your lecture.[178]

It is not difficult to see that Einstein seems to have held a motley of philosophical views in relation to the sciences (as all scientists seem to), but it is true that we need a correct conceptual scheme to balance the subjective and objective, which is one of the main purposes of my thesis. Most physicists, and scientists in general, have little regard for philosophy, at least in relation to their research, but I am not at all concerned about this group of physicists because they are completely dependent upon the pioneering efforts of the physicists that I am considering. All the deeply pioneering physicists, the ones who

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[174] Nadeau and Kafatos, 1999, p. 98.
[175] Nadeau and Kafatos, 1999, p. 98
[176] Einstein, 1954, p. 50.
[177] Fine, 1996, p. 109.
[178] Einstein as quoted in Heisenberg, 1971, pp. 65-66.

have had the greatest groundbreaking, revolutionary insights, have always been philosophically-minded by necessity.[179]

Moreover, I am not expecting philosophers to follow the physicists, nor vice versa, but philosophers need to be able to engage seriously with the physicists' philosophical views, despite their rational inconsistency. As Gibbins notes, 'from a great physicist one should not expect too much consistency of the type that philosophers value.'[180] But why should this be the case? Isn't physics a rational or logical activity, and, therefore, shouldn't its theories be rationally or logically consistent, or else risk being inconsistent and illogical or irrational? The answer is simple yet complicated. The same physicists whom I am asking the philosophers to take seriously as philosophical thinkers were anything but straightforwardly consistent. But, it was the physicists, not the philosophers, who were initially confronted with the apparent paradoxes of quantum theory, such as wave-particle duality and the clashing of the classical assumptions of materialism and naïve determinism against the experimental evidence of nonlocality. The physicists had to try to make sense of the data they were confronted with, which led them into very perplexing territory.

Many Platonists wanted to show that 'different philosophies really only appear to be different.' Lowry continues by saying that 'behind such a desire for agreement is the perhaps somewhat euphoric conviction that truth cannot be contradictory and that philosophy is by its nature reasonable.'[181] Nietzsche too seems to have held a similar view in this particular respect: 'The results of all the schools and of all their experiments belong legitimately to us. We will not hesitate to adopt a Stoic formula on the pretext that we have previously profited from Epicurean formulas.'[182] Strikingly, scientists too adopt a similar attitude to Proclus and Nietzsche, which is intriguing since these two philosophers are fundamentally at odds in most respects but had a certain agreement on

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[179] Finally some attention is starting to be given to such deeply metaphysical physicists. For example, see Atmanspacher et al (2007) who recently hosted a conference in Switzerland on 'Wolfgang Pauli's Philosophical Ideas and Contemporary Science'.
[180] Gibbins, 1989, p. 52.
[181] Lowry, 1980, ix.
[182] Nietzsche in Hadot, 2002, xiii.

this point. Baggott writes, 'I do not think it is weak-minded to recognize in actual scientific practice elements of *all* the different philosophical positions considered in this chapter [i.e. realism, antirealism, pragmatism, positivism etc].'[183] Consequently, it is not unreasonable to attempt to synthesize the relevant ideas from various physicists in attempting to further understanding in quantum theory.

The physicists could not be logically consistent, as Heisenberg correctly thought, because such a demand would make science impossible, but that does not mean that they are irrational. If physicists were completely logically consistent, then they could not be successful. For example, if Einstein adopted a positivist outlook in one case and was therefore required to keep that outlook always in order to be logically consistent, then he could not have gone on to further developments. 'A = A' is a tautology that tells me nothing about the nature of A. Moreover, nobody really knows what is meant by the '=' sign. If it means absolute identity, then A can only ever be absolutely identical to A in the abstract but never physically. Physically speaking, if each A refers to the same object, it still takes some amount of time to say (or even think) 'A = A', in which case not only is it logically and physically possible that during the time elapsed to say (or think) the sentence the object could have changed in some way, but, in actuality, it must have had some sort of change, even if only in its relative space-time co-ordinates. Thus, strictly speaking, 'A = A' can never mean absolute identity in the physical world. Moreover, no two macro objects, including electrons, can occupy the exact same space at that exact same time, so there must always exist some sort of difference in physical reality between any two objects. If this is true, and it seems rather difficult to refute, abstract logical relations can never guarantee deductive validity in the physical world, which is to say, we can never guarantee that physically 'A = A'. We can only say that in principle for every infinitesimally small moment, each object is what it is but only for that particular moment. Necessarily, therefore, physics, which incorporates both the abstract systems and the physical world, can never represent a completely logically consistent theory unless it has no concern whatsoever about the physical world. Thus, even if, as some physicists have believed, quantum theory is logically consistent, it can never be complete

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[183] Baggott, 2004, p. 116.

because it can never account for every physical aspect. And we do not need Gödel to tell us this; basic metaphysical reasoning shows it to be the case.

If the physicists can still be successful without being logically consistent, then there seems little need to worry about absolute consistency, which does not mean that we can then haphazardly assert just any nonsensical propositions. We do need to aim for logical consistency while knowing that in the end it is never possible to actualize in any physical sense. What I want to say turns on the following point: being logically consistent is not the same thing as being rational, for it is not even rational to expect logical consistency in science. And it is not rational to believe the following logically consistent (deductively valid) argument: Tom is a banana; All bananas are pink elephants; therefore Tom is a pink elephant. But it is rational to believe the following deductively invalid (though inductively plausibly) argument: The sun's rays have reached the earth every day in my past; the known laws of physics predict that the sun will continue to exist tomorrow; therefore I believe that the sun's rays will reach the earth tomorrow. As is commonly known, it is not possible to have a deductively valid argument when the conclusion is based upon the past. Since the physicists certainly believe the second argument, which is only based on induction and therefore is not logically a guaranteed conclusion, then physics (at least the aspects that relate to the physical world beyond the ideal relations of the mathematical laws), is inductive, which opens the door to apparently inconsistent claims because there is no absolute certainty. Yet, it is still rational to believe that the sun will shine tomorrow, even if it is not a deductively valid conclusion and is plagued by the perennial problems of induction.

As stated in *The Logic Book*, 'the techniques of formal logic cannot normally tell us which claims and beliefs are true and which are false. Truth is usually a matter of the way the world is, and logic does not tell us that.'[184] Logic cannot even tell us which premises to choose in the first place and so there is no way, ultimately, logically to begin to reason logically because the original premises cannot come from logic nor can logic tell us if our premises are actually true. Eddington, for example, makes a similar point: 'Reasoning

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[184] Bergmann, 1980, pg. 2.

leads us from premises to conclusion; it cannot start without the premises. The premises for our reasoning about the visible universe start in the self-knowledge of mind.'[185] This is a very important point that every philosopher (should) know but which is mostly ignored. And similarly, Russell, seemingly forgetting his belief that only science can give us truth, also admitted that 'it is quite difficult to think of the right hypothesis, and no technique exists to facilitate this most essential step in scientific progress.'[186] If there is no technique to begin science, then how do we begin science, and what are the implications of recognizing the limitations of the scientific method or of admitting that there is no scientific way to begin science? Similarly, there is no logical way to begin a logical argument, for logic cannot tell us what premises to choose out of indefinite number of possibilities. Some intuitive motivation is the starting point for reasoning and science. Joseph Agassi reminds us that the apparent orderliness of scientific research veils the hidden reality of the messy problem-oriented workshop.[187]

This significant admission about the messiness of the scientific workshop relates back to Baggott's point that in practice scientists may adopt various attitudes usually without giving much thought to any one of these positions or how they may or may not be compatible. The scientist—experimentalist or theoretician, is faced with a problem, but in seeking a solution often a very different way of thinking is required; after all, if the old way of thinking created or forced you into the problem, the same way of thinking is not likely to rescue you. Indeed, while writing this thesis I am aiming to present the ideas as logically as possible, with every point hopefully following another in a way that seems to make sense. But, the reality is that the many struggles involved in conceiving the idea for the thesis and in researching and especially in thinking of original arguments and clarifying concepts has been anything but a logical progression. Many insights have occurred suddenly while doing the most mundane activities. This point is extraordinarily important because by removing the 'human factor' and ignoring the reality of the messiness of the workshop, and especially downplaying the fact that there is no scientific

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[185] Eddington, 1929, p. 45.
[186] Russell, 1997, pg. 27. Bronowski writes that 'there are, oddly, no technical rules for success in science. There are no rules even for using test tubes which the brilliant experimenter does not flout; and alas, there are no rules at all for making successful general inductions.' (Bronowski, 1961, p. 71.)
[187] Agassi in Sachs, 1988, p. xviii.

method to begin science or logical method to begin logic, we can pretend that everything is fine so long as we have a consistent argument. The analytic philosopher can rest peacefully at night with her delusion that she has actually accomplished something.

What we have to admit is that physicists, especially when breaking new ground, cannot be held accountable to the unrealistic demands of the analytic philosopher who expects complete consistency in one's position. However, I am now going to make an apparently opposite claim, though the subtlety of it should steer me away from the charge of a manifest contradiction. Despite my above claims, we still need to correct the false, confused and misleading reasoning, pronouncements, and assumptions of these same pioneering physicists whom I just defended. The fact is, Heisenberg, Bohr and Einstein etc., were often quite blatantly inconsistent in the sense of not maintaining rationally plausible views, and at various times they had fallen prey to poor reasoning and false or highly problematic assumptions. And they often confused the meanings of important concepts and so sometimes talked past one another in their arguments, which resulted in unnecessary confusion permeating quantum theory. But if I have stated that logical consistency of the kind demanded by the analytic philosopher is not a reasonable demand to place on the ground-breaking physicists, then why should I bother attempting to correct the reasoning errors and false assumptions of these same physicists? My answer is quite simple.

When breaking new ground and confronting baffling data, physicists have to be able to make bold speculations that reach beyond the bounds of 'normal' science. They cannot be forced into the straitjacket of logically tight reasoning at the outset because first of all the premises to be used in such reasoning may be false since they would be rooted in the assumptions that are the reason for the unexplainable data in the first place. Second, as already shown, such complete logical consistency would not allow for inductive reasoning or the seeking of novel solutions in the problem-orientated workshop of actual scientific practice. However, the reasoning of the physicists still has to make sense, it has to be rational, which, again, can easily divert us into a different thesis topic concerning a dialectical exploration of the similarities and differences between rationality and logic

and what counts as something being reasonable. It is not possible in this thesis to say much more about this point than already stated, except to reinforce the fact that being rational does not necessarily entail being logically consistent. But sometimes these pioneering physicists made claims that were not rationally compatible, which is not necessarily the same thing as being logically inconsistent.

Thus, I am arguing that just because these physicists were not as analytically precise as the analytic philosophers suppose themselves to be, it does not at all follow that these physicists were not thinking philosophically. What they needed was a way of thinking more rationally about some of the foundational assumptions and arguments in quantum theory. But in offering such clarification we need to take these physicists seriously as philosophical thinkers, and only then can we apply our analytic and general philosophical skills in a meaningful way. But it is not just a matter of clarifying conceptual confusion in the sense of clarifying definitions, although such methods are also very helpful. Rather, we are seeking clarification of the ideas themselves; we are trying to reason about the nature of reality itself rather than limiting ourselves to philological disputes or pretending that philosophy will disappear after exposing all the pseudo-problems created by metaphysics, as Russell and Wittgenstein had deceptively tried to convince us.

Difficulties of Interdisciplinary Research

I have been extolling the importance of interdisciplinary research, but here we must note some barriers and caveats. It is not possible for anyone to be an expert in every field of knowledge. We must rely upon the specialized research of many scholars around the world in order to engage in serious interdisciplinary work (or even in highly specialized research), which means that we cannot help but avoid delving into detailed internal controversies among specialists in an area outside our own field of expertise. For example, classicists will continue debating doctrinal differences between Plotinus and Proclus and about whether or not we can say for sure what the essentials of Platonism are. As important as such debates are, they are not really relevant to this thesis. In an interdisciplinary thesis, one cannot follow up on all the counterarguments of every position because then this thesis, for example, could easily turn into a work on the classics concerned only with the history of ideas in tracking down the essence of Platonism. While such research is definitely worthwhile, it is not my goal. I am showing that the fruits of the labours of such specialists can actually be applied to other areas of knowledge in rich and meaningful ways with practical benefit, and in this thesis we are furthering understanding of conceptual difficulties in modern physics.[188] But, again, the caveat is that in doing interdisciplinary research one must necessarily forsake a specialist inquiry. However, I *am* specialising in the topic that is being explored in this thesis and, so, I am exploring in detail all the points that are relevant to further these goals. Thus, I am specializing in the interdisciplinary research area of metaphysics, Platonic realism, and physics. And it is not possible to avoid being mistaken at some point when doing interdisciplinary research.[189] It is with such a view in mind that I need to offer a counterargument to a couple of assumptions found in Norris because they could pose difficulties in understanding some of my key arguments in later chapters.

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[188] On January 20, 2006 I gave an invited lecture, 'Neoplatonism and Quantum Theory: the Importance of Classics for Modern Science', to the Postgraduate Lecture Series, Department of Classics, King's College London. The audience was particularly happy to realize that, as one scholar said, 'their research was actually valuable.'

[189] I have given presentations of different aspects of my research to audiences in several disciplines, including, psychology, mathematics, physics, management, philosophy, literature, and classics, and on various occasions I have been corrected on one point or another. But such corrections have been vital for fortifying my position in this thesis.

Norris' tremendously important work, which has helped to inspire and shape this thesis (as well as influence so many scholars in diverse areas), includes an inaccurate comment about Neoplatonism being akin to the many-worlds theories offered by David Lewis and David Deutsch.[190] I am speculating, but given my readings of Norris, it seems that he was misleadingly influenced by Derrida with respect to Platonism.[191] For the Neoplatonists, as for Plato, there is only one universe, which was brought into order out of chaos by the demiurge (which they also equated with Nous or the Divine Mind or Divine Intellect, and sometimes with the World Soul). There are different metaphysical levels of reality but there is only one physical universe, and the ultimate nature of all reality (physical and nonphysical) is the unifying principle the One (or the Good), which I discuss in Chapter Seven. Norris has argued well against the many-worlds interpretation, but such a view was alien to the Neoplatonists.[192]

A second example concerns Norris' implication that Aristotle was the first to advocate a realist position, but this claim is not correct.[193] Plato was not simply an idealist or rationalist as Norris claims, but was ultimately and pre-eminently a realist, although his idealistic claims were required to guarantee objective truth independent of human opinion. Norris may not look favourably upon the aspects of Platonism that are idealistic, but he does not give an ontological account of the verification-transcendent truths he cogently argues for, and I discuss this important point in Chapter Seven. Mueller makes the following relevant comments:

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[190] Norris, 1998, p. 335. See Deutsch, 1997.

[191] For a sample of how Derrida has unjustly attacked and misunderstood Socrates and Plato, see Mortensen, 2000.

[192] The Neoplatonists adhered to Plato's view, espoused in the *Timaeus*, that the maker of the universe 'made neither two, nor yet an infinite number of worlds. On the contrary, our heaven came to be as the one and only thing of its kind, is so now, and will continue to be so in the future.' (Plato, 2000, p. 16, 31b.) And Clark, the Platonic realist, writes that 'the Many-Worlds hypothesis amounts to just that abandonment of real explanation that I addressed before: 'we need not find an explanation for any particular event or entity since everything that can be conceived to happen does. But the point of an explanation is to show why some things don't.' (Clark, 1998, p. 57.)

[193] For example, 'The realist position – starting out with Aristotle and still very active in our day...' (Norris, 2001, p. 280). See also Norris, 2000-C, p. 40. In a similar way, the common assumption that Aquinas was an Aristotelian (if not anti-Platonist) has been shown to be incorrect. See Patrick Quinn (1996), The Introduction to Pseudo-Dionysius (1987), and Wayne Hankey (2004).

In Metaphysics M.1-3 Aristotle develops his own account of mathematical ontology, which the Neoplatonists understood as "abstractionism"—the view that mathematical objects are mental concepts derived from sensibles. In M.3 he defends this view by saying that we no more need to suppose that there are mind-independent numbers or geometric magnitudes than we need to assume that "the universal parts of mathematics" deal with the special objects other than numbers, magnitudes, etc. For Proclus, Aristotle is totally wrong on this point.[194]

Aristotle often vacillated between realist and antirealist positions,[195] but here at least he is a straightforward antirealist about mathematics, whereas it was Plato, Plotinus, and Proclus who were the realists. Norris' work is as diverse as it is challenging, compelling and inspiring, and the fact that he has made such comments about ancient philosophy is no detriment to the importance of his work, nor does it detract from his arguments on behalf of realists.

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[194] Mueller in Proclus, 1970, p. xxvi.

[195] Aristotle is difficult to assess in this respect, for he also believes that what is true is what the good man thinks (which is antirealist) but the man thinks it because it is true (which is realist).

Summary

In this chapter we have seen that although interdisciplinary research is acknowledged as an essential part of scholarly activity, it is still deterred by implication through the Research Assessment Exercise (RAE) and other intra-disciplinary prejudices. I have argued for the unavoidability of interdisciplinary research in general and especially in relation to the concerns of this thesis. I have also shown the significant interlinking role of beauty and how some of the key founders of quantum theory were influenced and inspired by ancient philosophy. Furthermore, I showed how these pioneering physicists who argued for the importance of interdisciplinary research cannot be held accountable to the same demands of logical consistency that the analytic philosopher expects, yet we still need to bring conceptual clarification to the false conclusions and assumptions held by such physicists. Finally, we noted some of the difficulties of interdisciplinary research.

CHAPTER THREE: Physics and Metaphysics – Distinct but Inseparable

Introduction

In this chapter, I will first offer a very brief general account of the nature of metaphysics before showing that many of the founders of quantum theory recognized the necessity of metaphysics, while some even endorsed mysticism.[196] After establishing that I am in good company in defending a relationship between metaphysics and physics, I will

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[196] 'All science presupposes some metaphysical system of beliefs, and mystical beliefs have been an important part of most systems.' (Trusted, 1991, p. xi). Also see Eddington (1929, 1935) to understand how far he engages in metaphysical speculation and ventures into mysticism. The original Greek *mustikos* meant a transcendental private experience of divine reality or something mysterious, secret or hidden (see Pseudo-Dionysius, 1987, footnote 2, p. 135.) Bernard McGinn admits that referring to Plato as a mystic is a controversial issue, but that he has 'no hesitation, along with Festugière and others, in doing so.' (McGinn, 1991, pg. 25.) It should not be controversial, as a thorough reading of his dialogues makes unambiguously clear that he prized direct inspiration from the gods above but *not* as distinct from rational analysis. This view is also at the cornerstone of scientific genius, where the insight appears to be logical only after the fact. There are at least four basic ways of categorizing mysticism, none of which have to do with being anti-rational:
1) Mysticism as part or element of religion
2) Mysticism as a process or way of life
3) Mysticism as an attempt to express a direct consciousness of the presence of God
(McGinn, 1991, p. xv-xvi.)
And based on my readings of these pioneering physicists, I add two more:
4) Mysticism as a part or element of the most fundamental creative process in science
5) Mysticism as 'seeking everywhere for evidence of mathematical proportion,' which was fundamental to the beginning and continual development of physics. (Benn, 1882, p. 82).
For an opportunity of deep personal insight into the scientific mind of a great physicist, which brings together several of the above meanings of mysticism, see Fanchon Fröhlich's Biographical Notes about her late husband, Herbert Fröhlich. She offers a description of how he believed 'that there is an impersonal, non-individualistic path or Tao embedded both in the world and in the mind, and that at some deep level of insight they coalesce. Thus with respect to modern science, he regards the coalescence of the abstract mathematics done in the laboratory as a source of wonder and mystery (in contrast to the reductionist who thinks this tautologically trivial). He has frequently said that in the creative process of thinking his mind goes out from his human frame and *becomes* the physical particle and field situation, feeling directly how they tend to behave, but using the techniques of mathematics both to capture this unknown situation and as an anchor so the mind can return to his own brain or everyday personality. Thereafter he solidifies what he has found during these mental voyages in calculations.' (Fröhlich, 2006) Original emphasis.
Finally, psychologist Michael Daniels defines mysticism 'as *the individual's direct experience of a relationship to a fundamental Reality*' (Daniels, 2003), which, as we shall see, resonates deeply with Plank's description of how we know the external world exists through a 'direct perception'. Surely, Julian Baggini and Peter Fosl's depiction of mysticism as being unintelligible, unreliable, and inconsistent is aimed at some other meaning of mysticism than given above. (Baggini & Fosl, 2003, p. 200.) Also, physicist Victor Stenger is intent on removing any notion of Platonism and other such nonsense from physics. He is 'telling people things that many do not want to hear: that according to our best knowledge, the world of matter is all that exists.' (Stenger, 1995, p. 11.) Unfortunately, it would appear that Stenger has just eliminated mathematics.

clarify three broad types of metaphysics, which I call *pure*, *applied* and *presupposed*. I then offer a detailed example of applied metaphysics by examining in detail the confusion surrounding the Heisenberg uncertainty relations. Finally, I discuss the nature of the rejection of analytic and overly sceptical philosophy by some of the pioneering physicists.

Metaphysics in Brief: In Through the Backdoor

Unlike in modern society, there was a time when metaphysics—not science—was thought to be the highest form of knowledge.[197] Metaphysics, on my account, embraces both ontology and epistemology, while digging even deeper into the nature of reality with its main tools being rational reflection and intuition aimed towards the highest good. Metaphysics, however, had begun to fall into disrepute during the age of enlightenment in the eighteenth century, especially with the widespread turn against the idea of 'natural kinds', the Aristotelian category of final cause, and other metaphysical entities considered unnecessary for explaining the constant conjunctions of events observed in the physical universe.[198] Of course, metaphysics has since been religiously attacked by positivists such as Carnap, beginning especially with Comte. 'Theology and metaphysics, said Comte, were earlier stages in human development, and must be put behind us, like childish things.'[199] But metaphysics cannot be vanquished, since it underpins every thought and utterance that has ever been made and ever could be made. Jennifer Trusted more recently writes that, 'if thrown out of the house, metaphysics has a tendency to re-enter through the back door. Even if science and mathematics could be adequately assessed in positivistic terms there would still be metaphysical assumptions underlying the scheme of knowledge expressed entirely in terms of sense experiences.'[200] And as Burtt states, 'there is no escape from metaphysics, that is from the final implications of any proposition or set of propositions. The only way to avoid becoming a metaphysician is to say nothing.'[201] More technically, however, just because one chooses to speak it does not follow that one is therefore a metaphysician. But making any sort of relatively coherent utterance whatsoever does necessarily entail that one is holding explicit or implicit metaphysical presuppositions.

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[197] Walsh, 1963, p. 11.
[198] See, Berlin, 1957 and Walsh, 1963, p. 13.
[199] Hacking, 1983, p. 46.
[200] Trusted, 1991, p. 144.
[201] Burtt, 1925, p. 224.

The word 'scientist' was coined in 1840 (or 1833) by William Whewell, and the Latin root *scientia*, which means knowledge,[202] symbolizes the general feeling in our culture that a scientist is one who knows. However, it is not always clear what she is supposed to know. The popular press often creates the impression that whatever can be known will eventually fall within the domain of science, and some publicity hungry scientists tend to add to this modern mythos. Even theology, according to global general relativity theorist Frank Tipler, needs to be absorbed into physics.[203] Many of the original founders of quantum theory, however, tended to be much wiser. Schrödinger writes that 'science cannot tell us a word about why music delights us, of why and how an old song can move us to tears.' Thus, if the scientific worldview does not even contain colours, tastes, beauty, delight or sorrow, and 'if personality is cut out of it by agreement, how should it contain the most sublime idea [God or the One of Parmenides] that presents itself to the human mind?'[204] Science does not and cannot embrace all that is worthwhile and meaningful in life. As Rush Rhees appropriately remarks, 'an illiterate peasant may be more mature, less infantile in the face of trouble, than an accomplished scientist.'[205] Science is a certain kind of knowledge; it is not all embracing.[206] Moreover, there is no such thing as *the* scientific method, a point that I have argued elsewhere.[207] There are different technical methodologies for the varying sciences, and even within the same scientific discipline there are entirely different conceptions of and approaches to scientific research. Those who work at the theoretical foundations of physics will be thinking about and approaching their research much differently than the experimentalist aiming for 'practical' applications.

A. E. Taylor writes that 'every great metaphysical conception has exercised its influence on the general history of science, and, in return, every important movement in science has

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[202] Ayto, 1990; the 1833 date comes from the online Stanford Encyclopedia of Philosophy. Also mentioned in Beck, 1959, p. 21.
[203] Tipler, 1994, p. xv.
[204] Schrödinger, 1954, p. 95. He used the terms 'God' and the 'great Unity—the One of Parmenides.'
[205] Rhees, 1969, p.16. Thanks to John Adams for this source.
[206] George Ellis argues that science cannot deal with 'ethics, aesthetics, metaphysics and meaning,' which *qua* science may be true, but science certainly has important contributions to make in these areas, and in fact rests upon prior assumptions from all of them. See Radford, 2004. Thanks to Nick Blanchard for this article.
[207] See Spencer, 2007-B.

affected the development of Metaphysics.'[208] Taylor's point is correct except that the most fundamental metaphysical ideas, such as order, truth, beauty, unity, good etc., must always be presupposed and cannot be eliminated by any development in science. Pronouncements such as Kant's, where he claimed that Euclidian space is *a priori* true, are not fundamental metaphysical ideas, but are metaphysical nonetheless. These secondary metaphysical considerations are open to scientific scrutiny and may need to be revised. We can also dispute the nature of the concept of order, and we must inquire into what it is, how it is, and how it operates throughout the universe, but no science can ever say that there is no order whatsoever. Order is presupposed by science and by any coherent attempt to say anything about anything. It is in this sense that fundamental metaphysical ideas cannot be overturned by any future science (and it is not possible here to give an exhaustive list of such primary metaphysical ideas as distinct from secondary ones, but only the general point need be understood).

Finally, as important as Harris' work is for my thesis, he does not acknowledge that his entire metaphysics is Platonic in essence (or at least harmonious with Platonism in general) and he argues that his metaphysical position is a 'consequence of the current scientific paradigm,'[209] which is an assertion that I wish to distance myself from. Platonism is implied by physics, but, more fundamentally, I am arguing that Platonism is *presupposed* by physics and that physics is only possible because Platonic realism is true. It is by making Platonic assumptions, whether implicitly or explicitly, whether *a priori* or being forced to them via reflection on empirical data, that the foundations of physics remain stable while allowing further pioneering breakthroughs that can be situated within the prior dynamic stability. In short, metaphysics underpins all of physics. As Eddington clarifies, 'the mere questioning of the reality of the physical world implies some higher censorship than the scientific method can supply.'[210] Even inquiring into the meaning of 'science' requires philosophical thinking. And as Whitehead notes, 'if science is not to

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[208] A. E. Taylor, 1936, p. 13.
[209] Harris, 2000, p. 5.
[210] Eddington, 1935, p. 276.

degenerate into a medley of ad hoc hypotheses, it must become philosophical and must enter upon a thorough criticism of its own foundations.'[211]

[211] Whitehead, 1953, p. 21. But Proclus seems to state correctly that 'no science demonstrates its own first principles or presents a reason for them; rather each holds them as self-evident, that is, more evident than their consequences' (Proclus, 1970, p. 62). But if science is not prepared to give some account of its first principles, which requires a metaphysical explanation, then the danger of dogma sets in, as Sachs mentioned in Chapter Two. That is one important reason for philosophers to work with scientists, especially concerning the most fundamental questions.

Physicists and Metaphysics

The distinctions between metaphysics and physics seem superficially clear until we begin to ask ourselves what we really mean by these terms and try to specify precisely their boundaries. No matter what viewpoint one professes allegiance to, there is no way to avoid having presupposed metaphysical assumptions, which I discuss in more detail below. If anyone disagrees, it is a simple matter to point out the metaphysical assumptions upon which their disagreement rests.[212] Thus, I have been perplexed by the fact that logical positivists and others who have despised metaphysics have also claimed to be serving science, for, as shall soon be clear, the strict elimination of metaphysics would necessarily entail the end of science. While relating a discussion between Bohr, Pauli, and himself, Heisenberg shows clearly how they all reacted badly to the positivists' dismissal of metaphysics. Bohr had told members of the Vienna circle that although he endorsed the positivist desire for conceptual clarity, which, as shown in Chapter One is not solely the province of the positivists or analytics, he also rightly claimed that banning metaphysics would 'prevent our understanding of quantum theory.'[213] Pauli's response, as related by Heisenberg, is worth quoting in full.

> 'When you say it would prevent our understanding of quantum theory,' Wolfgang said, 'do you mean physics does not simply consist of experiment and mathematical formulae but that it must also philosophize where the two meet? In other words, that we must use everyday language to explain the precise interplay of experiment and mathematics? I myself have a strong suspicion that *all the difficulties of quantum theory will be found to reside in this meeting*, a fact most positivists choose to ignore, precisely because their concepts break down at this point. The experimental physicist must be able to talk about his experiments and therefore he is forced to employ the concepts of classical physics, although he realizes full well that they provide an inadequate description of nature. This is his fundamental dilemma, and one he cannot simply dismiss....

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[212] Erik Erikson makes a relevant comment about the importance of psychology for history: 'Biographers categorically opposed to systemic psychological interpretation permit themselves the most extensive psychologizing—which they can afford to believe is common sense only because they disclaim a defined psychological viewpoint. Yet *there is always an implicit psychology behind the explicit anti-psychology.*' (Erikson in Waite, 1977, p. xiv. Original emphasis). The same can be said about metaphysics: there is always an implicit metaphysics behind any anti-metaphysics, which can only be concealed by disclaiming a defined metaphysical viewpoint.

[213] Bohr in Heisenberg, 1971, p. 208.

> [Bohr responds]... Only by using a whole variety of concepts when discussing the strange relationship between the formal laws of quantum theory and the observed phenomena, by lighting this relationship up from all sides and bringing out its apparent contradictions, can we hope to effect that change in our thought processes which is a *sine qua non* of any true understanding of quantum theory.'[214]

I have quoted this passage in full to emphasis the fact that the founders of the Copenhagen view were not positivists and believed that the difficulties of quantum theory could only be solved philosophically, specifically using everyday language in metaphysical reasoning.[215] Physicists and philosophers alike have ignored such essential insights of the founders of quantum theory, and an important aspect of my thesis is to remedy this neglect to help clarify conceptual confusions about quantum theory in order to increase our understanding. But it was not just the Copenhagenists who endorsed metaphysics. Einstein, Planck, and Schrödinger, who had apparently opposite views about quantum theory to Bohr, Heisenberg, and Pauli, also understood the importance of metaphysics. Schrödinger writes:

> In fact, if we cut out all metaphysics it will be found to be vastly more difficult, indeed probably quite impossible, to give any intelligible account of even the most circumscribed area of specialization within any specialized science you please...A real elimination of metaphysics means taking the soul out of *both* art *and* science, turning them into skeletons incapable of any further development.[216]

There is no way of knowing for certain how or in what way science will develop even though we can understand its metaphysical foundations. There is also no logical guarantee that our hypotheses, theories, or conceptual framework for designing, performing and understanding the results of any experiment will eventually not prove to be false, or even far less approximately true than previously supposed. Strict adherence to positivism will prohibit speculative science, which will eliminate creative science that reaches out into hitherto unexplored or currently unimaginable territory, which would in

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[214] Pauli and Bohr quoted in Heisenberg, 1971, pp. 208-210. (Emphasis added in the first paragraph.)
[215] Cf. Gibbins: 'Bohr was primarily a philosopher, not a physicist, but he understood that natural philosophy in our day and age carries weight only if its every detail can be subjected to the inexorable test of experiment'.' (Gibbins, 1989, p. 48.)
[216] Schrödinger, 1964, p. 3-4. Original emphasis.

turn be the end of the progress of the sciences by leaving them soulless skeletons. Whatever science we do have now was in fact always or almost always a direct or indirect result of speculation beyond the accepted empirical facts of the day, and so cannot be explained by positivism. Einstein appears to have been against metaphysics in a certain respect at an earlier point in his career,[217] but he seems to have recognized his earlier error. 'I believe that every true theorist is a kind of tamed metaphysicist, no matter how pure a "positivist" he may fancy himself',[218] and these statements despite the fact that some of the leading positivists 'begged him—almost put words in his mouth—to state that experimental data were the trigger of his speculations and achievements.'[219] Finally, consider Planck's remarks:

> As Einstein has said, you could not be a scientist if you did not know that the external world existed in reality, but that knowledge is not gained by any process of reasoning. It is a direct perception and therefore in its nature akin to what we call Faith. It is a metaphysical belief. Now that is something which the sceptic questions in regard to religion; but it is the same in regard to science.[220]

The idea of knowledge being gained through direct perception is profoundly explicated in the Neoplatonic tradition, especially through Plotinus and Proclus.[221] And Planck is not falling into empiricism. On the contrary, his point of a 'direct perception' is equivalent to an immediate grasping or insight that is beyond 'any process of reasoning.' I will discuss his notion of 'Faith' more in Chapter Four, but here we need only note his acceptance of the importance of metaphysics in science and religion. These physicists may not have

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[217] In 1912 he signed an 'antimetaphysical manifesto' (Jaki, 1978-A, p. 182).
[218] Einstein, 1954, p. 342.
[219] Jaki, 1978-A, p. 195. Recall also his review of Russell's book in Chapter One.
[220] Planck, 1932, p. 218.
[221] For example, Kevin Corrigan writes: 'Intellect (*nous*) and thought or understanding (*noêsis*) in ancient thought generally, and for Plotinus specifically, are not as we think of them in the modern world (i.e., rationality or thinking in a discursive, bit-by-bit way). For the ancients, intellect includes desire (*ordered* desire, as we shall see) and direct, immediate understanding, neither simply subjective nor simply objective, but both together in each other so that every object of understanding is also a subject understanding that object. This understanding is not the sort that has to work things out discursively bit by bit. Intellect's understanding is more like a complete grasp of the whole at one glance. Each part is not only in the whole but *is* the whole, so to speak, just by being itself.' (Corrigan, 2005, p. 34. Original emphasis). This 'direct understanding' is what Planck is referring to as 'direct perception', which can grasp the underlying whole behind the appearances—what Bohm and Bohr alike were seeking. One need only read Planck to understand that he is not simply endorsing empiricism but is making a claim about an intuitive act of the mind grasping some truth immediately beyond discursive thought. See also Rappe, 2000 and Siorvanes, 1996.

agreed upon which metaphysics was ultimately correct, but the fact is indisputable that they all accepted the indispensable need for metaphysics in science. So, why have so many contemporary philosophers ignored the philosophical views of these and other metaphysically inclined scientists who thought more like ancient philosophers? I think that a full account of the reasons would involve psychological, historical, sociological, scientific and philosophical responses, which clearly is beyond the scope of this thesis. But it seems safe to speculate that the reasons given in Chapter One offer a partial answer.

Categories of Metaphysics

I will now introduce the three broad categorizations of metaphysics that I have developed. There are no absolute boundaries between these divisions, so we can expect there to be many instances where they overlap, but I think this categorization is heuristically valuable for understanding the nature of metaphysics itself and the relationship between physics and metaphysics.[222] Metaphysics, which includes both ontology and epistemology, is, in essence, the rational investigation of the most fundamental questions about the ultimate nature of reality achieved through the reasoning mind alone so far as possible. I claim that there are three kinds of metaphysics: *pure*, *applied*, and *presupposed*. *Pure metaphysics* involves reasoning our way to ultimate conclusions without relying upon the prevailing scientific worldview at the time, or with as minimal reference as conceptually possible. Good examples are Proclus' *The Elements of Theology* or Descartes' *Meditations*.[223] Pure metaphysics can provide a consciously devised worldview that is believed to correspond to reality so far as possible and so is intellectually satisfying while serving as the background or framework within which our scientific research can be most aptly carried out. However, pure metaphysics may also provide moral or spiritual guidance for individuals and society. There are no ontological limits on pure metaphysics; only our own failure to think deeply blocks us from deeper investigation and understanding.

Applied metaphysics asks fundamental questions within a specific domain of knowledge. For example, physicists talk about electrons as if they exist, and a metaphysician will ask in what way exactly do they exist and what is existence as defined by a physicist (whereas in pure metaphysics we ask what is existence itself). Or a physicist may say that, in some sense, light is both a wave and a particle (and neither), and the metaphysical questions that follow are how can it be both simultaneously, or if not really either, then

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[222] After presenting an earlier version of these views in two presentations, I then discovered Trusted's book *Physics and Metaphysics* (1991), where she also outlines a tripartite division, but it is dissimilar enough in essential respects that we need not be concerned with it. My proposal is more fundamental and broader in scope and so ultimately more useful.

[223] For example, asking the question of why there is something rather than nothing can lead to an entire metaphysical worldview that only tangentially refers to modern scientific knowledge as examples but which could actually be applicable to any period of time in the past or future.

what exactly is light? Or if nothing physical can travel at the speed of light, then how does light travel at its own speed? The response that photons have zero rest mass is misleading because (1) photons are never at rest and (2) if they have only zero rest mass then it seems to follow that they have some sort of mass when travelling at c because after all, light is interfered with by physical objects. Such questions require clear answers if progress in understanding and further developments are expected to occur.

Science cannot escape relying upon metaphysics, for we must make rational judgements about what we assume to be empirical facts, which is to do applied metaphysics.[224] Applied metaphysics incorporates speculation and the attempt to bring together into a rational unity or coherent system what we have for the moment assumed to be scientific facts along with the questioning of these same supposed facts. This sort of questioning leads to speculative answers, which may in turn bring us back to empirical testing or may push us further into pure metaphysics—or at least deeper into pure metaphysics while remaining with the applied metaphysical question that prompted our inquiry.

Finally, *presupposed metaphysics* is not actually *doing* metaphysics or thinking metaphysically; rather, it refers to our implied or explicit fundamental metaphysical belief system within which we try to make sense of the world and ourselves. We all must have a presupposed metaphysical worldview or at least certain metaphysical assumptions (no matter how inconsistent, false or incomplete) even to begin to talk about 'facts', which I discuss in detail in Chapter Five. The danger, however, is that often if not usually these views are held uncritically and unconsciously, so that, for example, a logical positivist can decry the nonsense of metaphysics without realizing that her whole system

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[224] Cf. Jaki: 'To the Humean claim that certainty was restricted to matters of fact, in strict exclusion of reasoning and ideas, [the famous astronomer William] Herschel [1738-1822] answered with a phrase which brought witness to a basic pattern of scientific practice and revealed the radically unscientific character of the empiricist boasting about matters of fact: 'Half a dozen experiments made with judgement by a person who reasons well, are worth a thousand random observations of insignificant matters of fact.' Clearly, to do science was to make rational judgements about facts, that is, to do metaphysics. But metaphysics has an even more important role than to make science possible. Those of us, Herschel continued, who love wisdom, 'by metaphysics...are enabled to prove the existence of a first cause, the infinite author of all dependent beings' (Jaki, 1978-A, pp. 110-111).

rests on metaphysical beliefs that cannot be verified empirically.[225] Philip Frank's position is a striking example of pretending to eliminate metaphysical interpretations while adhering implicitly to a metaphysic that guides his own conclusions, which he asserts are simply scientific. Of course, Frank's positivist position rests on the metaphysical doctrine of empiricism.[226] One could object that Frank's position has more to do with methodology than with metaphysics, but that objection could only be sustained by neglecting the metaphysical presuppositions of the empiricist methodology. For example, empiricism presupposes that the only knowledge we can ever have must come from our five senses, yet our senses themselves could not possibly tell us that supposed fact; only our reasoning mind could offer an argument leading to such a conclusion. But this reasoning mind is eliminated under strict empiricism because the mind itself cannot be experienced directly by the five senses. If we admit that we can have experiences beyond the five senses in order to maintain an empiricist metaphysics then we have opened the way to allow for a whole range of experiences beyond the five senses, including Plato's belief that we have experienced the Ideas or the Forms prior to being reborn, which is a view that would be rejected by most empiricists (except, perhaps, extreme empiricists such as George Berkeley). Furthermore, the claim that there are facts existing independently of our sense experience is a *realist* belief that cannot be proven simply by appealing to our senses, and so strict empiricism leads straightaway into antirealism, which then eliminates the objective character of the sciences, which Frank would want to maintain.

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[225] Burtt: '...the lesson is that even the attempt to escape metaphysics is no sooner put in the form of a proposition than it is seen to involve highly significant metaphysical postulates. For this reason there is an exceedingly subtle and insidious danger in positivism. If you cannot avoid metaphysics, what kind of metaphysics are you likely to cherish when you sturdily suppose yourself to be free from the abomination? Of course it goes without saying that in this case your metaphysics will be held uncritically because it is unconscious; moreover, it will be passed on to others far more readily than your other notions inasmuch as it will be propagated by insinuation rather than by direct argument' (Burtt, 1925, p. 225).
As Socrates said famously, 'The unexamined life is not worth living' (Plato, 1914, p. 133. *Apology* 38a).

[226] 'The misinterpretation of scientific principles, as will be shown, can be avoided if, in every statement found in books on physics or chemistry, one is careful to distinguish an experimentally testable assertion about observable facts from a proposal to represent the facts in a certain way by word or diagram. If this distinction is sharply drawn, there will no longer be any room for an interpretation of physics in favour of a spiritualistic or a materialistic metaphysics.' (Frank, 1941, pp. 4-5.)

I think that when many positivistic-minded scholars object to metaphysics, what they are really reacting against is the category of pure metaphysics, especially its mystical branch.[227] It is impossible to object to presupposed metaphysics because a metaphysical worldview is presupposed by all of us in order even to voice such an objection, whether we are aware of those assumptions or implications or not. We need to ask questions and describe our views, theories, speculations, and conclusions in natural language. Unfortunately, analytic philosophers tend to have difficulty admitting the importance of using the natural language devoid of arcane logical formalisms. Dummett recalls that in Frege we find 'vehement denunciations of natural language.'[228] However, Heisenberg had the opposite view:

> We know that any understanding must finally be based upon the natural language because it is only there that we can be certain to touch reality, and hence we must be sceptical about any scepticism with regard to this natural language and its essential concepts.[229]

It is certainly a bit odd when the philosopher denounces natural language, the best tool for philosophers, yet the physicist tells us that we need it for understanding and touching reality. Despite all the arguments and highly significant quotations, positivism is alive and, if not flourishing, still doing well. I see its influence in various scholars from Hawking[230] and Nancy Cartwright[231] to Mark Balaguer[232] and Fine.[233] Positivism may not be dominant, maybe it never was, but its unjustified suspicion of metaphysics has left its definitive mark on diverse scholars.

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[227] '...and it is this aspect which positivists and logical positivists find especially suspect' (Trusted, 1991, p. ix).
[228] Dummett, 1996, p. 6.
[229] Heisenberg, 1958-A, pp. 201-202. Also, 'even for the physicist the description in plain language will be a criterion of the degree of understanding that has been reached.' (Heisenberg, 1958-A, p. 168.)
[230] Hawking in Penrose, 1997, p. 169.
[231] Cartwright in Penrose, 1997, p. 161.
[232] Balaguer, 1998, ch. 8, 'The unsolvability of the problem and a kinder, gentler positivism'. The only thing 'kinder' is perhaps the tone of his writing as compared to someone like Carnap.
[233] Fine, 1996.

While many philosophers are suspicious of metaphysical thinking, most physicists do not think philosophically at all.[234] Physicist Lee Smolin has written recently on the poor state of research and depth of understanding in fundamental physics because of this neglect of philosophical reflection. He argues that one of the main reasons researchers have become stuck on fundamental problems, whether in string theory or quantum gravity, is that they have neglected the necessity of philosophical thinking that was essential to the development of quantum theory. He concludes that 'perhaps the problems of unification and quantum gravity are entangled with the foundational problems of quantum theory, as Roger Penrose and Gerard t'Hooft think. If they are right, thousands of theorists who ignore the foundational problems have been wasting their time.'[235]

Metaphysics may not give us directly perceivable, tangible results, but neither does pure mathematics. However, the importance of mathematics when it is applied in physics can hardly be doubted, and likewise, without the possibility of metaphysics, we could not even understand rationally our sense perceptions in a scientific way, nor could we formulate pioneering questions that lead us to new areas of scientific exploration. Fortunately there is a slowly growing recognition of the importance of metaphysics in physics, although Gibbins inadvertently offers a good example of the lingering confusion that my tripartite distinction of metaphysics should help to clarify.

> If armchair metaphysics is out of date, a new kind of metaphysics, scientific metaphysics, has come into fashion. The new metaphysician asks: what is there in the physical world, and what is true of what there is in the physical world? The answers are provided by the philosophy of physics, a subject whose metaphysical part sets out to tell us the way the world is, if physics is true.[236]

Gibbins' use of the pejorative phrase 'armchair metaphysics' would correspond to what I have called pure metaphysics, and his notion of 'scientific metaphysics' is close to what I

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[234] And engineers generally do not care whether or not Planck's constant is an objectively true feature of reality or merely a fiction, but such practical scientists cannot claim to have any real understanding of the foundations of their discipline, which is one reason Einstein had been angry when his son chose such a career, saying that 'what he is interested in isn't really important, even if it is, alas, engineering. One cannot expect one's children to inherit a mind.' (Einstein quoted in Yourgrau, 2005, pp. 107-108.)
[235] Smolin, 2006-A.
[236] Gibbins, 1989, p. 1.

mean by applied metaphysics, except that scientific metaphysics would simply be one aspect of applied metaphysics. However, the sample questions he gives are not simply applied but are easily interpreted to be pure metaphysical questions, so it seems that he is doing armchair metaphysics after all. In any case, many of our greatest physicists have been 'armchair physicists' in that they themselves never did empirical experiments but relied on thought alone. And physicists such as Einstein were not simply interested in 'scientific metaphysics,' for he also admitted the importance of the guiding light of Platonic ideals:

> The ideals which have lighted my way, and time after time have given me new courage to face life cheerfully, have been Kindness, Beauty, and Truth. Without the sense of kinship with men of like mind, without the occupation with the objective world, the eternally unattainable in the world of art and scientific endeavours, life would have seemed to me empty. The trite objects of human efforts—possessions, outward success, luxury—have always seemed to me contemptible.[237]

Einstein has contempt for what most of us esteem important—success and luxury and so on, which are like the shadows on the wall of Plato's cave. The real guiding principles, the highest ideals, are Truth, Beauty, Kindness (Plato would have said Goodness). These ideals, these Platonic 'Ideas', were Einstein's guiding light. It is false (and insulting) to accuse Einstein of merely being a motivational realist, as Fine does. I discuss this point further in Chapter Five, but here we can note the highly unlikely possibility that Einstein would have wanted to follow a fairy tale of non-existent ideals. Surely he would have wanted to follow what seemed most important to him, what was more real and fundamental than luxury cars and fancy shoes. Thus, what seemed to be most real and fundamental for Einstein was not only mathematics but also the other Platonic ideals, just as Penrose believes too. 'One can well take the view,' Penrose writes, 'that the 'Platonic world' contains other absolutes, such as the Good and the Beautiful,'[238] although he does not venture into that territory because he is doing physics and applied metaphysics, while

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[237] Einstein, 1954, p. 9. (Einstein seems not to have used the phrase 'Platonic Ideals', but his oversight does not detract from the fact that these beliefs were beyond doubt Platonic.) Adams and Spencer (2007) contrast this quote with Rorty's desire to get tenure, arguing that Einstein was much more a true philosopher, at least in the ancient sense as discussed by Hadot (1995, 2002).

[238] Penrose, 1997, p. 1.

consciously exposing many of his presupposed metaphysical assumptions, but he does not engage in pure metaphysics, which is what is required if we are to venture into the Platonic realm of the Good and the Beautiful.

Metaphysics in Action: Where is the Uncertainty?

I will engage in pure metaphysics in Chapter Seven, so in this section I would like to help clarify a problematic issue in quantum theory through applied metaphysical reasoning, which will show how realism is presupposed no matter what view is assumed.[239] Barbour is better than most at explicating and demarcating the various distinctions involving the uncertainty relations; however, he has also made significant errors that are representative of the general conceptual confusion ignored by most physicists.[240] (I am going to ignore his frequent misuse of philosophical terms in order to elucidate the essence of his position and its concomitant conceptual confusion.)

The Heisenberg uncertainty principle is given an excellent metaphorical, and hence explanatorily helpful, description by Dickson:

> I am not really sure if it is a macroscopic example, an analogy or a metaphor, or perhaps all three. If you want to measure the speed (of a car say) you could put two posts by the road a known distance apart and measure the time it takes to go past them. The speed is given by distance/time with an uncertainty in the speed (for a particular accuracy of timing) that gets less the longer the distance between the posts. However the distance between the posts represents the uncertainty in the position of the car that goes with the measured speed. Thus, as the uncertainty in the position increases the uncertainty in the speed gets less and vice versa, with the product of the two uncertainties remaining a constant. This is exactly what the Heisenberg Uncertainty Principle states but in that case it is an ultimate uncertainty product related to the Planck Constant rather than a particular one related to the accuracy of the timing. The basic two variables for Heisenberg's Uncertainty Principle are momentum (speed times mass) and position also closely linked to my example.[241]

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[239] A very brief example of applied metaphysical questioning in relativity could be the following. We can never know for sure that if we flashed a beam of light from an object travelling at the speed of light that the light would still travel away at *c* because the theory of relativity also says that no (macro) object can travel at *c*. This is a case of a theory that rules out the possibility even in principle of empirically testing its counterintuitive claim

[240] See Barbour, 1966, pp. 289-315 for his discussion on this issue.

[241] Dickson, private correspondence, 2007. The uncertainty principle 'stated that the momentum and position values for a particle in any given direction could not be determined at the same time to an accuracy greater than $\Delta p_x \, \Delta x \geq h$. Or, more precisely, $\Delta p_x \, \Delta x \geq \hbar / 2$.' h = Planck's constant, which is about 6.62 x 10^{-34} joule-seconds; $\hbar = h / 2\pi$; Δp_x = the uncertainty in a particle's momentum; and Δx is the uncertainty in its position. (Rowlands, 1992, p. 221.)

The uncertainty principle resulted from Heisenberg's *thought* experiment[242] and although it has been accepted as fact, even reluctantly by Einstein,[243] Bohr eventually felt forced to give up on the uncertainty principle, or the so-called disturbance argument, as a defence against Einstein's attacks, for it implied, as Baggott contends, an 'almost classical realist conception of the measurement interaction,'[244] which would have played into Einstein's demands for a reasonable theory.[245] But Bohr was essentially reacting against Einstein's materialism and strict determinism, not his realism.

Barbour outlines three possibilities: (1) the uncertainty is due to temporary human ignorance, (2) it is inherent to experimental or conceptual limitations, or (3) it is in nature itself.[246] I will here give a summary of Barbour's explanations of these three possibilities and critically assess his views. Einstein, Planck, Bohm, de Broglie [and I should add (sometimes) Schrödinger], for example, held to the first view.[247] According to this view, the quantum system must be objectively determined even though subjectively we may never be able to predict with absolute certainty any particular outcome. Tossing a coin could, therefore, in principle be predicted with complete accuracy if we knew all the relevant variables. Yet, because such knowledge is extraordinarily difficult to attain, the result of the coin toss appears to be random. However, I would add that one could quite easily imagine a pre-programmed robot flipping a coin with pre-specified momentum etc., in an environmentally controlled room that could allow us to predict the outcome with great precision—enough to consider the system determined.

We should also note that the laws of statistical probability appear to be objective, as Heisenberg contended, which accords with Barbour's third option, which is what he endorses. Barbour also discusses Bohm's hidden variables alternative and states that 'most scientists are *dubious about such proposals*. In the absence of any clear experimental evidence, the defence of determinism rests largely on philosophical

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[242] Baggott, 2004, p.37.
[243] Einstein, 1954, p. 334.
[244] Baggott, 2004, p. 186,
[245] Baggott, 2004, p. 133.
[246] Barbour, 1966, pp. 298-299.
[247] For example, see Planck, 1931, pp. 47-48.

grounds.'[248] Norris has written extensively on precisely this sort of dogmatism and lack of philosophical clarity resulting in a prejudiced opposition to any alternative such as Bohm's. What Barbour misses here is that *any* interpretation of quantum theory, or alternative theory, necessarily rests on philosophical assumptions, so resting on philosophical grounds is no criticism of hidden variables or of any theory whatsoever. Moreover, the idea of a measuring device interfering with the system it measures is not new, for as Schrödinger remarks, the contention that both subject and object are inextricably interwoven 'is almost as old as science itself.'[249]

According to Barbour, Bohr was a chief proponent of the second view, where the uncertainty is not just due to human ignorance but is a fundamental limit on human knowledge. There are two versions of this view: the experimental and the conceptual. The former says that uncertainty is due to the disturbance of the physical system through interaction with an instrument or observer; although Barbour is quick to point out that he does not endorse any reference to the consciousness of the experimenter (trying to save 'objectivity' it seems).[250] However, this view cannot account for uncertainties when nothing has disturbed the system, such as radioactive decay or, as I add here, nonlocal effects.[251] 'The unpredictability of the atomic realm, then, appears to be a distinctive feature of quantum mechanics—from whose postulates the Heisenberg Principle can be derived without reference to disturbances introduced by the observer.'[252] The conceptual version of the second view, however, concerns our human epistemological limitations.[253] On this view, which is usually considered to be positivist and agnostic, we can never know physical reality in itself (much like Kant's noumena).[254] And 'the ontological

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[248] Barbour, 1966, p. 300. Original emphasis.
[249] Schrödinger, 1952, p. 52.
[250] Barbour, 1966, p. 301.
[251] Barbour, 1966, p. 302.
[252] Barbour, 1966, p. 302.
[253] Barbour, 1966, p. 302.
[254] For example, Trusted writes that 'Kant suggested that all our empirical knowledge was knowledge of a phenomenal world that *we* had constructed. We could know noting of ultimate reality (things-in-themselves), whether that reality was material, spiritual or both or neither of these. This phenomenal world that we were of was only perceived as an objective reality because we had organized our perceptions according to certain intuitions and concepts that were common to all human beings.' (Trusted, 1991, p. 122.) If Trusted's brief interpretation is correct, then Kant sounds like an idealist, even though he argues against what he calls 'empirical idealism'. (Kant, 1929, p. 350.)

question of the character of the world is ignored or dismissed as meaningless,'[255] which is why it is rightly assumed to be positivistic in this sense.

The third position, which Barbour also approves, is endorsed by many physicists and 'holds that *indeterminacy is an objective feature of nature*, and not a limitation of man's knowledge.' [256] Barbour follows Heisenberg in claiming that the uncertainty comes about only by the observer making a choice about how and when to make a measurement, which results in actualizing one of the many possibilities. However, Gibbins also notes that sometimes Heisenberg 'writes as if it is only our *knowledge* of the world that is indeterminate, not the concepts which we take to apply to physical systems big and small.'[257] But the notion of indeterminism in quantum theory is problematic. If the range of values is continuous, as it is assumed to be in classical physics, then in principle we could have infinitely smaller values between any two points. However, in quantum theory, energy levels for the electron are definite and determinate and not continuous. The allowable energy levels for an electron have definite and determinate values, and, thus, it seems that our terminology is quite confusing here and ends up being misapplied.[258]

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[255] Barbour, 1966, pp. 302-303.

[256] Barbour, 1966, pp. 303. Original emphasis. Newton also intimated indeterminacy, as is shown by a comment recorded by his Boswell, David Gregory: 'A ray of light has paroxysms of reflection and refraction and indeterminate ones at that.' (Rowlands, 1992, p. 224.) This is an example of how classical physics actually shared similar assumptions with quantum theory.

[257] Gibbins, 1989, p. 53. original emphasis.

[258] Furthermore, consider the following description of a photon in a university physics textbook, which assumes (a) that determinism in some way still occurs and (b) that we discover fundamental laws that are universally applicable.

'A photon is the "quantum" of electromagnetic energy and momentum emitted or absorbed in a single process by a charge particle. It is entirely determined by the frequency of the radiation. Therefore, we may state the following principle:

> *When an electromagnetic wave interacts with a charged particle, the amounts of energy and momentum which are exchanged in the process are those corresponding to a photon.*

The principle stated above is one of the fundamental laws of physics. It is applicable to all radioactive processes involving charged particles and electromagnetic fields. It does not stem from any law we have stated or discussed previously, but is a completely new principle, to be considered on the same level as such universal laws as the conservation of energy and momentum. The discovery of this law in the first quarter of this century was a milestone in the development of physics.' (Alonso & Finn, 1968, p. 19. Original emphasis.)

Barbour also claims that this view negates '*absolute causation*' (or determinism) and is better called 'weak causality' since 'the probabilities at one instant are precisely and unambiguously determined by the wave-functions at earlier instants.'[259] But it would seem to follow, however, that although not just anything is possible (out of its precisely determined possibilities), which negates absolute chance, events that are actualized may not be exactly repeated if the universe were replayed in absolutely the same detail. But if an observation or measurement is what brings potentiality into actuality, and if the observation or measurement which occurs at time *t* entails result *r*, which is to say that there was no other possibility than *r* given an observation or measurement at *t*, then it still makes sense to think deterministically. The question of whether or not *r* could have been otherwise is purely metaphysical, which is fine so long as we do not pretend to have unambiguous empirical data proving that absolute determinism is false and if we admit that we are reasoning metaphysically. Barbour probably would not want to make such an admission since he has already inappropriately dismissed hidden variable alternatives because they rest upon philosophical considerations. But if the machine or sentient creature making the measurement or observation is also susceptible to the same quantum laws, then they too will have been actualized by some other sentient creature or a machine, which in turn must have been susceptible to the same laws. (And this reasoning, if taken to its logical conclusion, leads to the original source of all creation, which must have been outside creation, as Goswami argues when he says that consciousness is the ground of all existence.[260])

The first two views concerning the epistemological limitations, whether due to experimental error, physical interference with the system, conceptual difficulties or simple human ignorance, both more or less amount to the same thing. Barbour makes it appear that these positions equally assume that the uncertainty is due to epistemological limitations and not an ontological reality, but that assumption is unwarranted. We cannot avoid epistemological limitations as outlined above, or even if we could we still could not prove that we had done so without falling into the sceptical trap. But admitting that there

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[259] Barbour, 1966, p. 305. Original emphasis.
[260] Goswami, 1993.

are such limitations does not necessarily imply that the uncertainty is not in nature itself. In other words, the different viewpoints are not mutually exclusive options. Moreover, and most importantly, it is wholly unwarranted to claim it has been empirically and unambiguously decided that the uncertainty is in nature itself, for this claim is (mostly) metaphysical. It involves presupposed assumptions and mostly applied metaphysical reasoning, although also on the edge of pure metaphysics. There is no way to prove empirically that the uncertainty is in nature. One may point to 'random' decay or non-local effects, but that is merely question begging. Calling a phenomenon 'random' and then claiming that, therefore, it is not completely determined is not good reasoning, for it is true simply by definition. We do not *know* that any decay process is random, for there may very well be some sort of determining possibility that we have not yet conceived, and, in any case, we really do not know what we mean by 'random'. The only way *a priori* to rule out hidden variable theories, especially ones such as Bohm's that allow for nonlocal effects and so cannot be materialistic, is by believing undefended metaphysical assumptions as if they were empirical certainties (and also trusting in our senses to give us truth). Claiming that the uncertainty is in nature does not actually make it so, and any possible evidence must be based upon an interpretation of the data, which is applied metaphysical reasoning.

Even if I wanted to accept that the uncertainty is in nature, it is still wholly unclear as to what is meant by 'nature'. If the claim is no more than saying that the uncertainty is in *physical* nature, then that is rather trivial, although still fraught with difficulties, as I will explain shortly. But the uncertainty cannot be in the laws themselves, although we must be very careful with our language here. The laws may describe probabilities, and those probabilities are supposed to reflect what is actually happening in the physical world. But the laws themselves do not change (which I discuss in detail in Chapter Seven). The laws themselves are entirely certain (within their limited domain of applicability) and unchanging. Thus, the question of whether or not uncertainty is in nature hangs on the question of what we mean by 'nature,' and the ambiguity of this essential term creates much unnecessary confusion. If by 'nature' we are referring to physical reality, then it may be true that there is inherent uncertainty in the trivial sense that all physical reality is

constantly changing and therefore in some sense uncertain, but if we are referring to the laws themselves, then the claim that the uncertainty is in nature must be false. But there is a further difficulty. Even if the uncertainty is in physical nature, it does not necessarily follow that how physical nature unfolds is purely random or uncertain. The uncertainty seems most likely to be due to the difficulties of *knowing* anything for certain about any aspect of physical reality itself, because physical reality is constantly in motion.[261]

Bohr accepts a sequence of cause and effect in the atomic realm that conforms with 'elementary demands of causality', although he claims that we still must abandon 'ideal determinism.'[262] But there are various difficulties here. First, it is unclear how he can admit that there is a sequence of cause and effect while simultaneously denying ideal determinism, which seems to be a denial that every single effect has some cause and that the effect could not have been otherwise. Quantum theory assumes that things could be otherwise within certain predetermined limits; therefore, we could have a system that is determined to behave within limits that are imposed upon us, which is admitting the realist position because these limits are not simply arbitrary human creations, but how these processes unfold may be different every time the experiment is performed. The specific behaviour of any particular subatomic particle (or wave, or energy field) apparently cannot be known prior to the result of the experiment. For my purposes, the reason for the uncertainty is not as important as clarifying that the ontological claim that nature is uncertain is not necessitated by physical experiments. Likewise, experiments alone give no conclusive support to ideal determinism either. But, as Dickson says above,

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[261] The notion of free will hinges on very deep metaphysical assumptions about the nature of the self and its relation to physical reality; however, I will not discuss this issue because it is too far afield from our concerns. But it is worth noting that evoking quantum theory to support free will merely gives in to the materialism that quantum theory apparently overthrows, and, in any case, if one rejects consciousness as merely being an epiphenomena of neurological activity (instead of being the immaterial foundation of all physicality) then there is no necessary logical contradiction between maintaining free will for sentient creatures such as humans and holding on to strict causality in the physical universe. Planck would agree: 'All studies dealing with the behaviour of the human mind are equally compelled to assume the existence of strict causality...human free will is perfectly compatible with the universal rule of strict causality.' (Planck, 1931, pp. 84-85.) It is also interesting that although the antirealist B. Allan Wallace, whom I discuss in Chapter Six, pledges allegiance to Tibetan Buddhism, apparently the Dalai Lama has 'confessed to having difficulties with the philosophical implications of quantum physics, especially the role of chance and causality in nature. As the idea of determinism is central to Buddhism, the existence of purely random acts might call into question Buddhist doctrine.' (Quoted by Quirin Schiermeier, 2005.).

[262] Bohr, 1963, pp. 4-5. Bohr is the least clear writer of all the physicists I am discussing here, often making it very difficult to determine what he actually means.

there is an 'ultimate uncertainty product related to the Planck Constant', which, if it really is an *ultimate* uncertainty, then it must be an objective feature of nature. If it is an objective feature, then it is mind- and instrument-independent, which means that realism is vindicated even if there could never be ideal determinism.

It is here worth noting an important inconsistency in quantum theory that follows on from the above reasoning, which, so far as I know, no one seems to have noticed. Bohr has said famously: 'There is no quantum world. There is only an abstract quantum physical description. It is wrong to think that the task of physics is to find out how nature is. Physics concerns what we can say about nature.'[263] And Heisenberg has said that 'we have to remember that what we observe is not nature in itself but nature exposed to our methods of questioning.'[264]

Thus, assume that the following two assumptions, which apparently are held by the majority of physicists, are true.

1) The goal of physics is not to describe nature as it is in itself but as it is exposed by our questions.
2) The uncertainty captured in the uncertainty principle is inherent in nature itself.

These two statements are incompatible. Even the first claim is metaphysical because there is no possible physical experiment that could prove that the goal of physics is to describe nature as exposed to our questioning; rather, such a claim provides the metaphysical basis for the way physicists think about their theoretical and experimental work, and the onus is on my opponent to construct an actual physical experiment to prove assumption one. And I am not saying that only non-falsifiable claims are to be considered metaphysical, but if there is no way in principle ever physically to prove or test a claim,

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[263] Bohr in Baggott, 2004, p. 109. Also quoted in Nadeau and Kafatos, 1999, p. 96.
[264] Heisenberg, 1958-A, p. 58. Also: 'The atomic physicist has had to resign himself to the fact that his science is but a link in the infinite chain of man's argument with nature, *and that it cannot simply speak of nature 'in itself'*....Thus even in science *the object of research is no longer nature itself, but man's investigation of nature.*' (Heisenberg, 1958-B, pp. 15, 24. Original emphasis.)

then it is necessarily metaphysical, and even when some claim may be testable it will still rely upon implied and explicit metaphysical assumptions. In this case, the above claim regarding the goal of physics is not at all the sort of claim that is generally considered to be scientific. It is like saying that the goal of life is to be rich or to be a saint. Such claims are not part of the scientific package as such, even though they are fundamental and prior to the sciences and so implicitly permeate the sciences. But even assuming that the first claim is somehow or other a physical fact, it would still be incompatible with the second claim. The reason for this incompatibility is because the claim that the uncertainty principle is inherent in nature is a claim about nature itself, *as it really is*. But it should be obvious that if the first claim is true then we can never make *any* claim about nature *as it really is*, so we cannot consistently say that nature *really is* inherently uncertain, at least not without violating our first claim. Moreover, if anyone believes either or both claims to be true, then she must be a broad realist, discussed in Chapter Five, because she would be making a claim that is supposed to be true regardless of what others happen to believe, thus giving her claim mind-independent or at least belief-independent status.

Even more significantly, there is another subtle argument. The first claim is also necessarily endorsing a realist view in the following way. The claim that we are describing nature as it is exposed by our questioning clearly implies that there *really is* a nature that is what it is, but that we are only able to access certain aspects of it depending on the kinds of questions that we ask, which is an argument that would support Bohm's notion of unbroken wholeness. Either there is no nature at all, nothing at all, and then we would not be here, or there is something that exists prior to us and we are doing our best in trying to grasp it, however imperfectly and however much our answers depend upon our questions. Clearly, the latter option is more reasonable.

I actually agree with Bohr that physicists are describing nature as it is exposed to their questions, where the trick is to ask the right questions, for the epistemological limitation is unavoidable. But that is not an antirealist view, it is a realist position when properly understood because it does not follow that just because I have a partial and limited understanding of nature that my understanding is false or merely a convenient fiction.

That is poor reasoning: I know only a part of the whole and not the whole itself and therefore the part I know must be false or unreal. This reasoning is only possible at all by assuming that there is a whole in the first place, that nature actually really is what it is, in order to make the argument that my partial understanding entails that I have false or fictional understanding. But if it is true that there is a whole or nature in the first place, then the antirealist conclusion is false. Physics is not about claiming to have absolute knowledge; it seeks to illuminate a portion of reality, a point made somewhat poetically by Eddington: 'If our so-called [scientific] facts are changing shadows, they are shadows cast by the light of constant truth.'[265]

Rowlands argues that physics, if it is to be a powerful, universal, unifying system, has to be as simple and abstract as possible. Physics must aim not to define nature itself or give it any characteristics because then we would be limited to the asymptotes of our assumptions.[266] He also argues that naïve realism is false, where we believe that there are real forces interacting with real particles, which is a denial of materialism. However, he here seems to create a similar ambiguity as mentioned above concerning the word 'nature', which can make it difficult to explain how physics can actually work if there is nothing at all about nature (physical and nonphysical aspects of reality) that corresponds to what is described by the equations. But he certainly does not believe that the laws of physics are mere fictions, for he does believe that they are real, not in the physical sense but in the nonphysical, abstract sense. Maybe physical nature (or reality) cannot be given any particular defining characteristic, since it is a constant and universally interconnected flow, but the mathematical laws of physics are limited albeit constant, unifying and powerful aspects of nonphysical nature (or reality). Unfortunately, if taken out of context, some of Rowlands' remarks could be interpreted as being antirealist, but he is simply denying naïve realism, which is materialism, and arguing that physics works because of its nonphysical, abstract nature. He believes that the 'physical' world actually is mathematically abstract, and his Platonic/Pythagoreanism permeates his entire view of

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[265] Eddington, 1929, p. 55.
[266] Rowlands also writes that 'Newton introduced the category of universal law, an abstract statement of a relationship between physical quantities that was independent of any model to which it could be applied.' (Rowlands, *Physics: The Quest for Unification*.)

fundamental physics.[267] Rowlands ends up being a realist in all the ways that I describe for Bohr and Heisenberg in Chapter Five.

Drawing the ontological conclusion that there is no determinate quantum reality (and perhaps no quantum world at all) from these epistemological warnings is not justified.[268] As Harris notes, if we accept the third viewpoint, then the assumed probabilistic nature of physics permeates all of science. 'Thus, reality, so far as we have any indication of its nature, seems to be wholly random and unaccountable in its underlying activity.'[269] Harris further notes that those who think in this way generally try to make sense of the apparent order of the world by saying that in science we impose this order. In paraphrasing Harris' objection with my own views, it is clear that such thinking is incoherent. If we are materialists, then we too are subject to the same randomness apparently inherent in quantum physics, but then there is no way to explain coherently the fact that we do have order in science and in our experiences. Relying on a statistical averaging is deceptive. If the statistical laws continuously allow us to make accurate predictions, then there is clearly an operating or driving principle behind the statistical laws. Without a presupposition of underlying order, statistical laws would be meaningless or impossible. If events are truly random, then we cannot make any useful prediction at all and there could not be any sense of order in science or our experience. If we can make accurate predictions, which indeed we can, then that presupposes some sort of order. If there is some sort of order, then we cannot be imposing it upon the world. If the world or reality itself had no order, then, since we must be a part of this reality (or else we would be unreal) we too could have no order. But if we had no order then it would be impossible even to image how we could be coherent enough to impose order, for how could something completely without order (in this case, us humans) in a reality

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[267] Rowlands, 2003. Cf. Burtt: 'The famous Pythagorean doctrine that the world is made of numbers is apt to appear quite unintelligible to moderns till it is recognized that what they meant was *geometrical units*, *i.e.*, the sort of geometrical atomism that was taken over later by Plato in the *Timaeus*.' (Burtt, 1925, p. 30.)

[268] Cf. Yourgrau:
'The uncertainty principle, after all, is an example of the same tendency to draw ontological conclusions from epistemological premises, in this instance, from our inability in principle to know simultaneously the position and velocity of a subatomic particle, to the non-existence of such a combined state. Not only did Einstein reject this reasoning, he resisted what he took to be Heisenberg's more fundamental belief that we should abandon the very idea of "quantum reality."' (Yourgrau, 2005, pp. 107-108.)

[269] Harris, 2000, p. 158.

completely without order ever be ordered enough to create and sustain order? I will set aside this improbability.

Harris notes further that in actuality the statistical laws of modern physics 'imply a certainty that the modern physicist recognizes,' which I have already discussed above. He also reminds us that not only Planck and Einstein but also Penrose have thought that uncertainty cannot be an actual property of physical reality,[270] and I have here provided independent arguments in support of such views. In addition, I have also shown how Dickson, for example, can be correct about the ultimate uncertainty related to the Planck constant when we see how the uncertainty is built into the equation. Even while the equation *itself* is not uncertain—for it yields accurate predicitions, physical reality is not ontologically uncertain in the sense of being random, and the nonphysical reality of the mathematical laws of physics are not themselves uncertain. Moreover, the fact the quantum theory yields such powerfully accurate predictions seems to belie the assumption that there is really uncertainty in nature itself, especially when considered together with my above arguments.

Penrose tells us that 'Euclidian geometry is accurate to smaller than the width of a hydrogen atom over a metre's range.' Newtonian mechanics is accurate to about one part in 10^7; Maxwell's electrodynamics in conjunction with quantum mechanics corresponds to a range of scales of 10^{35}or more; Einstein's relativity is accurate to about one part in 10^{14}; and quantum field theory (which is the combination of quantum mechanics with Maxwell's electrodynamics and Einstein's Special Theory of Relativity) has results accurate to about one part in 10^{11}.[271] Quantum mechanics can also explain the stability of atoms, spectral lines, chemical forces, black-body radiation, the reliability of inheritance, lasers, superconductors and superfluids,[272] and as stated already, about thirty percent of the manufacturing industry relies on quantum mechanics. The supposed uncertainty in quantum mechanics yields extraordinarily precise predictive results, far beyond what

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[270] Harris, 2000, p. 31.
[271] Penrose, 1997, pp. 50-51.
[272] Penrose, 1997, pp. 54-55.

classical physics, the supposed harbinger of materialism and strict determinism, is able to offer.

Prying Philosophers

The pioneering physicists we have been considering understood the inextricable importance of metaphysics for physics, but they still sometimes had strong reservations about getting caught in a philosophical web spun by the professional philosophers, despite the fact that physicists often recognize that Einstein's main work in physics was actually mostly philosophy.[273] But these physicists were often sceptical of the philosophical fashion of the time. Eddington is quite blunt: 'It would probably be wiser to nail up over the door of the new quantum theory a notice, 'Structural alterations in progress—No admittance except on business,' and particularly warn the doorkeeper to keep out prying philosophers.'[274] Einstein concurs:

> when the very foundations of physics itself have become problematic as they are now...when experience forces us to seek a newer and more solid foundation, the physicist cannot simply surrender to the philosopher the critical contemplation of the theoretical foundations; for, he himself knows best and feels more surely where the shoe pinches.[275]

What could have prompted Einstein and Eddington to keep out the 'prying' philosophers, especially at the point where they would seem to be most needed, when the 'very foundations of physics itself have become problematic'? Einstein certainly has a point that the physicist may feel 'more surely where the shoe pinches' but the problematic issues, including his disagreements with Bohr, were philosophical in nature rather than being grounded purely on established empirical evidence. They argued about the meaning, interpretation, and understanding of the results of experiments, and they disagreed over the future possibilities based on thought experiments and applied metaphysical reasoning. If the philosophers could have somehow enforced a restriction on the physicists that eliminated any possibility whatsoever of engaging in metaphysical

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[273] James Trefil, Clarence J. Robinson Professor of Physics at George Mason University, writes that Einstein 'published a paper that was mainly about philosophy. When it appeared, scientists dispensed with their usual arguments about data and took the new ideas to heart. A big reason for the reaction comes from the fact that relativity is beautiful. I know that is a strange word to apply to what is, after all, a mass of equations, but that's the way physicists perceive it.' (Trefil, 2007, p. 26.)
[274] Eddington, 1935, p. 208. This publication was based on his Gifford Lectures.
[275] Einstein, 1950-A, p. 59.

reflection in relation to physics, then that really would be the end of physics, as Bohr had implied.

It is not unreasonable to conclude that Eddington's and Einstein's warning to philosophers to stay out of quantum theory until it is had achieved relative conceptual stability was a warning to the materialists, positivists, budding analytics and overly sceptical philosophers. For example, Eddington argues that physics has rendered materialism 'dead', thus rejecting the materialist philosophers.[276] Eddington also argued against two previously prevalent views endorsed by philosophers such as Russell who wrote that he (Russell) 'cannot admit any method of arriving at truth except that of science'[277] and that 'science has nothing to say about values.'[278] If Russell were correct, then it would clearly follow that we could never know ethical truth, which means that we could never know what is good and what is bad. We could not even know whether or not science itself has any value. Russell's views, as Eddington recognized, would also leave science incapable of discussing issues that are most meaningful to us as human beings. Eddington argued that science has its limits, but that what is beyond its limits is in no way less real or important just because science has little or nothing to contribute to our understanding of this particular area. However, Eddington cannot totally agree that science has nothing to do with values: 'If it were literally true, it would mean that, when the significance of our lives and of the universe around us is under discussion, science is altogether dumb.'[279]

While first building or restructuring the theoretical edifice in the new physics, the physicists would also want to keep out any overly sceptical philosophers. It is relatively easy to wave the banner of scepticism, tearing down every utterance made by another (or seemingly doing so even to oneself) but such a sceptic still believes (or acts as if she believes) that, for example, her molecular structure will not instantaneously

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[276] Eddington, 1929, p. 31. Yet Rorty reminds us that 'American philosophy has now reached a position which, though still plausibly described as "materialistic" or "physicalist", is no longer in any way scientistic.' (Rorty, 1991, p. 113.)
[277] Russell, 1997, p. 189.
[278] Russell, 1997, pg. 175.
[279] Eddington, 1929, p. 38.

metamorphize into a pink elephant, nor does she think that the force of gravity will suddenly become a million times stronger and in the next instant disperse altogether throughout the universe.[280] It may be helpful to remind ourselves that having a critical attitude does not mean lapsing into *scepticism*, which is a metaphysical doctrine. Similarly, denying the metaphysical doctrines of materialism, pragmatism and empiricism does not entail that we do not believe in material objects, that we are never pragmatic, or that we reject empirical research.[281]

While Sachs is correct that physics should not have stayed away from philosophy, it is important to respect these physicists' concerns about philosophers possibly adding to the confusion before the physicists at least have some idea what they themselves mean by phrases such as 'wave-particle duality'. Demanding to have precise analytical clarification of, say, the nature of the uncertainty relations, before permitting any applications of the principle may not be a feasible option. It does not follow that we can forever ignore such problematic issues and hope to make any serious groundbreaking advances in fundamental physics. Likewise, philosophers still have not come to any generally accepted unambiguous criteria for what counts as knowledge, but just because we do not have certainty about the foundations of epistemological inquiry it does not mean that philosophers or anybody else cannot claim to have knowledge about various things, even if such knowledge is nevertheless problematic once scrutinized with analytic precision. If we had to have rock solid foundations in epistemology before being permitted to think philosophically in other areas of inquiry, then neither philosophy nor physics could have developed. But it does not follow that epistemological questions are meaningless, and similarly the foundational metaphysical questions permeating quantum theory need to be considered in depth by both physicists and philosophers even while others are pursing practical applications so far as possible without any understanding of such issues.

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[280] K. Ward (1996) makes a similar point.

[281] Cf. Clark: 'The office of sound philosophy, as I have been urging throughout this work, is to counteract the arguments of despair. Scepticism, relativism, indifferentism, reductivist materialism, solipsism, and the rest are not rationally inescapable options. On the contrary, serious attempts to think through them reveal that they constitute the death of reason.' (Clark, 1984, pp. 85-86.)

I think that the mutual distrust of analytic philosophers and the deep thinking physicists is revealed quite clearly in Susan Stebbing's obvious anger at Eddington and Jeans. She accuses Jeans of 'cheap emotionalism and specious appeals' and writes that Eddington's desire to be entertaining 'befools the reader into a state of serious mental confusion.'[282]

> Jeans, who believes it to be an advantage not to be trained in philosophy or to have an inclination for it if one wishes to draw philosophical conclusions from physics, seems nevertheless to have read both Plato and Berkeley. Evidently he has not studied any criticisms of either of these philosophers, and is consequently unaware that he has put forward views that have been seriously criticized—views that, in the opinion of most philosophers, have been decisively refuted.[283]

It is often the case that scientists tend not to think through the deep philosophical assumptions and issues that permeate and are foundational to their discipline, and a few behave as if an arrogant wave of the hand suffices to rebut any attempt at proper clarification and elucidation.[284] But the physicists that we have been concerned with did not have such an attitude, and it is poor philosophical reasoning on Stebbing's part to argue that just because some view is apparently at odds with the opinion of 'most' philosophers it must therefore be false. Such assumptions are based purely on prejudice, not philosophy. Thus, Jeans did rightfully think that it could be a disadvantage to study the kind of philosophy that Stebbing, Russell, and Wittgenstein were doing because, as already argued, the assumptions of this analytic tradition are antithetical to the empirical developments and required modes of metaphysical reflection that unfolded with the advent of quantum theory. But Jeans was influenced by Plato and Berkeley, as their metaphysical views and ways of thinking were most akin to the new physics. Hence, Jeans clearly was not against philosophy but simply rejected the analytics.

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[282] Stebbing, 1944, pp. 13-14.
[283] Stebbing, 1944, pp. 196-197. See Jeans, 1930.
[284] I have seen such actions firsthand often enough, and Clark has also discussed this problem with me in relation to biologists cursorily dismissing any notion of animal consciousness or desires. Such scientists make the same mistake as the antirealist because they claim that just because *they* cannot know what an animal may be experiencing or desiring therefore the animal cannot have any conscious awareness or intentions at all. In other words, if we cannot know X then X cannot exist, which is a convenient assumption to hold uncritically when applying for research grants to perform animal experimentation.

Schrödinger goes so far as to argue that consciousness is universal and singular: 'there *is* only one thing and what seems to be a plurality is merely a series of different aspects of this one thing, produced by a deception (the Indian MAJA).'[285] He even writes that 'the mystics of many centuries, independently, yet in perfect harmony with each other (somewhat like the particles in an ideal gas) have described, each of them, the unique experience of his or her life in terms that can be condensed in the phrase: DEUS FACTUS SUM (I have become God).'[286] He ends this Epilogue of his *What is Life?* by saying that the point of view he has been arguing for, which is in harmony with the great mystics' throughout the ages, 'levels with what Aldous Huxley has recently—and very appropriately—called Perennial Philosophy. His beautiful book...is singularly fit to explain not only the state of affairs, but also why it is so difficult to grasp and so liable to meet with opposition.'[287] I cannot imagine any analytic philosophy department studying seriously Huxley's *Perennial Philosophy*. But, again, it is more than perplexing how the analytics have pretended to be scientific at the same time as rejecting the views of these great scientists. So, these pioneering physicists were not rejecting philosophy wholesale, they were rejecting prying positivists and analytics.

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[285] Schrödinger, 1967, p. 95. Original emphasis.
[286] Schrödinger, 1967, p. 93.
[287] Schrödinger, 1967, p. 96. See Huxley, 1946.

Summary

In this chapter, I have shown by independent argument and historical analysis how metaphysics was and must continue to be of fundamental importance to foundational physics. I have offered three heuristically valuable categories of metaphysics— pure, applied and presupposed—and have shown how the positivist injunction seems mostly to have been levelled against pure metaphysics because positivism itself rested upon presupposed metaphysics, and applied metaphysical reasoning is also inescapable, whether arguing for empiricism or realism etc. I also offered a detailed example of applied metaphysical reasoning in physics whereby I argued that the common assumption that the uncertainty relations reflect actual uncertainty in nature is most likely to be false. Finally, I considered possible reasons that these pioneering physicists wanted to keep away from the prying analytic philosophers while simultaneously embracing philosophical views that were spiritual in nature. I think that Baggott accurately summarizes the views I have been arguing for in the first three chapters.

> Despite the positivists' efforts to eradicate metaphysics from philosophy, the old metaphysical questions escaped virtually unscathed. I find it rather fascinating to observe that although the possibility of the existence of God and the relationship between mind and body no longer form part of the staple diet of the modern philosophers, they appear to have become increasingly relevant to discussions on modern quantum physics. Three centuries of gloriously successful physics have brought us right back to the kind of speculation that it took three centuries of philosophy to reject as meaningless.[288]

There are exceptions of course. Some philosophers have continued to discuss these questions with great enthusiasm and some physicists detest the idea of talking about God or consciousness, but as a general comment it does not seem too far off the mark.

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[288] Baggott, 2004, p. 262. And Stanley Rosen, Borden Parker Bowne Professor of Philosophy at Boston University, makes a similar point: 'We may be dependent upon theoretical physicists and cosmologists for the preservation of a genuinely speculative, and indeed, synthetic or universal philosophical tradition. This is especially interesting in view of the fact that the loss of interest by philosophers in 'big questions' is due in large part to the influence of modern science.' (Rosen quoted by Chase in Adams & Spencer, 2007)

CHAPTER FOUR: Physics and Faith

Introduction

The purpose of this chapter is to clarify, so far as is necessary for my immediate goals, the nature of faith in relation to (a) the presupposed metaphysical assumptions that must be true in order for physics to be possible, (b) the beliefs of the relevant pioneering physicists themselves, and (c) the views of realists (and even antirealists) with respect to physics. I also discuss how some of these important pioneers in physics were capable of being 'fanatical' in defending their faith in the truth of their ideas.

What is Faith?

Perhaps the average experimental physicist will be relatively unconcerned about this discussion on the role of faith; however, the fact is that the word (or implied concept of) 'faith' is often evoked by deeply reflective physicists (and other scientists[289]) as being a fundamental grounding of the discipline. This chapter is essential because realists all need to rely on faith,[290] but what is probably more interesting is that the supposed antirealist founders of the Copenhagen interpretation also shared the same sort of fundamental faith as their opponents about the eternal reality of the laws of physics. *All* scientists, whether capable of admitting it or not, must have such faith, for it is embedded in the very fabric of the entire structure of their scientific beliefs. Yet, despite the importance of this discussion of the role of faith, there is little to be gained here from an overly detailed analysis. It is impossible to do philosophical justice to the notion of faith in a short chapter, and I am not going to offer a minutely detailed analysis of its various uses and meanings, nor shall I delve into a comparative discussion concerning the related notion of 'belief'.[291]

I could simply say that physicists cannot absolutely empirically prove their fundamental assumptions, such as cause and effect relations, or the relative uniformity of physical nature and possibly absolute uniformity of the fundamental laws of nature. They cannot even prove the four conservation laws (energy, mass, momentum and angular momentum), which 'are the foundations upon which all of physics is built, Newtonian, relativity and quantum mechanics.'[292] Consequently, all such fundamental assumptions must be accepted on faith. But, for example, we do not 'blindly' believe in the conservation laws. Many experiments do support or imply these laws, and it was by maintaining belief in the law of conservation of energy against physical evidence that

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[289] For example, zoologist Stanley Beck writes that 'without an underlying faith in natural consistent behaviour in which causes as well as effects are detectable, scientific progress would be impossible.' (Beck, 1959, p. 38.)

[290] Cf. Baggott: 'Why, then, did Einstein choose realism if the only justification that can be found for it is an appeal to faith? Einstein's answer is simple. The existence of an observer-independent reality founded on causal laws had been largely an unstated belief of scientists for hundreds of years and had remained unquestioned until the advent of quantum theory. It had been the unspoken drive behind all the most significant discoveries in science.' (Baggott, 2004, p. 115.)

[291] For an extended detailed analysis of the notion of belief, see Price, 1969.

[292] Physicist Nick Blanchard, private correspondence, 2004.

physicists were led to search for the neutrino. However, we cannot logically or empirically prove these laws beyond doubt either. Physicists may or may not be religious or spiritual, may be Christian or Buddhist or atheist, but that does not matter because all scientists must share a faith that the world is somehow able to be comprehended. They need to be able to believe that they can find out what they presently do not know while being able to rely upon the relative stability of what they do presently know. Thus, they need a rational faith in the laws of physics, while remaining open to the possibility that they could be superseded, but only by a law that is more abstract, simple, and predictively powerful, an essential point that I discuss in Chapter Seven. But we cannot *prove* that these fundamental laws hold throughout the universe, or even that they will continue to be true in the next experiment involving different variables, although we must assume that they will continue in order to be able to carry on with our physics (and even to be able to walk around without expecting that our entire molecular structure may instantly be transformed into that of a frog). We cannot even prove that whatever we mean by 'proof' is actually a good proof, nor can we prove that we need to have a proof for any claim, at least not without begging the question. But the assumption that the fundamental laws unveiled by physicists will remain valid within their applicable domains throughout the universe must be adhered to, must be fully believed, in order to do physics. But this is exactly the assumption that antirealists, such as Karl Rogers, want to deny, but which Heisenberg (the supposed antirealist) wholeheartedly endorses, a point that I discuss in Chapter Five.

Thus, if such assumptions, as mentioned above, cannot be proven empirically, even in principle, and since there is no logical omega point where all possible doubts and questions about fundamental propositions come to an eternal rest, then there seems to be no other choice than to have faith in them. Even if we believe we could provide adequate evidence to prove them through empirical means, the sceptic can force us to see that there are still presupposed metaphysical assumptions underlying the notions of 'proof', 'evidence' and 'empirical', to mention only the obvious. Thus, there would still seem to be required some unproven and perhaps unprovable fundamental assumption(s) that would have to be taken on faith. I will disagree with theoretical astrophysicist David

Lindley over his apparently unintentional slip into antirealism, but he makes other helpful points. For example, he notes Planck's comment that 'over the entrance to the gates of the temple of science are written the words: Ye must have faith,' and continues by adding that 'underpinning all scientific research, but especially research in fundamental physics, is this article of faith: that nature is rational.'[293] Such observations seem to be all that is required in establishing the role of faith in physics, or in any system of knowledge. However, a more detailed discussion can help us to understand the deeper significance of the importance of faith for physics, and thus for realism.

As with any fundamental concept, we all know what we mean by the word 'faith' until we begin to examine it more closely, but I am concerned with how the physicist uses the word faith, with the kind of faith that is required in order to be able to do physics, in order for physics even to be possible. As discussed in Chapter Two, fundamental physics is not simply a logical deductive or even purely inductive activity. Faith, insight, imagination and passion are all required ingredients of the pioneering physicist (and philosopher).[294]

It seems that what the physicists mean by faith is that they have to believe in certain fundamental assumptions in order for them to be able to do physics or for physics even to be possible, and such assumptions can never be proven through experimental procedures or even demands of mathematical coherence because they are the starting points from which math and physics are possible. It also appears to be the case that the greatest discoverers who made the most fundamental breakthroughs at the conceptual level had to be motivated by an intense faith that reality is intelligible to the human mind, that we can discover truths no matter how partial our insights may be, which allow us to understand the universe and ourselves better. Based on my extensive reading of the relevant physicists' ideas, these further assumptions, which follow from the belief that the

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[293] Lindley, 1993, p. 6.

[294] Cf. Clark (1990, p. 37), who cites Planck as saying that innovative science depends on 'the imaginative vision and faith in the ultimate success.' Also Medawar: 'Ever since Plato spoke of the divine rapture or divine fury of creativity, the act of poetic invention has been held in awe by those who exercise it, just because it seems to embody an infringement of divine copyright....If the generative act in science is imaginative in character, only a failure of the imagination—a total inability to conceive what the solution of a problem *might* be—could bring scientific inquiry to a standstill.' (Medawar, 1984, pp. 84-85.)

universe is rational, include but are not limited to the following: (1) the laws of physics are susceptible to mathematical formalization, and thus, in the Pythagorean/Platonic sense, the physical world seems to be composed of numbers; (2) the more powerful a law of physics the more simple, abstract, explanatorily useful, and unifying it must be; (3) the more powerful the law, the more closely it resembles the truth of the matter; (4) some kind of trans-rational or pre-rational insight is required to see what others have missed even though having the same available data; (5) in some way our minds must be in harmony, or have the potential to be able to be in harmony to different degrees, with both the pre-existing laws and the physical universe, and somehow conceive their unification. This list is not exhaustive, but includes the most essential.

It could be argued, along with Clark, that only the theistic hypothesis can ultimately make sense of such assumptions, which is plausible, but that is not my concern here. The fact is, the assumptions are prior to physical experiment and must be believed, at least implicitly, prior to theorizing, for there would be no point in theoretical speculation or empirical testing if we did not really believe that relatively stable answers could be discovered. Polanyi agrees with Jeans' point that the 'outstanding landmarks in the progress of science' have always been due to seeing the inherent order in already known facts.[295] Examples abound of scientists who had profound insights into already existing data, including Nicolaus Copernicus, Newton, Charles Darwin, Einstein, John Dalton, Louis de Broglie, Heisenberg, Schrödinger, and Paul Dirac.[296] Planck's insight, for example, concerning discrete energy was based upon widely available data and, as Polanyi notes, 'he alone saw inscribed in it a new order transforming the outlook of man. No other scientist had any inkling of this vision; it was more solitary even than Einstein's discoveries'.[297]

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[295] Polanyi, 1964, p. 28.
[296] Polanyi, 1964, p. 28.
[297] Polanyi, 1966, pp. 67-68.

Mary Midgley offers what seems overall to be an accurate description of faith.

> The faith we live by is something that you must have before you can ask whether anything is true or not. It is basic trust. It is the acceptance of a map, a perspective, a set of standards and assumptions, an enclosing vision within which facts are placed. It is a way of organizing the vast jumble of data. In our age, when that jumble is getting more and more confusing, the need for such principles of organization is not going away. It is increasing.[298]

How can we even ask whether or not some proposition *p* is true unless we first believe (have faith) that truth is a viable concept, that *p* being true or not is a matter of whether or not it accurately describes a real state of affairs? Realism clearly presupposes faith in our abilities to find or at least approach truth, which in turn presupposes that truth is real even though beyond our grasp, such as is embodied in the concept of verification-transcendent truths. Even the antirealist has faith that her claims are true, as I discuss further in Chapter Five. Moreover, the 'set of standard assumptions' in physics allows us to place empirical facts in a coherent system, even though it sometimes appears to be the case that various so-called facts are really only facts that supervene on the theory and hence on the fundamental assumptions (but I discuss this difficult idea in Chapter Five under the heading of factual realism.) And Heisenberg, too, thought that faith entails the deepest trust: 'If I have faith, it means that I have decided to do something and am willing to stake my life on it.'[299]

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[298] Midgley, 1992, p. 57. Paul Helm also argues that 'faith is not simply belief, it is also trust,' (Helm, 2000, p. xv.) while Clark use the terms 'faith' and 'ungrounded intuition' interchangeably (Clark, 1984, p. 33), which sounds akin to the notion of mysticism discussed in Chapter Three. It interesting to note Toffler's correct observation that our economy is becoming based on the intangible and super-symbolic, which involves an important implicit faith. 'Increasingly detached from material embodiments, capital and money alike change through history, moving by stages from totally tangible to symbolic and ultimately today to its "super-symbolic" form. This vast sequence of transformations is accompanied by a deep shift of belief, almost a religious conversion—from a trust in permanent, tangible things like gold or paper to a belief that even the most intangible, ephemeral electronic blips can be swapped for goods or services. Our wealth is a wealth of symbols. And so also, to a startling degree, is the power based on it.' (Toffler, 1990, p. 68.) The ideal laws of physics have intangible, eternal power that do not depend upon us for their being, whereas the power based on abstract symbolization of wealth maintains itself through our continued belief in its value. Nevertheless, the fact that all of us have so much (essentially unquestioned) faith in our own intangible creations of wealth can only lend credence to the possibility that there are deeper intangible realities that do not depend upon us for their being. We have the power to create symbolic systems of wealth, but we do *not* have the power to create the universe.

[299] Heisenberg, 1958-B, p. 65.

However, there is no fundamental agreement among philosophers and theologians about the distinction between faith and belief, and I do not wish to travel the many paths that unfold from such arguments. For my purposes, it is enough to recognize that I am basically in agreement that faith is essentially a fundamental belief that requires trust: trust in oneself and trust in others (whether other people, divine beings, God, the universe, or the laws of physics).

Paul Helm argues for a web-like notion of interlocking beliefs, and he claims that because the lines of justification for beliefs are not linear 'there is no danger of regress of justification proceeding indefinitely, and therefore no need to invoke a non-inferential stopping place for such regress.' [300] But I think he is wrong for at least two reasons. First, although beliefs are interlocking, clearly some are more fundamental than others, which implies some sort of hierarchical linearity infused within dynamic interrelationships. Believing that God is real is more fundamental than believing that Liverpool will beat Everton. Second, Helm argues that what justifies the reasonableness of our beliefs (in his case, our religious beliefs) is that they cohere as a whole. And, again, striving for coherence is a necessary condition, but achieving it or approximating it is not a sufficient condition to guarantee the truth of our system. This coherentist view could conceivable lapse indefensibly into subjectivism and relativism because coherence alone does not necessarily entail any significant relation to reality, and, hence, this view would seem to rest more easily upon the shoulders of antirealists.

Our beliefs must be coherent to as great a degree as possible, but they must also correspond to reality. Again, the philosopher usually attempts to place us in one camp or the other at the exclusion of other possibilities, which is a problem that plagues almost all areas of philosophy. Our system should strive for coherence, but it must also correspond to the way things actually are. Yet, a bunch of random statements that happen to correspond to reality are generally quite useless and certainly are not representative of the sciences because we need to be able to place our beliefs into a unified, systematic whole; in other words, our beliefs must also cohere so far as possible. We need both—coherence

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[300] Helm, 2000, p. 48.

and correspondence, but achieving the appropriate balance is a never-ending challenge. Thus, while I am defending a sort of foundationalism against mere coherence, I am also claiming that our views must cohere so far as possible.

In relation to religious belief, Helm argues that we must have some sort of evidence for the truth of what is believed in. If the evidence for *x* is small then our faith in *x* cannot be other than small or weak. 'If the evidence is greater, belief is stronger, and faith may be correspondingly strong.'[301] This idea can easily be extended to science; for example, concerning the law of conservation of energy and the discovery of the neutrino. The law of conservation of energy cannot be absolutely proven, empirically or metaphysically, but in experiments we are given strong evidence to believe more deeply in this law, to have more faith in it. When we encounter some data that appear to contravene this law, then we look for an explanation that still allows for the law to be satisfied rather than rejecting the law (although Bohr was misguided in thinking about giving up the law of conservation of energy).

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[301] Helm, 2000, p. 20. Although 'Tertullian is reported to have said that the death of the Son of God is certain because it is impossible.' (Helm, 2000, p. 18.) And for those religious believers that pretend that *only* faith is necessary, Augustine has an appropriate reply: 'they should remember that they have learned at least the alphabet from men.' (Augustine in Clark, 1998, pg. 119.)

Faith-filled Physicists

Unfortunately, several philosophers, applied scientists (such as engineers, chemical researchers etc.) and other academics in the arts (especially literary theory) that I have talked with seem incredulous (and have sometimes been quite upset) when I say that Planck, the founder of quantum theory, believed that faith was essential to the physicist. Planck's scientific faith was not equated with faith in papal infallibility or the holy trinity, etc., (although arguments obviously can be made for such beliefs), but he believed in the possibility of knowledge and had faith in the rationality and goodness of the cosmos, which are views that are definitely akin to those underlying theological systems. And Gödel was fond of reminding philosophers, much to their general annoyance, that the founders of modern science were not atheists.[302] One may respond that in the context of their time, it was not unusual for Copernicus, Kepler, Galileo, and Newton to believe in God. But I think such a response indicates a lack of appreciation of how the development of scientific thought depended precisely upon the sort of theologically inspired faith as mentioned in relation to Planck.[303] Without that faith in such a metaphysics, which was given its fullest expression and logical development in the Platonic tradition, science could not have been born.

Moreover, not all contemporary philosophers with a deep understanding of the sciences have rejected theological underpinnings. Clark, one of the most notable examples, has argued extensively that 'in ethics and in science alike we must rely on faith, on indemonstrable axioms,'[304] which is simply a fact—we cannot demonstrate the veracity of all (or perhaps even any of) our fundamental propositions and assumptions. He argues even further that reason itself, or rather our ability to reason and the concomitant assumption that reality should be amenable to our reasoning mind, cannot be proven by the application of reason alone.[305] We must admit that 'reason rests on faith.'[306] Louis de Broglie makes a related point:

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[302] Yourgrau, 2005, p. 13.
[303] See Rowlands, 1992, 2007 (forthcoming).
[304] Clark, 1998, p. 26.
[305] Clark has been arguing for years that only a Platonic/theistic hypothesis can make sense of the possibility of rational scientific inquiry. 'I have offered good reason, as I suppose, for thinking that the explicability of the universe—what Einstein called its one incomprehensible feature, that it is not

Pure science untiringly pursues the search for this hidden order, for these ultimate realities...The great wonder in the progress of science is that has revealed to us a certain agreement between our thought and things, a certain possibility of grasping, with the assistance of the resources of our intelligence and the rules of reason, the profound relations existing between the phenomena. We are not sufficiently astonished by the fact that any science may be possible, that is, that our reason should provide us with the means of understanding at least certain aspects of what happens around us in nature.[307]

Those who have reflected deeply on how or why it should be possible that our thoughts are capable of grasping 'the profound relations existing between the phenomena' find it difficult to avoid concluding that it is astonishing, a 'great wonder'. Why should there be any relations at all, let alone 'profound' ones, between things, and how is it possible that we can grasp these stable relationships that are responsible for the changing phenomena? Logic will not provide the answer to this question of the rationality of the cosmos.

The predominant philosophy of the Middle Ages simply took for granted that the universe was intelligible to us,[308] which was an essential assumption for the rise of modern science. Those who have not understood this point have assumed, as Gibbins points out, that, for example, Newton's theological conjectures were an 'aberrant and antiquated appendage' to the corpuscular philosophy. '[309] But in actuality the exact

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incomprehensible—is explicable, and expectable, on the theistic hypothesis alone, I do not wish to make this a mere hypothesis. That the universe can be understood is one thing, and well explained by the supposition that the universe and the human mind have a common intellectual source; that the Source is wholly comprehensible is another, and unlikely thesis.' (Clark, 1984, p. 185.) Also see pp. 25-26, 35, 93-94.

[306] Clark, 1984, pp 93-94.

[307] de Broglie, 1955, pp. 208-209. But in the same book he also writes that quantum physics 'no longer leads to an objective description of the external world', (p. 131) which can sound antirealist when taken in isolation. However, he was simply placing a limit on what physicists *qua* physicists can tell us about the physical world.

[308] Unlike a preoccupation of modern philosophers with epistemology, 'knowledge was not a problem for the ruling philosophy of the Middle Ages; that the whole world which man's mind seeks to understand is intelligible to it was explicitly taken for granted.' (Burtt, 1925, p. 2.)

[309] Gibbins, 1989, p. 5. It is quite fascinating to see how often even well-informed scholars fail to understand the importance of the metaphysical beliefs of pioneering scientists. Lindberg, for example, dismisses Galen's theological and Platonist beliefs as being of no scientific consequence. 'Galen certainly believed that behind the admirable design found in living things could be discerned a designer; but this belief had no major influence on his analysis of disease or on his diagnostic and therapeutic procedures.' (Lindberg, 1992, p. 131.) On the contrary, it was precisely this metaphysical belief that informed Galen's entire outlook on and approach to medicine, health and healing. Similarly, as we shall see shortly, I have

opposite is true; his theological propensities were the foundation of his scientific thinking. As Rowlands argues, Newton was not a mechanist but had the 'theological cast of mind to recognize the true abstract nature of scientific thought,'[310] and the abstractness of fundamental physics has been growing ever since. Those writers (and there are many) who have falsely attributed materialism and determinism to Newton have completely overlooked these points.[311] Indeed, the common assumption of the conflict between the rising of the sciences against the oppression of religion is not completely false but it is a distorted view that obscures deep metaphysical interconnections that have persisted (at least implicitly and sometimes explicitly) as part of the foundational guiding beliefs of many of the quantum pioneers. John Hedley Brooke makes the following apt comments, which are very much worth quoting at length:

> The very possibility of a rational science of nature is usually considered to depend on a uniformity in the relations between cause and effect. In the past, religious beliefs have served as a *presupposition* of the scientific enterprise insofar as they have underwritten that uniformity. Natural philosophers of the seventeenth century would present their work as the search for order in a universe regulated by an intelligent Creator. A created universe, unlike one that had always existed, was one in which the Creator had been free to exercise His will in devising the laws that nature should obey. A doctrine of creation could give coherence to scientific endeavor insofar as it implied a dependable order behind the flux of nature.
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> To say that religious belief could function as a presupposition of science need not entail the strong claim that, without a prior theology, science would never have taken off. But it does mean that the particular conceptions of science held by its pioneers were often informed by theological and metaphysical beliefs. When natural philosophers referred to *laws* of nature, they were not glibly choosing that metaphor. Laws were the result of legislation by an intelligent deity. Thus the philosopher René Descartes insisted that he was discovering the "laws that God has put into nature." Later, Newton would declare that the regulation of the solar system presupposed the "counsel and dominion of an intelligent and powerful Being."[312]

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not discovered any other scholar who has recognized the fact that Heisenberg's mystical experience allowed him to understand the *Timaeus*, an experience that influenced his conception and development of quantum theory.

[310] Rowlands, 1992, p. 18.

[311] As one example, Laszlo writes that 'Einstein substituted the relativistic universe for Newton's mechanistic clockwork universe.' (Laszlo, 2004-B, p. 536.)

[312] Brooke, 1991, p. 19.

Among the most fundamental metaphysical presuppositions underpinning all of physics, past and present, are the ones offered by Platonism, which I have already discussed in the thesis Introduction. It may be out of fashion to use the same kind of overtly theological tones and references in one's writing today, but the essential axioms of Platonic realism are just as much at work in the metaphysical foundations of quantum theory as they were four hundred years ago with the rise of modern science.

However, given repeated failures throughout the centuries, it seems to be impossible to construct an argument that convinces everyone of the reality of God—regardless of whether or not the argument may be sound and irrespective of whether or not we are speaking of the personal God of Abraham, or the 'impersonal' God of the ancient philosophers and the deists—and so I am not interested in trying to convince the reader that only the theistic hypothesis can underpin reason and the possibility of science. But there are two important points that I will defend. The first is easy, as one need only read the relevant literature: many eminent physicists, from Kepler to Planck, have admitted the importance of faith in physics, which is a significant challenge to if not an outright rebuttal of the militant atheism[313] of Dawkins who writes that faith qualifies 'as a kind of mental illness.'[314] Second, in the next section I will offer brief arguments to support Clark's claim that reason rests on faith. These two points taken together will be significant for the realist because clearly we cannot prove that there are verification-transcendent truths but we must believe or have faith in their ontological reality. After all, if we claim along with Norris and other realists in general that there must exist truths that are currently beyond our present-best powers of understanding, and may in principle be beyond any sentient creature's ability to discover even in principle, then we certainly cannot rely upon physical experiments to provide proof of their existence (or being).

Clark refers to Planck and Einstein who evoked some of the necessary requirements for innovative science, such as intuition, creative imagination, and faith in ultimate success and in the underlying order behind the appearances. Without these attributes, Clark

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[313] Simon Blackburn states approvingly that 'Dawkins is an atheist, and indeed a strenuous, militant atheist.' (Blackburn, no date).
[314] Dawkins, 1989, p. 330.

argues, we must remain like Plato's prisoners, 'making our untutored guesses about the shadow play.'[315] I would like to develop Clark's point by looking in more detail at a few key passages from both physicists, as well as from Bohm. Planck states that Kepler's 'faith in the existence of the eternal laws of creation' was an essential factor enabling him to see the inherent order in the disparate astronomical observations, whereas Brahe 'remained only a researcher.'[316] He also argues that there is no logical way to find the most suitable scientific hypothesis, and only an independent imagination, strong creative power, and accurate knowledge of relevant facts can make it possible for the mind somehow immediately to grip the problem or seize 'upon some happy idea.'[317] Moreover, he also agrees with Einstein that you cannot seriously do science unless you believe that an external world really exists, but that proof or refutation of this belief is beyond logic. Knowledge that there must be an external world is not gained by any process of reasoning. As mentioned in Chapter Three, Planck says that it is 'a direct perception and therefore in its nature akin to what we call Faith. It is a metaphysical belief.'[318]

Einstein writes that 'the most beautiful experience we can have is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science. Whoever does not know it and can no longer wonder, no longer marvel, is as good as dead, and his eyes are dimmed.'[319] Einstein was indeed deeply mystical, especially in the sense of having 'knowledge of the existence of something that we cannot penetrate', which any realist adhering to verification-transcendent truths must at least implicitly admit, but he was quite strongly opposed to organized religion and what he saw as the naïve belief in personal existence after death. Yet his description of this essential mystery as being the 'profoundest reason and the most radiant beauty' could have come straight out of almost any Platonist, and he devoted his life to trying to understand a portion, 'be it ever so tiny,

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[315] Clark, 1990, p. 37. Rowlands also shows how the 'development of science depends on individual creativity.' (Rowlands 1992, p. 47.)
[316] Planck, 1932, p. 216
[317] Planck, 1931, p. 61. William Whewell used the phrase 'happy guesses', 'until, as if recollecting that he was Master of Trinity, he wrote "felicitous strokes of inventive talent."' (Medawar, 1984, p. 51.)
[318] Planck, 1932, p. 218.
[319] Einstein, 1954, p. 11. cf. Whittaker: 'The emotions in which philosophy and science had their common source was exactly the same in ancient Greece and renascent Europe. Plato and Aristotle, like Descartes and Hobbes, define it as "wonder."' (Whittaker, 1928, p. 8.)

of the Reason that manifests itself in nature.'[320] I am not going to pursue this point much further, but I will note that this mystical view that permeated the thoughts of so many of the founders of contemporary physics (relativity and quantum) was just as much at work in the founders of modern science four hundred years ago. Galileo is usually misused to represent a great struggle against religion at the cost of neglecting his deeply mystical faith in God. As Rowlands writes, Galileo 'constantly prayed to God' and believed that 'Divine Providence' had been revealed to him.[321] He rejected the dangerous parochialism of the church leaders who were terrified to allow critical and original thought, yet he had the deepest faith in God. Moreover, without the religious drive for truth and understanding, fundamental science would come to a halt. 'To this', writes Einstein, 'there also belongs faith in the possibility that the regulations valid for the world of existence are rational, that is, comprehensible to reason. I cannot conceive of a genuine scientist without that profound faith.'[322] Finally, Bohm writes that

> one may be puzzled by a wide range of factors, things that do not fit together, until suddenly there is a flash of understanding, and therefore one sees how all these factors are related as aspects of one totality (e.g. consider Newton's insight into universal gravitation). Such acts of perception cannot properly be given a detailed analysis or description.[323]

First, Bohm used the same kind of language as Planck to describe this insight beyond logical thought, both using the word 'perception' in its widest sense. Moreover, if we consider the views of these three physicists together, we can see that there is general agreement about the limited applicability of logical analysis, to the consternation of the analytic philosophers. It does not follow that no analysis is possible of the act of insight, the flash of intuitive understanding, but only the foolish would believe that we could actually capture such creativity in an airtight logical package that could be replicated by anyone following the same apparent steps.[324] Surely I do not need to stress the most

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[320] Einstein, 1954, p. 11.
[321] Rowlands, *The Scientific Revolution 1: 1500-1618.*
[322] Einstein, 1954, p. 46.
[323] Bohm, 1980, p. 13.
[324] cf. Plato (1914, 275c) reminds us in the *Phaedrus* that anyone who takes the written word too seriously, expecting everything to be completely clear and certain, 'would be an utterly simple person'.

obvious point that genuinely novel creativity does not happen like that.[325] But because this point is so obvious and yet difficult to pin down, it is easy to gloss over it, to turn away to more manageable endeavours that are amenable to logical analysis with much less ambiguity or fewer mystical overtones and implications. However, the truly revolutionary insights in science (and the arts), the sort of acts of direct perception like Planck's that gave birth to quantum theory, have been due to insights beyond logical thought. Unfortunately, the current trends in research have been to throw large sums of money at a group of scientists and tell them to create something. Genuine creativity does not work that way: as Medawar notes, scientific discovery cannot be premeditated, for not even the greatest scientist can say that she will make a scientific discovery.[326]

Knowledge that does not depend on any process of discursive reasoning, which is a 'direct perception' (not of the empiricist kind), a 'flash of understanding', is essentially what the Neoplatonists referred to as *non-discursive* knowledge. The scientists would want to add that we still must be able to test these insights (as they may still be wrong or not as approximately true as they first may have appeared to be), which is an important aspect of scientific methodologies. But this scientific addendum does not negate the essential role of intuition or instantaneous insight, (and Buddhists commonly argue that the teachings of the Buddha can also be empirically tested for oneself in one's mind and way of life, which raises a question mark about the assumptions of purely 'empirical' testability).

Sarah Rappe explicates this mode of perception through a comparative analysis of the ancient Neoplatonists and contemporary thinkers. She shows how the Neoplatonic texts were 'written to convey to the reader a wisdom that must simultaneously be discovered either outside the text or beyond the text.'[327] The notion of 'Reason' permeating the cosmos is also Platonic, for it is *Nous* (Divine Mind) that first emanates from the primal One, where Nous itself is radiating absolute beauty and pure truth. This is why so many physicists, mathematicians, and great artists have naturally grouped beauty and truth

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[325] See Knoblich & Oellinger, 2006 for an interesting discussion on the 'Eureka moment'.
[326] Medawar, 1984, p. 51.
[327] Rappe, 2000, p. 3.

together. Finally, genuine scientists must admit a 'profound faith' in 'the possibility that the regulations valid for the world of existence are rational.'

Heisenberg, too, shared in such faith. He was deeply influenced by Plato's *Timaeus* in his youth and had direct personal, mystical experience of the 'central order' of things, which was to affect his later thoughts 'profoundly'.[328] Heisenberg had originally thought that the *Timaeus* was 'completely nonsensical' and he kept 'wondering why a great philosopher like Plato should have thought he could recognize order in natural phenomena when we ourselves could not.' He had attended a Youth Assembly offering various political speeches but was frustrated because all their viewpoints were only partial fragments that had split off from the central order and 'were no longer directed toward a unifying center.' This disharmony was increasingly painful for him, and he was 'suffering almost physically', yet he was not able to find a way to the central order through all the variety of clashing opinions. After several hours of such speeches and agony, suddenly a hush descended upon the crowd as a violinist on a balcony started playing Bach's Chaconne. At that moment, something extraordinary happened to Heisenberg:

> All at once, and with utter certainty, I had found my link with the center....There had always been a path to the central order in the language of music, in philosophy and in religion, today no less than in Plato's day and in Bach's. That I now knew from my own experience.

Heisenberg then understood Plato's idea that the underlying structure of all matter is of geometric forms rather than things, and such forms appear to refer to the 'atom's structure in time and space, to the symmetrical properties of its forces, to its ability to form compounds with other atoms,' all of which is fundamental to the *Timaeus*. These structures are not material objects, and so will not be amenable to normal descriptions of things, but they must be susceptible to mathematical treatment. Thus, here we have an excellent example of what I have been arguing. It required a direct personal experience transcending simple discursive reasoning (the flash of understanding, a direct perception)

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[328] Heisenberg's quotations and my explanation in this paragraph come from Heisenberg, 1971, pp. 7-12.

for Heisenberg to understand Plato's notion of unifying order and symmetric nonphysical geometric forms as the basis of physical reality. This he knew with utter certainty, which is quite significant coming from the man who gave us the uncertainty principle. Moreover, it was this experience that profoundly affected his later thoughts, deeply influencing his way of understanding quantum theory. Here we can see the roots of the Copenhagen non-materialism that put more emphasis on the underlying geometric symmetries represented in the mathematical laws of physics, which have more reality than the physical world because they are representative of the eternal central order of the cosmos, what Einstein referred to as Reason. Analytic philosophers can protest as much as they want about this way of speaking and thinking, but such assumptions have given us quantum theory and all of physics.

But, in the absence of personal experience, metaphysical reasoning can help convince us of the reality of such truths, and even with such insights we still need metaphysics to help us understand and integrate them for ourselves and present them rationally to others. Mysticism does not entail an antiscientific view; rather, in the way I am using the term, it merely implies an immediate or direct apprehension of some important truth—a truth that is discovered, which is what the physicists we have discussed have been proclaiming. Thus, mysticism in this sense implies realism because we are discovering verification-transcendent truths. Eddington writes that 'the physicist now regards his own external world in a way which I can only describe as more mystical, though not less exact and practical, than that which prevailed some years ago...'[329] And Schrödinger writes in a similar vein: 'I have therefore no hesitation in declaring quite bluntly that the acceptance of a really existing material world, as the explanation of the fact that we all find in the end that we are empirically in the same environment, is mystical and metaphysical.'[330] I do not wish to add much more here about the nature of mysticism, except to note that they are simply referring to the intuitive flash of insight or understanding that, as Bohm noted, is not amenable to detailed analysis, and, therefore, is mystical because beyond

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[329] Eddington, 1935, p. 330. (See also pp. 304-339.)
Interesting also to note that the department of physics building at the University of Liverpool is named after the eminent physicist Oliver J Lodge, who believed in spiritualism and became a devotee of psychic research. (Asimov, 1967, p. 115).
[330] Schrödinger, 1964, p. 94.

logic and even beyond discursive rationality. That does not make it irrational; rather, it makes it super- or trans-rational, which is what the Platonists argued.

But, in any case, even if we have had such insight as discussed by Bohm et al, we still are completely dependent upon discursive reasoning to lead us to this experience and then help us unfold and integrate it. In the absence of such insight, however, we have no choice but to engage only in metaphysical reasoning, and all presupposed metaphysical assumptions, which cannot themselves be absolutely proven, must be taken on faith. Analytic philosophers seem to be afraid to admit along with Polanyi the fact that in the end we must rely upon ourselves, our own convictions, no matter how much reasoning we offer in support of our beliefs,[331] which is not to give in to antirealism. It is to admit the inescapable role that *we ourselves* must play in all such considerations.

Despite Hume's arguments against our knowledge of causes and effects, or at least of there being any way logically to prove that there are causes and effects beyond mere constant conjunctions, Whitehead writes that 'scientific faith has risen to the occasion, and has tacitly removed the philosophic mountain.'[332] Hume was right to raise doubts about reason, but he was wrong to reject the faith required in order to make his anti-reason arguments intelligible and reasonable in the first place. He necessarily had faith in reason and in his abilities to argue reasonably, whether or not he openly admitted this fact. After all, he believed his own arguments to be reasonable and (I would assume) true. Jaki writes, rather sarcastically, that 'for Hume, reason was a welcome ally only when its sharp thrust served his purposes.'[333] There is no way to escape reason, just as there is no way to escape the deep faith required in reason. Contemporary physicist Stephen Barr summarizes these points:

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[331] Polanyi, 1964, p. 9.
[332] Whitehead, 1953, p. 5.
[333] Jaki, 1978, p. 104.

> Even the atheist, precisely to the extent that he is rational, has a certain kind of faith. He asks questions about reality in the expectation that these questions will have answers and that these answers will make sense...It is a faith that reality can be known through reason.[334]

Furthermore, Lindley has shown how cosmology and particle physics have become conjoined, where, in their mutual search for the fundamental forces and particles, they have reached or at least been forced to recognize that there are limits to empirical testing in their respective fields. Much larger particle accelerators apparently will do little to take us any farther in the subnuclear realm and no one was around to witness the beginning of the universe, if there even was a beginning. 'Full understanding of the fundamental particles and forces of the birth of the universe will be achieved, if it is ever achieved, only through a long and indirect chain of reasoning from what happened a long time ago,

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[334]Barr, 2003, p. 266. It is also worth noting the 1969 Carnegie Commission survey of more than 60,000 American college professors. The following table is in Stark et al, 1996, p. 436.

TABLE 1—RELIGIOUSNESS BY SCHOLARLY FIELD

	Percentages		
Field	Is religious	Attends regularly	Opposes religion
Math–statistics	60	47	11
Physical sciences	55	43	11
Life sciences	55	42	11
Social sciences	45	31	13
Economics	50	38	10
Political science	51	32	10
Sociology	49	38	12
Psychology	33	20	21
Anthropology	29	15	19

Notes: Data are from the Carnegie Commission's 1969 Survey of American Academics.

I think it is wise never to place too much emphasis on surveys and such studies, but this one displays the interesting phenomenon that the mathematicians and physicists are most likely to be religious. This statistic is noteworthy because the Platonists, such as Proclus, place mathematics as the intermediary between the divine and the sensible, which is discussed in Chapter Seven. This survey also fulfils the minimal yet important of offering a rebuttal to critics who think that science necessarily disproves religion. (See Banner (1990) who argues for a 'significant analogy between the justification of science and of religious belief.') I cite this study as further evidence that many physicists are not hostile even to more conventional religious faith, though I have met many physicists who may not consider themselves 'religious' in the sense of going to church etc., but who say they are spiritual, they believe that there is some divine power at work in the universe. For a brief sample of further reading on the spiritual views of scientists, see Goswami, 1993 and Fritjof Capra, 1991; physical chemist Lothar Schäfer, 1997; biologist Lipton, 2005; and philosopher Ervin Laszlo, 2004-A. Finally, it was suggested to me that such statistics would not be relevant in the UK, but, first, all that would matter is if the ratios were similar, and, secondly, according to the Home Office statistics for the England and Wales 2001 census, 77.3% of the population is affiliated with a 'faith group', whereby 73% are Christians. Maybe the British do not attend church so often, but apparently they are still psychologically or emotionally loyal to religion. (See O'Beirne, 2004, p. 6.)

under circumstances we can barely imagine, to what is before us now.'[335] It is this 'indirect chain of reasoning' that is applied metaphysics and that presupposes predictable cause-effect relations since the beginning of the universe governed by eternally stable laws that it is the business of physicists to discover. Seldom do I see experimental physicists appreciating the extraordinary philosophical complexity of such assumptions, which they must take on faith in order to be able to conduct an experiment that apparently replicates the conditions of the Big Bang. The physicist must believe in the possibility of this indirect chain of reasoning and in the truth of cause-effect relations, but she is wrong to assume that there is any logical proof for such beliefs. There is no logical proof available, but it is still rational to have faith in these assumptions. As Clark and Heisenberg have argued, taking seriously Hume's denial of induction and causation would, as Heisenberg writes, 'destroy the basis of all empirical science.'[336]

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[335] Lindley, 1993, p. 156.
[336] Heisenberg, 1958-A, p. 84.
Clark: 'that the Humean analysis of causation is inadequate is an argument too vast to be attempted here. It is, at least, inadequate to the needs of practising scientists, who seek some intelligible description of events that will rule out magic.' (Clark, 1984, p. 139-140); 'David Hume's analysis of human knowledge eliminates most scientific theory in the process of eliminating scientific realism.' (Clark, 1998, p. 27). Schäfer also notes the Hume's attack on causality is logically justified when limited merely to observing external events, but when the self-conscious mind is involved then causality is clearly established, even though such principles of inference 'are non-rational and non-empirical in the sense that they cannot be verified by an observation of physical reality nor derived by a process of reasoning.' (Schäfer, 1997, p. 88.)

Fanatical Physicists

Sometimes these physicists found themselves far from the path of the so-called detached, objective, unemotional, unbiased scientist extracting facts from the physical world. It is not unusual for many people, including 'practical' scientists, to cultivate such an image, but nothing could be further from the truth. The following brief section is not simply a mere excursus. I am here arguing against the narrow conception of what constitutes accepted scientific inquiry, showing how the founders of quantum theory were thinking and acting far beyond such conventions of laboratory measurements or the testing of hypotheses. Their beliefs, attitudes, and actions played important roles in the development of quantum theory itself, thus legitimizing their sometimes fanatical moments as a genuine part of pioneering science.

For example, Bohr had referred to Schrödinger's and Einstein's views as 'appalling' and 'high treason,'[337] and Einstein had his own nasty rebuttal. In a letter to D. Lipkin on July 5, 1952 he writes: 'this theory (the present quantum theory) reminds me a little of the system of delusions of an exceedingly intelligent paranoic [*sic*], concocted of incoherent elements of thought.'[338] Surely the image of Bohr, as Heisenberg puts it, acting as 'a remorseless fanatic, one who was not prepared to make the least concession or grant that he could ever be mistaken'[339] when trying to persuade Schrödinger (who was lying sick in bed) of his views, tarnishes the image of the detached, dispassionate scientist. Schrödinger could not accept Bohr's views and expressed his frustration rather bluntly: 'If all this damned quantum jumping were here to stay, I should be sorry I ever got involved with quantum theory.'[340]

But Heisenberg seems to have been at least as prone to anger at his competing colleagues, which is clear in his 1926 letter to Pauli: 'The more I think about the physical part of

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[337] Quoted in Fine, 1996, p. 22.
[338] Quoted in Fine, 1996, p. 109
[339] Heisenberg, 1971, p. 73.
[340] Schrödinger as quoted in Heisenberg, 1971, p. 75. In a more sober, academic moment, Schrödinger writes: 'On grounds upon which we cannot enter here, we have to assume that a small system can by its very nature possess only certain discrete amounts of energy, called its peculiar energy levels. The transition from one state to another is a rather mysterious event, which is usually called a 'quantum jump'.' (Schrödinger, 1967, p. 52.)

Schrödinger's theory, the more disgusting I find it.' He goes on to write that he considers Schrödinger's views to be '*Mist*' (translated variously as junk, rubbish, crap and bullshit).[341] These physicists found themselves in the middle of a very messy workshop, a workshop that seemed to have been all but demolished and was being rebuilt by fanatical, self-styled prophets. And the everyday experimentalist relies entirely upon their efforts, having unwittingly followed Simmias' advice in the *Phaedo* that if we cannot be taught or find out where truth is ourselves then we should 'at least take the best possible human doctrine and the hardest to disprove, and to ride [sic] on this like a raft over the waters of life and take the risk.'[342] Their raft is the Copenhagen interpretation, but despite its success, its unresolved conceptual difficulties have played an important part in the growing unease in physics and in providing the impetus for the development of alternative approaches, such as the 'hidden variables' and 'many worlds' alternatives. Indeed, some physicists even claim that there are no quantum jumps or particles,[343] which would have made Schrödinger happy.

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[341] Hilgevoord, 2006.
[342] Plato, 1956, p. 490. (*Phaedo* 85d.)
[343] Zeh, 1993.

Summary

In this chapter, I have shown how faith has been acknowledged by the pioneering physicists to be an indispensable part of their research, and how it must underpin all of physics. This faith is essential because it is not even possible to prove that the conservation laws, for example, apply universally, despite having reasonable evidence to suggest that they do, and we cannot prove that we need a proof for our assumptions. More fundamentally, the notions of cause and effect relations and the uniformity of nature, despite not being logically provable beyond doubt, presuppose that the universe is somehow or other intelligible, by employing what Einstein referred to as 'Reason'. That reason must permeate the cosmos for science to be intelligible cannot be proven but must be believed, must be trusted to be true and so require faith, in order for the scientist rationally to expect to be able to discover unknown physical laws that can be applied successfully to a wide variety of phenomena and circumstances.

I also discussed how the coherence of a theory is a necessary but not sufficient guarantee of its truth. We need both internal coherence and correspondence with reality, as far as possible, and philosophers should not be so quick to demand that we pledge allegiance to one particular theory at the expense of rejecting important aspects of alternatives. In order to make my case, I relied significantly on the actual beliefs of these relevant physicists; however, I also offered independent arguments in general support of all these views.

I have shown that mathematicians and physicists are more likely to be religious believers than academics in other disciplines, which makes sense given the Platonic explanation of mathematics being an intermediary between the divine and the sensible realms. On their search for intelligible (and hence beautiful) answers, the physicists I discussed were not shy about using the word 'mysticism,' which, in the sense implied here, at least entails an immediate, non-discursive and ultimately logically unanalyzable apprehension of some solution (a 'happy idea') coupled with seeking mathematical proportions. I also briefly discussed how these pioneers could fanatically pursue their goal of understanding reality. And I defended both Heisenberg's and Clark's views that relevant Humean assumptions are inadequate for the sciences, whereas Platonic realism allows science to make sense.

CHAPTER FIVE: Quantum Theory and Realism: But *Which* Realism?

Introduction

Norris notes that intuitions are so divided on the issue of realism versus antirealism that it is almost impossible for one to conceive how the other can maintain her opposite beliefs.[344] But in this chapter I will presume that Socrates' rebuttal suffices to refute Protagoras' famous dictum that 'man is measure of all things,'[345] and thus refute global antirealism at the core. If Protagoras is correct, then whatever I believe to be true is just as true or just as false as anything else. If I believe that elephants can really fly, become invisible at will, and do calculus, then my belief is just as sound (or unsound) as any other belief. Thus, if Protagoras is correct and Socrates thinks he is not correct, then, by Protagoras' own doctrine Socrates must be correct and so Protagoras incorrect.

There have been a few dissenting antirealist voices, but as Barbour notes, scientists usually assume realism in their work. Dinosaurs, for example, 'are held to be creatures that actually roamed the earth, not useful fictions with which we organize the fossil data...Even the physicists, who more than the others have been forced to examine their concepts, still speak of the *discovery* (rather than the *invention*) of the electron.'[346] Contrary to Rorty's misplaced call to eradicate any such discussion, Vision notes that 'from its inception to the present, philosophy may be viewed as a series of struggles between various realisms and anti-realisms.'[347] There remains pervasive confusion surrounding this struggle, especially concerning quantum theory. My arguments and classifications are not free from problems, but I do believe that I can bring deeper understanding of how quantum theory is actually realist. However, at least thirty-five types of realisms can be distinguished, which can lead to much confusion: naïve realism,

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[344] Norris, 2002-A, pp. 1-2.
[345] Plato, 1997, pp. 189-190 (*Protagoras* 170b-171d). I also presume Norris' criticisms of postmodernism and relativism. (Norris, 1992, 1993). See also 'Postmodernism R.I.P.', *The Philosopher's Magazine*, Issue 20, Autumn 2002.) But this is not an *a priori* denial of antirealism in quantum theory.
[346] Barbour, 1966, pp. 171-172. Original emphasis.
[347] Vision, 1998, p. 3.

external realism, internal realism, global realism, local realism (i.e. particular instances), local realism (i.e. Einsteinian limit of c for meaningful signal transmission), metaphysical realism, practical realism, scientific realism (in general), scientific realism (metaphysical stance), scientific realism (semantic stance), scientific realism (epistemic stance), scientific realism (for entities), scientific realism (for theories), physical realism, structural realism, direct realism, critical realism, dogmatic realism, empirical realism, agnostic realism, ontological realism, logical realism, conceptual realism, moral realism, rational realism, bare realism, realism-in-general, realism-in-particular, mechanical realism, political realism, thin realism, robust realism, and transcendental realism.[348]

Norris gives the best overall characterisation of the general beliefs of realists and antirealists that I have found, and I here offer a paraphrased version of his explanation. Realists generally believe that:

(1) there is a mind-independent reality whose properties must be discovered (rather than merely invented).

(2) there are verification-transcendent truths that exist beyond our epistemological limitations.

(3) mature scientific theories are true descriptions of physical reality.

(4) theories should explain the phenomena via a causal (depth-ontological) account.

Antirealists, of course, deny all of the above. They deny (1) because all properties of 'reality' are merely internal relations rather than reflections of a mind-independent reality; (2) because it makes no sense to talk of truths beyond our best knowledge; (3) because 'truth' just is our current best explanation; and (4) because they are sceptical of ontology as being a return to naïve, pre-scientific metaphysical habits of thought.[349] With

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[348] Some of these terms are from specific authors while others are used more generally by various authors. The following references are samples of places to find these different kinds of realism. Einstein, 1954, p. 20; Vision, 1988, pp. 6, 8, 14, 74-77; Norris, 2000, p. 54; 2002[A], pp. 3-5; Heisenberg, 1958[A], pp. 81-83, 144-145, Hacking, 1983, pp. 26-30; Psillos, 1999, pp. xix, 146; Ladyman, 1998, pp. 409-424; Turner, 1925; Barbour, 1966, pp. 171-172; Bhaskar, 1978; Bhaskar & Norris, 1999; Kant, 1929, pp. 349-350; A. E. Taylor, 1936, pp. 71-72; Yourgrau, 2005, p. 102, 172; Shafer-Landau, 2003; Banner, 1990, pp. 34-35; Rogers, 2005, pp. 13, 33, 106; Maddy, 2005; Goldstein & Pevehouse, 2006.

[349] See especially Norris, 2002-A, p. 36. cf. Clark: 'I firmly believe that there is a reality essentially independent of all human cognition and experience which may nonetheless be known by us.' (Clark, 1990, p. 87.)

important qualifications and further developments, I will argue in favour of these general realist beliefs, although there are a few good points implicit within quantum antirealism that force the realist to hone and clarify her position more clearly. In no way can a denial of external reality—a reality beyond whatever I or any species happens to be capable of apprehending at any given moment—ever be metaphysically or scientifically credible, and because I discuss antirealism in detail in the following chapter, I will here, for the most part, assume the truth of realism in general in order to clarify which aspects of realism the Copenhagenists explicitly admitted and which ones all proponents of this interpretation must admit at least implicitly, despite any contrary remarks.

I offer four different categories—*broad realism*, *abstract realism*, *factual realism*, and *motivational realism*, which are all aspects of Platonic realism. These distinctions provide broad categories that should be helpful in sorting through the various relevant realisms in relation to quantum theory, although it is not possible to discuss in detail all or even more than a few of the above examples. Fortunately, they often overlap and tend to differ mostly in terminology, or at least have close conceptual affinities, but sometimes I will refer to those aspects that are most relevant to our discussion and that help make distinctions clearer. Although some mention will be necessary here, antirealism and idealism will be discussed in detail in the next chapter. Clark admits to being a 'dogmatic and quite unembarrassed realist,'[350] and I aim to show that he is justified in making such a claim.

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[350] Clark, 1990, p. 87.

Challenges for the Realist

The first claim that there is a mind-independent reality is not as obviously true as most realists suppose. Claiming that reality is mind-independent seems to imply that reality is outside my mind and so my mind would not be in or part of reality and therefore somehow be unreal, which is not what realists want to assert. Thus, my mind must also be part of reality, which would mean that strictly speaking reality is not independent of my mind. However, the antirealists make the logical mistake of arguing that just because my mind cannot be separate from reality, therefore, all of reality depends upon my mind, which usually ends up meaning that I have created reality with my mind. Clearly, the reverse is more reasonable: I, and my mind, depend entirely on the rest of reality in order to have existence, yet the rest of reality seems not to need me or my particular mind. In other words, if the rest of reality (excluding me and my mind) did not exist already, or at least certain aspects of the rest of reality (such as oxygen, water, the laws of physics etc.,), then I could never have become physically manifest. A similar analogy would be how humans are an intricate part of the global ecosystem yet the rest of nature (minus humans) would seem to get along just fine without us, whereas we are completely dependent upon the rest of nature, (which is why haphazardly polluting our environment is so insane). Thus, admitting that my mind is also part of reality, and so strictly speaking there cannot be a mind-independent reality if my mind is also a part of reality, does not in any way give support to the antirealist claim that reality is a mere mental construct with no intrinsic or objective existence. Perhaps we should say that reality is *belief*-independent. I may believe that I can fly, but when I jump from the roof of a thirty-storey building gravity will ensure that I fall. Any antirealist who doubts this point is free to jump.

Simply put, reality does not care about my beliefs. Galileo believed that Nature cares 'nothing whether her reasons and methods of operating be or be not understandable by men'[351] and Proclus made a similar point: 'Deliberation is the mark of thought's encounter with difficulties: this is why Nature produces and knowledge says what it says

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[351] Quoted in Burtt, 1925, p. 64.

without deliberation.'[352] In less gnomic terms, Nature cannot be in contradiction with itself, and I have no idea what it would mean to claim that it could. But even if nature simultaneously could be what it is and what it is not, then 'Nature' would simply say what it says without deliberation and it would not care a bit whether or not it violated our sacred principles. If nature is apparently contradictory to our reason, then our reason has failed. A lack of understanding of this issue has led Richard Feynman to say that Nature is absurd[353] and Dawkins to imply that the universe is 'too queer' for us to understand.[354]

I can sympathize to some degree with the views of Feynman and Dawkins because there are numerous conceptual difficulties in modern physics, and Dawkins makes the plausible but not original assertion that our biological equipment and our perceptual and cognitive limitations may in principle prevent us from ever understanding the universe completely; but this worry is misplaced. Just because we cannot understand *everything* about the universe in *completely* exhaustive detail, it does not follow that we cannot understand *some* things, and unless we were able to discover some very important true (or close enough to being true) aspects of reality, then it becomes increasingly difficult (if not utterly impossible) to imagine how we could have evolved to this point. The universe in its absolute entirety may forever remain beyond the conceptual and experiential grasp of any sentient creature that has arisen from within this cosmos, but it does not follow that our confusion resulting from our lack of total comprehension entails that the universe or reality itself is absurd or queer.[355]

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[352] Proclus, 1987, pp. 602-603.

[353] Feynman, 1985, p. 10. Even Heisenberg sometimes felt that nature might be absurd. After talking with Bohr for hours on end resulting in despair, Heisenberg would walk through the park alone and reflect: 'Can nature possibly be as absurd as it seemed to us in these atomic experiments?' (Heisenberg, 1958-A, p. 42.)

[354] Dawkins in Twist, 2005. See K Ward (1996, esp. p. 11-12) and Alister McGrath (2004), for a critique of Dawkins with respect to his distortion and misrepresentation of religion and philosophy, Barr (2004) for several examples of how Dawkins gets his science wrong, and Midgley (1979) for philosophical criticisms of his position.

[355] Cf. Vision who argues against Putnam's claim that 'external realism' entails that there is 'exactly one true and complete description of "the way the world is".' (Quoted in Vision, 1988, p. 74.) Besides claiming that Putnam's 'internal realism' is in essence an antirealist position, which Norris has also argued, (Norris, 2000, p. 54) Vision notes that 'the detail of any fragment of the describable world is inexhaustible; thus no finite description could have the required uniqueness.' (Vision, 1988, p. 77.) However, pace Strawson (1959), it does *not* follow that just any description fits just any aspect of the describable world. Some descriptions are more accurate than others, while some are just false. It also does not follow that any particular description must be able to describe a particular aspect of reality in absolute and unfailing detail.

The second challenge for realists concerns the ontological status of verification-transcendent truths that exist beyond our epistemological limitations but which we are nonetheless able to discover. It seems that many realists do not consider this a genuine problem but rather take for granted that such truths can simply be discovered. However, we cannot discover something that has *no* existence (or being) or *no* potential to be or exist; we can only discover what already exists or already has being. Thus, it is important to be able to talk in some way about the ontological status of truths that are yet to be discovered, as well as those truths that have been discovered. Otherwise, the antirealist merely needs to ask us for an account of the supposed truths that we can discover, and when we are unable to respond then they feel more confident in saying that our 'truths' are nothing but social constructions. So how can realists respond?

It seems that there are at least three (and probably more) different sorts of truths that we could discover. First, there are conventional truths that follow logically from an arbitrary set of rules. If I am allowed to do X or Y in game G then it may logically follow that I can also do Z, where Z could be a hitherto unknown corollary of accepting X and Y. Thus, in some sense, we could say that I have discovered Z when I finally realize that Z follows logically from accepting X and Y. At first glance, we have merely agreed with what many antirealists would also admit because such an admission in no way necessitates correspondence with reality beyond the conventions of our arbitrary rules in G. I could have initially chosen A and B instead of X and Y, and then Z would never be discovered because it would not follow from A and B. But the antirealist cannot be let off so easily. Even within the rules of G, if Z is logically implied by X and Y even though it was never formally stated as a rule and may or may not have even been conceived to follow from X or Y, the fact that Z is a logical implication necessarily entails that something about *logical entailment itself* is not bound by the rules of G or of any particular game. Thus, it would follow that something about logical entailment (and logic itself) is belief- and game-independent and so would require the same sort of ontological clarification as verification-transcendent truths that realists endorse.

One could object here and say that the rules of logic themselves are arbitrary, but such an objection cannot seriously be maintained, at least concerning the most fundamental axioms of logic. In order even to formulate any argument, antirealist or otherwise, we must first rely on fundamental axioms of logic, whether explicitly stated or known or not, which in turn require an ontological account. If the rules of logic were truly arbitrary, then, again, it would make no sense to say that Nature is absurd because we would only be comparing Nature to an arbitrary set of rules. Moreover, even to construct any sort of logical system requires the implicit guidance of some way of binding together the various axioms and propositions in a way that makes sense. But why should my logical system make sense if logic is truly and absolutely arbitrary? Again, antirealists rely upon the very assumptions that they deny to realists. And many logicians, such as Gödel and even the early Russell, were logical realists.[356]

Moreover, it is not at all obvious what it means to say that Z follows logically from X and Y, for this 'fact', albeit one rooted in the convention of the arbitrary rules of G, has no physical reality and yet would act as a dictating rule that must be obeyed if one is to remain within the particular game. Thus, in some important sense, Z would be more fundamental than the actual physical playing of G because whatever one does in G is controlled by Z (and the other rules). If one disobeys X, Y, or Z and gets caught, then one would be punished in whatever way is demanded by the other rules of G. So even the antirealist, on her own terms of arbitrary game rules, is compelled to give an account of the implied nonphysical logical framework that underpins the rules of G.

Penelope Maddy is now defending what she calls 'thin realism', which, as it is applied to the notion of sets, is analogous to the above discussion of rules. In thin realism, claims about sets could be true or false but only within the internal (and arbitrary) set of initially established rules about sets. Thus, thin realism (and her more obvious antirealist account referred to as 'arealism') can 'avoid this problem', as Maddy says supportively, of trying to account for whether or not claims about sets are true independent of the arbitrarily

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[356] As Yourgrau notes, Gödel had approved of Russell's early belief in logical realism, where logic is just as concerned with the 'real world' as the sciences, but it is more abstract and general. (Yourgrau, 2005, p. 102.)

devised set of rules, which is what would be required of what she calls the 'robust realist'. However, thin realism is only thinly disguised antirealism, much like the response-dependence approaches criticized by Norris, for here truth amounts to nothing more than adhering to human convention, in much the same fashion as any set of rules for any game can be broken and thus be considered 'false'. But a natural law cannot be broken, and so we still need to account for the reality behind the laws, which thin realism is incapable of doing. 'Avoiding' a problem does not make it go away.

The second sort of truth that could be discovered concerns brute physical facts. Smashing A against B brings about result R. If someone hits me hard in the face with a large rock the result will include physical pain *ceteris paribus*. If the sceptical antirealist claims that there are no physical facts or at least that we could never have knowledge of such physical facts, then that would be a claim susceptible to verification and falsification (although lacking such features does not necessarily mean that a statement is not scientifically valid). The antirealist need only let me hit him in the face with a large rock to see whether or not pain results. If after being struck he still insists that even though he knows that pain resulted in this particular instance (in good Humean fashion) he still does not know that the next time I hit him with a rock the result will be similar, then, again, I can test that claim too, for as long as he wishes to maintain that he does not know any brute physical facts. There are brute physical facts that I can discover without knowing anything about physics, and I discuss the notion of factual realism in more detail in the next section. However, the ultimate reasons or explanation for the fact that I feel pain when being hit with a stone leads us into the third sort of truth; namely, the laws of physics. (Of course we must consider physiology and neurology, etc., but ultimately these sciences depend on an understanding of molecules and atoms, which ultimately depend on a physical understanding.)

I am not going to spend much time here defending the reality of the laws of physics because I devote a large section of Chapter Seven to such a task. Briefly stated, however, either the laws of physics are mere convenient descriptions or they are laws in a sense similar to the ones in a game but are such that they cannot be broken. Sometimes it may

appear as if a genuine law of physics can be broken, but that can only occur where a hitherto unknown law eventually accounts for anomalies that the prior law cannot explain because of being beyond its applicability. If the laws of physics are just descriptions then they could not have any non-trivial predictive ability. 'My sweater is black', 'the sun is bright', 'Soccer fans are crazy' are all examples of descriptions, but none of them are useful for making predictions in the way that the laws of physics are. A black sweater may help conceal me at night; if the sun is bright then I should wear my sunglasses while driving; and when Liverpool plays Everton I should stay safely at home. Thus, in a trivial sense these descriptions allow me to make certain predictions, in much the same way that any statement about anything allows me to make a prediction (if I am creative enough). But none of these predictions are remotely similar to the way quantum theory allows us to make extraordinarily accurate predictions about widely disparate phenomena under varying conditions. I could pile up a million descriptions but unless the inherent laws are discovered that unify the descriptions and allow us to make novel predictions, then science will not develop. If the laws of physics are not of such a character, then ultimately they must be considered to be fictions, for there can be no middle ground (which is again similar to Norris' arguments against the response-dependence middle ground between realism and antirealism). Thus, realists must be able to give an account of such nonphysical unifying truths.[357]

The third challenge for realists is their general claim that mature scientific theories are true descriptions of physical reality. As a realist, I cannot bring myself to accept fully this claim, and yet I do not side with quantum antirealists such as Gibbins who states ominously that 'quantum mechanics is not known to be true. It is a truism of the

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[357] The claim that there can be no middle ground may seem a bit too quick, but it is easily defended. If the laws of physics are not discovered, then in some way they must be invented. If they are invented, then either these inventions impose themselves upon physical reality, in which case we could in principle have an unlimited number of competing laws of physics if every sentient creature created her own, which makes it difficult to conceive as science as it actually is. Or, we could invent the laws in the trivially true sense of inventing the symbolisms of the mathematical equations and relationships, but then we have to explain how one equation, $E=mc^2$ for example, works whereas my equation, $E=mc^3+5$ does not. Either Einstein has some sort of greater magical (or some other) power than I do to impose his will upon the physical world, or his equation actually represents reality more accurately than mine. It is most plausible to assert the second alternative and, therefore, it would be correct to say that he has discovered the law. Thus, there ultimately can be no middle position here.

philosophy of science that no generally applicable physical theory ever could be.'[358] And I am not taking a middle ground between realism and antirealism either. Rather, my realist position is that, given our perceptual and cognitive limitations, it does not seem possible to say that we could ever know absolutely that any given theory is absolutely true, even if considered only within its applicable limits. Empirical 'facts' never correspond *exactly* and *absolutely* to theory; there is always some degree of discrepancy, even if it is practically negligible in the macro world of everyday experience. As Einstein has said in a moment where he seems to have forgotten his desire to have an exact correspondence between theory and physical reality, 'as far as the propositions of mathematics refer to reality, they are not certain; as far as they are certain, they do not refer to reality.'[359] Of course he was referring to *physical* reality, for otherwise he would be implying that mathematical equations are not real just because they are not physical, and are thus fictions, which would play into the hands of the antirealist tendencies that he so vehemently argued against. But if the mathematical laws of physics do not refer directly to physical reality, then they cannot be absolutely complete descriptions of reality, and if not complete then they cannot be absolutely accurate when referring to physical reality. It is not that the theories are false, but that they are approximately true.[360]

The fourth challenge concerning the antirealist's scepticism of ontology as being a return to naïve, pre-scientific metaphysical habits of thought has already been addressed in Chapters Three and Four, so I will set this issue aside and address another confusing aspect of realism. If realism is supposed to mean that all things exist as completely separate entities that require no interaction whatsoever with anything else, then that is quite obviously false. I don't think anyone who has ever thought about the issue has ever come to such a conclusion. I am here and you are there, but clearly we need and share air, water, food, etc., and so need to be in relation with other things. Condemning realists as believing that everything exists independently of everything else with no interaction is

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[358] Gibbins, 1989, p. 2.
[359] Einstein, 1954, p. 233. Similarly, Kepler wrote that the 'conclusions of mathematics are most certain and indubitable.' (Kepler quoted in Burtt, 1925, p. 57.)
[360] Popper (1979, pp. 23-24) gives a good defence of objective truth, which implies approximate truths: 'The very idea of error, or of doubt (in its normal straightforward sense) implies the idea of an objective truth which we may fail to reach.'

simply attacking a straw man. No realist believes that, at least none that I have read (where the only exception is that God or the One is not dependent upon anything). Indeed, to have ever written such an idea requires paper and pens and computers to exist, which were produced by people involving tremendously complex and interconnected processes. Realists accept interconnectedness.

Quantum Theory and Realism

The relatively recent struggle between realist and antirealist philosophies at the heart of modern physics seems to have been openly inaugurated by the well known Einstein-Bohr debate, which was 'one of the most important scientific debates ever witnessed,' for Einstein was directly challenging Bohr about the meaning of quantum theory.[361] Baggott continues: 'at stake was the interpretation of quantum theory and its implications for the way we attempt to understand the physical world. The outcome of the debate would determine the directions of the future development of quantum physics.'[362] The main emphasis of the debate, especially in the way it developed over the years, has been declared to be a clash between realism and antirealism although it was more about materialism and non-materialism, and physicists such as Hawking and Penrose have ended up continuing the saga.[363] I am not going to discuss the debate or the Einstein-Podolsky-Rosen (EPR) paper that attacked the orthodox interpretation of quantum theory because I want to focus on other important yet often neglected related issues.[364]

Realism in physics has often come to be associated with materialism; that is, with strict physical causal relations between separate, independent and determinate particles of matter. Antirealism, conversely, has become associated with indeterminism, uncertainty, inseparability and immaterialism.[365] For example, Gibbins writes that 'realism in the philosophy of quantum mechanics means the idea that quantum systems are really like classical particles. Everything points against it.'[366] Heisenberg also conflates what he calls metaphysical realism and dogmatic realism with materialism and strict determinism, which he believes quantum theory has abandoned.[367] He says that 'practical realism', which is similar to, but really a subset of, what I below call broad realism, has always

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[361] Baggott, 2004, p. 121. This is the general opinion, although there are some dissenters. See Torre *et al*, 2000.
[362] Baggott, pp. 121-122.
[363] Baggott, 2004, p. 287.
[364] For the Einstein-Bohr debate see Whitaker, 1996 and Sachs, 1988, and for EPR see Gibbins, 1989 and Norris, 2000.
[365] Of many possible examples, see Gibbins, 1989, pp. ix, 5-6, 89; Bohr, 1963; Einstein, 1954, p. 334; Nadeau & Kafatos, 1999, p. 67; Eddington, 1935, p. 283.
[366] Gibbins, 1989, p. ix.
[367] Heisenberg, 1958-A, pp. 81-83 and 1958-B, p. 39.

been and always will be an essential part of science,[368] but he attacks Einstein's apparent dogmatic realism because he equates it with 'the old materialistic ontology.'[369] Through a series of confused arguments and equivocations on the word 'realism', many philosophers and some physicists have falsely assumed that quantum theory is antirealist while some have then extrapolated to antirealism in general, which denies the very conditions and assumptions that are presupposed by the physicists, including the Copenhagenists, in order to do physics in the first place. Thus, it is essential to reclaim the essence of Platonic realism, which claimed that what is more real or has more being is that which is unchanging, such as the laws of physics. As Bhaskar rightly claims, one is only worried about quantum theory posing special problems for realists if 'one is wedded to normally implicit, atomistic presuppositions of empiricist ontology.'[370]

It is true that Bohr and Heisenberg made certain claims that seem to be antirealist, and I will argue against such views in the next chapter. But here I will show how they were mostly realists; although, in order to do so we need to clarify various forms of realism that are relevant to this discussion. As already mentioned, I offer four different categories—*broad realism*, *abstract realism*, *factual realism*, and *motivational realism*, which are aspects of Platonic realism. *Broad realism* simply states that *any* claim, theory, idea or belief may be true or false or right or wrong independent of our beliefs etc.[371] Bohr was a broad realist for he believed that he was *really* right and that Einstein was *really* wrong. It is impossible to do science or have a proper dialogue or philosophical argument with anyone who denies broad realism for it would not be possible to hold anyone or any scientific theory accountable if truth were nothing but a fleeting entity that could change from moment to moment.[372] Antirealists believe they are really right, and

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[368] Heisenberg, 1958-A, pp. 81-83.
[369] Heisenberg, 1958-A, p. 144.
[370] Bhaskar & Norris, 1999. And with a very different agenda in mind, Dawkins shows how theism is incompatible with materialism, which is true, but then he deceives 'the reader into thinking that all respectable scientists are really materialists—which is as false a belief as most that one can think of. (Ward, 1996, p. 101.)
[371] Banner's 'bare realism' appears similar to what I have called 'broad realism' but in fact they are quite different—broad realism is the most fundamental realism in the widest sense. Banner's idea of bare realism concerns science, which is basically what others have called 'naïve realism'. (See Banner, 1990, pp. 34-35.)
[372] As Polanyi correctly observers, 'any effort made to understand something must be sustained by the belief that there is something there that can be understood.' (Polanyi, 1964, p. 44.) Compare also Clark,

that realism is really wrong, so they must be broad realists, which means that they are really qualified realists, as we all must be in one way or another. As Bhaskar says, 'It's not a question of being a realist, or not a realist. It is a question of what kind of realist you are going to be – explicit or tacit.'[373]

All supposed antirealists believe that realists are really wrong, which would mean that they are necessarily claiming that there is some sort of truth about the way things actually are that is independent of our beliefs. Clark puts the point succinctly:

> Those who regularly sneer at the naïvety or presumed arrogance of realists like myself, seem to be involved in the most obvious of pragmatic self-contradictions. If I am *wrong* to be a realist, there is at least one 'fact of the matter' that is more than a social norm, and anti-realism is therefore false (and I am *not* wrong to be a realist.) So if I am wrong, I am not wrong; therefore I am not wrong ('necessarily: if *p* implies not-*p* then not-*p*'). Some things are true whether we know them or not, and even whether we could ever know them or not.[374]

Broad realism is the denial of general antirealism but it is not a denial of quantum antirealism. The general antirealist, such as Rorty, denies any talk of truth about anything, which, as already noted, ends up being a patent contradiction (and I argue more fully against his views in the next chapter). Broad realism only says minimally that we could really be wrong and thus be held accountable even though we need not yet give any account of how or in what way we could be wrong. We can be wrong, and therefore occasionally be right. Supposed quantum antirealism is not antirealist in general (although some have made that leap); it is definitely broad realist, as Norris also notes.[375]

1990, p. 12: 'It is wholly irrational to speak of scientific progress while at the same time we disdain all knowledge of realistic truth.'

[373] Bhaskar & Norris, 1999. I am not able to explore all options in this thesis, and therefore am unable to discuss Bhaskar's philosophy of science. For example, see Bhaskar, 1978.

[374] Clark, 1990, p. 87.

[375] Norris: 'Bohr was enough of a realist – in this respect at least – to take it for granted (1) that replications of the two-slit experiment bore witness to the *actual repeated occurrence* of results confirming wave-particle dualism, no matter how strange by hitherto accepted standards of scientific realism; and (2) that even in the case of those ingenious counterfactual thought experiments what counted was the rigour of consequential reasoning from (orthodox) QM premises to certain strictly unavoidable conclusions concerning events in the real-world microphysical domain' (2000, pp. 82-83).

Abstract realism (a term I adopt from Sachs but develop further) refers to the Platonic procreative and providential Ideas of Beauty and Justice etc, but also includes mathematical truths and the laws of physics. My focus obviously will be on the latter. For example, if you interpret mathematics as somehow or other being ideal and divorced from sense experience and physical phenomena and being more fundamental than physical reality, and that mathematics can fruitfully be applied to physics, then you are a mathematical Platonist.[376] On the other hand, 'if in particular you pretend that physics needs no other basis than experience and must be built directly on perception, that mathematics has to content itself with the secondary and subsidiary role of a mere auxiliary, you are an Aristotelian.'[377]

Heisenberg was clearly an abstract realist, as all physicists must be, commending Plato over Democritus' materialism on several occasions in *Across the Frontiers*.[378] He also argued for 'the objective character of mathematics,' by saying that true or valid mathematical principles will retain their truth and validity for *any* sentient being in the universe. And against any misplaced appropriation of quantum theory by constructivist antirealists, Heisenberg emphatically said that we can only discover the basic forms, such as mathematical laws of physics; 'one cannot simply construct them.'[379] And such discoveries are of eternally valid laws. For example, regarding the laws of the lever formulated by Archimedes more than two thousand years ago, Heisenberg writes that 'we can have no doubt that, at all times and all places, they retain their validity', and likewise with Newtonian mechanics.[380] The important caveat is that 'we are by no means able to claim that all phenomena can be described in terms of these concepts.'[381] Newtonian mechanics is true (or approximately true to a significant degree) insofar as we recognize

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[376] Koyré, 1968, pp. 36-37 and Wedberg, 1955, p. 137. Sriraman, 2004, p. 134.
[377] Koyré, 1968, pp. 36-37
[378] Heisenberg, 1974, pp. 11, 22, 24, 26, 27, 105, 110, 116, 117, 118, 140, 171, 172, 173, 174, 181. For example, he writes that 'on this point modern physics has definitely decided for Plato [over Democritus]. For the smallest units of matter are in fact not physical objects in the ordinary sense of the word; they are forms, structures or—in Plato's sense—Ideas, which can be unambiguously spoken of only in the language of mathematics.' (Heisenberg, 1974, p. 116.) It is perhaps ironic that, as Shorey reminds us, Bacon, despite his debt to Plato, propagated the view that Democritus was the scientific victor over Plato. (Shorey, 1927, p. 180.)
[379] Heisenberg, 1974, pp 86-87.
[380] Heisenberg, 1974, pp.185-186.
[381] Heisenberg, 1974, p. 186.

and do not transgress its inherent limitations. Of course, the same reasoning must apply to quantum theory (which the Copenhagenists sometimes seemed to have forgotten, as I discuss below under motivational realism).

That the laws of nature hold good for life anywhere in the universe, Heisenberg continues, 'is not just a theoretical opinion, for we can see in our telescope that the same chemical elements exist there as they do with us, that they enter into the same chemical combinations and emit light of the same spectral composition.'[382] Moreover, he says that there must be at least three universal constants, such as Planck's constant, which are '*independent* constants of nature.'[383] Pauli also believed that there is a 'cosmic order independent of our choice and distinct from the world of phenomena.'[384] In other words, there must be an inherent rationality to the universe that never changes but always is just what it is. It must be beyond the phenomena but somehow be responsible for ordering the phenomena. This idea is very similar to what Einstein meant by 'Reason' permeating the cosmos. And even Bohr believed that the abstract laws of physics and logic were true independent of human belief or knowledge.

> Naturally it is possible to have different forms of speech and thought...just as there are different races or different parts of an organism. But as much as all living organisms are constructed in accordance with the same laws of nature, and largely from approximately the same compounds, so the various possibilities of logic are probably based on fundamental forms that are *neither man-made nor even dependent on man.* These forms must play a decisive part in the selective development of language; they cannot be its mere consequences.[385]

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[382] Heisenberg, 1974, pp. 73-74.

[383] Heisenberg, 1974, p. 13. (Emphasis added.) There are now considered to be at least 16 'universal' constants and more than 280 fundamental physical constants. (See The National Institute of Standards and Technology: http://www.nist.gov/). Although astronomer Michael Murphy believes that he has evidence that the fine structure constant might have 'changed by about one part in two-hundred-thousand during the last 10 billion years.' (PhysOrg.com, 11 April, 2005). Of course, as I argue against Smolin in Chapter Seven, even if such constants and laws are changing, they are either changing randomly, which would seem to destroy science, or they change according to some higher order, constant or law, which itself cannot change.

[384] Pauli in Jung & Pauli, 1955, p. 152.

[385] Bohr quoted by Heisenberg, 1971, p. 138; Emphasis added.

Bohr also told Heisenberg that 'we have good reason to assume that quantum-mechanical laws can be proved valid in a living organism just as they can in dead matter,'[386] entailing that abstract quantum mechanical laws apply to everything in the universe. Clearly, the founders of the Copenhagen interpretation were abstract realists.

The Copenhagen enemies—Einstein, Planck, and Schrödinger—were obviously abstract realists. Whitehead notes how Einstein was in the Plato/Pythagorean tradition,[387] which would seem to be against my claim that Einstein had more of a materialist bent except that scientific Platonism embraces materialism but not vice versa. Schrödinger too, although disparaging Plato's apparently failed social and political philosophy, believes that the reason for Plato's fame is 'that he was the first to envisage the idea of timeless existence and to emphasize it.'[388] He accepts Plato's belief that mathematical relations hold 'irrespective of our inquiry into them. A mathematical truth is timeless, it does not come into being when we discover it.'[389] Norris has said as much the same: the truth or falsity of the theories that undergird our present-best science is 'decided by the way things stand in physical reality or in a realm of *nonphysical objective truths*, for example, those of mathematics that are wholly unaffected by whatever we might think or be able to establish concerning them.'[390] In some contexts, Norris seems to be a materialist, as when

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[386] Bohr quoted by Heisenberg, 1971, p. 92.

[387] 'The Platonic world of ideas is the refined, revised form of the Pythagorean doctrine that number lies at the base of the real world...So to-day [sic], when Einstein and his followers proclaim that physical facts, such as gravitation, are to be construed as exhibitions of local peculiarities of spatio-temporal properties, they are following the pure Pythagorean tradition. In a sense, Plato and Pythagoras stand nearer to modern physical science than does Aristotle....Aristotle by his Logic throws emphasis on classification. The popularity of Aristotelian Logic retarded the advance of physical science throughout the Middle Ages.' (Whitehead, 1948, pp. 42-43.) However, Aristotle raises the following distinction: 'Plato says that the numbers are apart from the objects of sense; whereas the Pythagoreans say that things themselves are numbers, and they do not place the "mathematicals" in between them.' (Aristotle, 1963, pp. 48-49. *Metaphysics* Bk I.6.) I am not convinced that Aristotle understood the full picture.

[388] Schrödinger, 1967, p. 153.

[389] Schrödinger, 1967, p 154.

[390] Norris, 2002-A, p. 53. Emphasis added. Norris also writes that the realist 'will say that there exists a vast number of objective truths about mathematics, physics, chemistry, biology, history and other 'areas of discourse' which we don't presently know – and may indeed have no possible means of finding out – but which nonetheless determine the truth-value of any statements we make concerning them.' (Norris, 2002-A, p. 139.) These views make Norris a straightforward mathematical Platonist. 'The Platonist viewpoint is that mathematical objects exist prior to their discovery in an ideal and eternal platonic realm. This means "any meaningful question about a mathematical object has a definite answer, whether we are able to determine it or not" [quoting from Davis and Hersh, *The Mathematical Experience*, 1998, p. 318, which I

arguing for Bohm's hidden variables alternative, although Bohm himself was not a materialist. Indeed, the hidden variables need not be material, and his theory could accommodate nonlocality, which renders materialism false. But here Norris clearly is not a materialist for, along with Schrödinger, Einstein, and Heisenberg et al, he is claiming that there must exist (or be) nonphysical objective truths that we can *discover*.[391] Given the importance of the fundamental nature of mathematical relationships, it is worthwhile to give brief consideration to the movement of structural realism, which is a species of abstract realism on one interpretation but a qualified antirealism on another.

According to John Worrall, scientific realism (what Barbour called naïve realism), claims that the nature of things is correctly 'described by the metaphysical and physical content of our best theories.'[392] Against this scientific (or naïve) realism, which is clearly different from the realism implied by scientific Platonism, is a form of realism that bases itself solely on the abstract mathematical relationships or structures discovered by scientists (and mathematicians). 'On the structural realist view what Newton really discovered are the relationships between phenomena expressed in the mathematical equations of his theory.'[393] For Proclus (and Platonism generally) 'truth is a relation, not a thing' (Siorvanes, 2000, p. 54), which makes Platonism sound similar to structural realism. However, it is not that things are not real or that we can give no account of them at all but, rather, the abstract nonphysical mathematical relations have more being (or are more real) and so have greater truth content than the diversity of constantly changing physical phenomena. But the physical phenomena, according to scientific Platonism, are still real; they are just lower on the scale of reality in the metaphysical hierarchy.

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do not cite]. According to this view, mathematicians do not invent or create mathematics—they discover mathematics.' (Sriraman, 2004, p. 134.)

[391] 'As concerns mathematics the realist will hold that we *discover* the truth of certain theorems, conjectures, numerical hypotheses, etc....' (Norris, 2002-A, pp. 4-5. Original emphasis.) See also Norris, 2002-A, p. 30. Even Frege stated that 'the mathematicians cannot create things at will, any more than the geographer can; he too can only discover what is there and give it a name.' (Frege quoted in Collins, 1998, p. 704.)

[392] Ladyman, 1998, p. 409.

[393] Worrall quoted in Ladyman, 1998, p. 410. Recall that scientific Platonism endorses mathematical Platonism and adds that there really are physical entities in the universe that obey the abstract mathematical relations (and metaphysical principles) that have more being or reality than the physical world, and that our theories can approximate (and perhaps even achieve) true representation of the actual state of affairs concerning the dynamic interplay between the physical and nonphysical aspects of reality.

Psillos writes that 'structural realism relies on a distinction between the *nature* of the entity, or process, and its *structure*, and claims that the latter is captured by the mathematical equations describing the behaviour of an entity, while the former somehow 'lies beyond' what can be quantitatively described.'[394] Psillos claims that structural realism ultimately fails, for it is not realist enough essentially because such a position remains silent about the entities and processes that are described by mathematical structures. The fact that mathematical equations or relationships do survive is a good indication that structures are of a natural-kind, though such structures do not have a physical basis in themselves even though they may state the relationship between physical entities or processes.

Hacking notes how Russell was a realist about theories but an antirealist about the entities posited by those theories, whereas Cartwright is an antirealist about theories and a realist about entities.[395] Hacking claims to have become a realist about the material reality of electrons because of an experiment in which electrons are 'sprayed.'[396] The details here are not important because what matters is that he admits that he would not have been a realist about electrons prior to such an experiment, which would seem to make him an empiricist materialist. But from the fact that electrons apparently can be sprayed, it does not follow that electrons *qua* electrons exist in physical reality in the *exact way* in which they are thought to exist. We still cannot say exactly what an electron is and what we are apparently spraying may not be electrons as we currently conceive them—they may be something else that we have not yet understood although *greatly resembling* what we have called electrons. On the other hand, there may very well be an exact correspondence between the entities we now call electrons and our theoretical understanding of them even though we may never be able to prove or know that we have achieved such definitive knowledge. And Hacking does have a point: if we can spray them, then surely they, or something very much like them, are physically real. But then it seems that we should always act as if all the entities of successful theories are real because if we had

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[394] Psillos, 199, p. 146.
[395] Hacking, 1983, pp. 27-28, 37.
[396] Hacking, 1983, p. 23.

really believed that electrons were not real in 1908, then we would not have done any more experiments trying to understand them better, for only a fool would do an experiment searching for something that we are sure does not actually exist.

Bohr adds to this confusion for he seems to have been a structural realist but an antirealist about the entities, although, as noted above, he believed in the reality of chemical compounds so it is not clear whether or not he really believed in material entities or was simply a cautious realist. But Faye remarks that

> Bohr thought of the atom as real. Atoms are neither heuristic nor logical constructions....What he did not believe was that the quantum mechanical formalism was true in the sense that it gave us a literal ('pictorial') rather than a symbolic representation of the quantum world. It makes much sense to characterize Bohr in modern terms as an entity realist who opposes theory realism.[397]

Eddington too was a structural realist but seems to have been an entity realist only by metaphysically assuming that entities exist because he recognized the limitations of physics *qua* physics as not being adequate for penetrating beyond the symbolisms. In other words, it is not possible for physicists to talk intelligibly about the things in themselves but only about the relationships between the things, which of course presupposes that there are things, whether such 'things' are material objects or nonphysical laws of nature.[398]

How are we to make sense of this motley of apparently incompatible views? First, it is incoherent to believe that entities postulated by successful theories do not actually exist (or entities very closely resembling the postulated ones) while maintaining a realistic belief about such theories. Second, it makes no sense to accept that the entities postulated by the theories are real while claiming the theories themselves are meaningless

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[397] Faye, 2002.

[398] Eddington, 1935, p. 281.
'It would not be a bad reminder of the essential unknownness [sic] of the fundamental entities of physics to translate it into 'Jabberwocky'; provided all numbers—including metrical attributes—are unchanged, it does not suffer in the least. Out of the numbers proceeds the harmony of natural law which it is the aim of science to disclose. We can grasp the tune but not the player.' (Eddington, 1935, p. 281.)

constructions or fictions, as Cartwright claims to believe. Just because a theory cannot give us an exact pictorial representation and must instead rely upon the mathematical formalism of the theory, it in no way follows that our theories are not true or approximately true and accurate representations of the way things are. As already noted, no theory ever matches experimental data perfectly, for theories and laws are ideal unchanging relations, whereas the physical world is in constant flux. The materialistic demand for an exact pictorial representation, which entails a correspondence between micro-phenomena and our everyday experience of macro-phenomena, is misplaced.

On the other hand, if atoms are not real then we have a difficult time explaining the devastation caused to Hiroshima and Nagasaki (which I discuss further in the next chapter). Clearly, as Bohr himself believed, atoms are real. But if they are real then either they are absolutely fundamental building blocks (which then requires an explanation for how they came to be and can remain what they are while coming together to make different things—a problem that blocked atomism since the ancient Greeks), or they are made of parts, as is the common and apparently true assumption. These parts include many subatomic particles that at the moment can only be accounted for via quantum theory, which means that even if electrons and neutrinos, etc., are merely convenient labels for mathematical constructs that do not have actual physical existence, then since atoms are not most fundamental there still must be something or a bunch of somethings working in a unity that give us atoms. If atoms are real then so are the entities that make up their existence. Perhaps electrons as we know them in our theories are not absolute and perfectly correspondent with the actual entities that are part of the constitution of the atom, but our theories allow such accurate predictions that they must be close resemblances at least, which is enough to vindicate entity realism. Thus, it is not coherent to be an entity realist about atoms yet be an antirealist about the theories that make possible an understanding of the atoms. However, we should not naively assume that we ever have the final, absolutely correct account.

Perhaps we may remain ignorant about things in themselves, but we still have the potential to comprehend their relationships. Newton discovered a relationship between

phenomena, but this discovery entails that there really are phenomena that exist in order for them to be in relationship. The structural realist position on its own cannot give any account of the entities themselves, which, as noted already, is rather odd. Structural realists must either deny that there are such entities, which would be an antirealist claim, or they have to remain agnostic. We can remain agnostic in the sense that because we are not perfect then by definition it follows that we could not have perfect knowledge. But such agnosticism would be logically trivial. Or we could be agnostic in the sense that although we have good reason to believe in the reality of electrons, we have to admit that it may actually be they case that what really exists is something that is only very similar to but still not absolutely identical with what we have called electrons, which is really being a cautious realist, which is part of being a scientific Platonist. But if we are agnostic about whether or not any entities exist at all then we have lapsed into the untenable position of antirealism.

In response, one could assume a holistic realist stance, such as stated previously by Schrödinger, that there is ultimately only one thing (or as the Buddhists say, ultimately only Emptiness), and so in that ultimate sense there are not really any entities at all. But even if all things except the supreme One consciousness or Buddhist Emptiness are mere illusions, they are still illusions that require scientific explanations. The Platonist does *not* believe that everything is an illusion, for the shadows on the wall of the cave are still real shadows. The problem is that we are *deluded* into believing that the shadows represent ultimate reality when in fact they are, as the Buddhist would say, aspects of conventional reality. And as we seem to spend most of our time in conventional reality, then it is still reasonable to claim that conventionally existing entities must have some sort of existence in order to be in relationship.

Regardless, structural realism necessarily entails that material entities exist even if the structural realist or the physicist can never tell us exactly what those entities are. And the idea of having constant relations with varying terms is a fundamental aspect of Platonism.[399] Thus, while structural realism is an important example of mathematical and

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[399] For example, see Grimes, 1998, p. 218.

logical aspects of abstract realism, this category of realism does not in itself account for physics. Platonic realism, however, embraces mathematical Platonism (which is an aspect of abstract realism) and also scientific Platonism that accounts for the reality of real physical entities, despite their being in constant change.

Factual realism depends entirely on what we mean by 'facts'. Some facts reduce to 'the way things are', such as the fact that a conglomerate of islands, which we happen to refer to as Japan, exist somewhere on the earth, regardless of the conventions of longitude and latitude. These islands exist whether we measure them or not, and such facts should come under the subheading *independent factual realism*, which can be illustrated by the following example. When I lived in Korea several years ago, my apartment was full of cockroaches (as is common), and I remember trying to catch one on a particular day and reflecting on how he sure seemed to be thinking about how to escape from me. I exposed him by lifting up my laundry bag and immediately he scurried under my clothes dresser. I remember wondering how he possibly could have known that he would be safe there. I am quite sure that he had no way of conceptualizing or understanding what a clothes dresser really is, and I seem to have no idea what such an object means to him beyond being a hiding place (and even then I have to assume that somehow he 'knows' that). But, despite the apparently unbridgeable gulf between our two perceptual and cognitive worlds, there is still the fact that *something* exists that both holds my clothes and prevents me from catching the damned cockroach. And that something exists regardless of whether or not there are an infinite number of possible interpretations and ways of understanding what it is. But such facts need not apply only to the physical world; they may also cross over with abstract notions, thus blending into abstract realism.

I must here briefly anticipate antirealist arguments from the next chapter because John Wheeler writes that '...useful as it is under everyday circumstances to say that the world exists 'out there' independent of us, that view can no longer be upheld.'[400] Wheeler is correct that our *knowledge* of the past is constrained and in a certain sense chosen by our measurements, but Norris correctly clarifies Wheeler's confusion between epistemology

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[400] Wheeler quoted in Norris, 2000, p. 207.

and ontology, for Wheeler makes the same mistake as his teacher Bohr by saying that 'no elementary phenomenon is a phenomenon until it is a registered (observed) phenomenon'[401] But Bohr, at some moments, would seem to disagree with Wheeler: 'the use of phrases like "disturbance of phenomena by observation" or creation of physical attributes of objects by measurements" is hardly compatible with common language and practical definition.'[402] The very fact that we perceive anything at all seems to imply that there is *something* 'out there' and that it was there before we noticed it. We cannot measure or see (or even say or think) what *is not*, as Parmenides warned us so long ago.[403]

However, some facts, such as wave-particle duality or the orbit of an electron, seem to depend on the theory that we adopt. Even Einstein told Heisenberg that 'it is the theory which decides what we can observe.'[404] We seem unable to avoid agreeing with Einstein that there is an epistemic constraint on certain facts that result from a theoretical interpretation of the observations which are already selected by our theoretical bias.[405] But this does not mean that there are no verification-transcendent truths because facts, in this second sense, are still only true if they actually correspond to the way things are, even if we are ignorant regarding this correspondence. Therefore, we could have, strictly speaking, false or partially true facts, although if it turned out to be false then we would have to say that is no longer a fact and never really was a fact. This view is entirely compatible with and even necessitated by the realist position which allows us to be (really) wrong or partially correct while also moving closer towards some truth.

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[401] Wheeler quoted in Baggott, 2004, p. 18; also quoted in Norris, 2000, p. 254. Wheeler is trivially correct if by 'phenomenon' he means a sensory datum, which, after all, we cannot have until the moment it becomes a sensation. But given his denial of an independently existing world 'out there', he seems to be referring to physical subatomic phenomena, which definitely makes him a quantum antirealist.

[402] Bohr, 1963, p. 5.

[403] Wheelwright, 1985, p. 245.

[404] Einstein quoted in Heisenberg, 1971, p. 63. Cf. 'Herman Bondi, one of the founders of the steady-state theory, once declared that one should never believe an observation in cosmology until it is supported by theory.' (Lindley, 1993, p. 183.)

[405] Eddington makes a related point in the section 'Selective Influence of the Mind' in his *The Nature of the Physical World*, 1935, pp. 234-238.

Moreover, Einstein did not say that we are *creating* facts—and neither did Heisenberg think so; rather, Einstein claimed that our theory decides which facts we observe. There are an infinite number of possible theory-independent facts, all of which we cannot possibly observe or even contemplate, and so our theories and interpretative mechanism allow us the possibility of coherently selecting what is of most relevance to us. But that which is selected for consideration by such theoretical presuppositions already exists, and that which we have chosen to ignore within our theoretical limitations still exists.

As Price notes, 'it is perfectly proper to speak of observed facts, as we all do in practice, whatever philosophical theories we may hold.'[406] He uses the example of seeking further evidence for his belief that it will be raining in ten minutes when walking to the station. The request for further evidence comes to an end when he goes outside, feels the rain pelt his body, and sees that there is no break at all in the dark clouds from which the rain is descending. Our sceptic, of course, could pretend to disagree with Price and say that it is logically possible that he is deluded; he thinks he feels rain when in fact he is just in the shower, or he may be in virtual reality, etc. These are logical possibilities, which is why faith, ultimately, is the ground for all our beliefs because we could always logically doubt any belief except, perhaps, (following Descartes) the belief that there must be *something* existing in order to have any belief, deluded or otherwise, about anything at all. But even then we would have to have faith that our reasoning was sound.

Many facts, however, *are* theory-laden because our observations only make sense within a presupposed theoretical understanding. Bohm, too, makes this point: 'when we look at the world through our theoretical insights, the factual knowledge that we obtain will evidently be shaped and formed by our theories.'[407] But we must be careful here. Just because previous apparent facts turned out to be wrong or only partially true, it does not follow that there are no facts at all about anything. In order to understand deeply what exactly a brick wall is, for example, I should know a lot about chemistry, physics and engineering, and thus many facts about the wall will depend upon the theories that make

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[406] Price, 1969, p. 102.
[407] Bohm, 1980, p. 5.

sense of them. And today's 'facts' about brick walls may turn out tomorrow to be wrong or probably just incomplete. However, regardless of whatever deeper scientific understanding of bricks may be possible, even if I am illiterate or only a small child and so am not capable of reading scientific texts about bricks, when I bang my head against a brick wall it is still going to hurt. Brick walls are real, and they must exist independently of me, my mind, my sensual capacities, and of any possible theoretical understanding. Surely all this is obvious, but apparently not to Barbour. He seems to be correct that there are '*no completely uninterpreted data* in science' but then makes the philosophical mistake of implying that, therefore, the data are not 'independent of either the observer's experimental operations or his interpretative categories.'[408] But he is equivocating on the word 'data' in a similar way the Wheeler use the phrase 'phenomenon' ambiguously. If, tautologically speaking, 'data' refers only to whatever emerges from our experimental observations and interpretative categories, then he is trivially correct. However, the data must represent or come about from or arise from *something*, and whatever that something is, it cannot merely be dependent upon or created by our theories and experimental operations. One may wish to counter that various particles seem to be created by particle accelerators, but we are forgetting that we are using particles, and particle accelerators, that must actually exist in order to smash them together in the first place. What seems to have been missed is the following point. Instead of saying that theory-laden facts imply that such facts would not exist outside the theory, it is equally logically possible, and even more rationally plausible, that such facts already exist (or have being) but that we can only know them once we have found the most accurate theory that allows them to shine forth. The standard analogy of a fishing net that only catches fish of a certain size reminds us that there are still other fish in the sea than the ones we happen to catch, and there are still theory-independent facts beyond the theory laden or theory-dependent facts that we happen to be able (or want to) notice.

If a theory is successful then there is good reason to suppose that it is at least partially true and the entities it presupposes must exist or represent in an approximately true way the entities that really do exist. In such a case, theory-dependent facts support realism

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[408] Barbour, 1966, p. 178. Original emphasis.

because they are presupposing a reality which they are representationally approximating. However, this apparently instrumentalist justification of realism is not enough. String theory, for example, may be the most accurate theory in history, but we may not know that fact for another hundred years, although it could only be accurate if it corresponded to reality to an appreciable degree. Or, a theory may be completely incoherent and not correspond to reality in any way at all, and apparent 'facts' that depend upon this theory will still support realism because these supposed 'facts' and their supporting theory can only be wrong if there is an independent reality about which they are mistaken. Thus, *dependent factual realism* is also a genuine subcategory of realism.

Motivational realism is a term adopted from Fine.[409] Fine argues that Einstein's realism was only yet importantly motivational in that we must believe that there is a mind-independent world that the scientist (and the rest of us) is able to uncover to some degree and discover various truths about. For Einstein, the realist drive behind fundamental and groundbreaking work in physics is akin to the 'religious feeling'.[410] Given the various quotations I have offered from Einstein, Fine seems to be wrong that Einstein was *only* a motivational realist, and his error seems to have been due to his prejudice against realism and metaphysics in general. However, despite the motivational aspect of realism being essential in fundamental science, it is in this respect that Bohr and Heisenberg could be seen as being antirealists. For example, Norris quotes Heisenberg as saying that 'nature works only in such a way as not to violate quantum mechanical formalism.'[411] I cannot really defend the Copenhagenists here because, although they had internal disagreements,[412] their pronouncements seemed to have a note of finality suggesting that

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[409] Fine, 1996, pp. 109-111
[410] Fine, 1996, p. 109.
[411] Heisenberg in Norris, 2000, p. 97.
[412] Bohr wrote that 'Werner Heisenberg occupied an outstanding position' in the development of the new physics (Bohr, 1963, p. 78). They spent considerable time together –sailing, skiing, hiking etc., and very often engaged in important physical and philosophical conversations. Nevertheless, as Baggott tells us, ' Bohr put Heisenberg under intolerable pressure—so much so that harsh words were exchanged on all sides, and at one point Heisenberg was reduced to tears' (Baggott, 2004, p. 39). Baggott says that Heisenberg believed that 'there are limits on what is *measurable*, and it is impossible to do anything other than speculate on what is not measurable. Bohr vehemently disagreed with Heisenberg on this point. For him, it was wave-particle duality that lay at the heart of quantum mechanics. All the rest—including the uncertainty principle—were the physical and mathematical consequences of using two diametrically opposed classical concepts, waves and particles, to describe something that was fundamentally non-

there was no going beyond quantum theory.[413] Bohr's obstinate self-confidence is reminiscent of Planck's professor, Philipp von Jolly, who told him that physics was essentially a complete science with little prospect of further developments.[414] But there is no end to the possibility of deeper understanding in physics. The only way physics as a discipline could come to an end is if we stop pursuing such research.

Baggott writes that Bohr's antirealism 'denied that quantum theory has anything meaningful to say about an underlying physical reality that exists independently of our measuring devices. It denied the possibility that further development of the theory could take us closer to some as yet unrevealed truth.'[415] A very important point here is that perhaps it is true that quantum theory cannot be developed any further and that, as it stands, it cannot tell us about nature itself. On the most charitable interpretation, their view merely recognizes the limits of the theory and does not in any way entail that a further deeper theory beyond but embracing quantum theory, in a similar way in which relativity surpasses yet incorporates Newtonian physics, could not bring us 'closer to some as yet unrevealed truth.' Indeed, Einstein told Heisenberg not to confuse what we know about nature and what nature really does. 'In science we ought to be concerned solely with what nature does. It might very well be that you and I know quite different things about nature. But who would be interested in that?'[416]

Bohr did, however, clearly acknowledge that 'further abstractions into the formalism will be required to account for the novel features revealed by the exploration of atomic processes of very high energy,' which seems to entail that he was a motivational realist after all because he admitted that we will need deeper explanations to account for new

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classical. According to Bohr, quantum theory tells us not what is measurable but what is *knowable'* (Baggott, 2004, p. 38).

[413] Cf. Gibbins: '[Quantum mechanics'] principal philosophical outcome (I suggest, humbly following Niels Bohr) lies in presenting us with the limits of theorizing in physics, the limits of our power to represent the physical world.' (Gibbins, 1989, p. 16.)

[414] School of Mathematics and Statistics, University of St. Andrews. The same false belief seems to keep reoccurring: 'By around 1780, the belief had become widespread among leading mathematicians that mathematics had exhausted itself, that there was little left to discover. Unexpectedly, the following century was the most flamboyant in the history of the field, proliferating new areas and opening the realms of abstract higher mathematics.' (Collins, 1998, p. 697.)

[415] Baggott, 2004, p. 109

[416] Heisenberg quoting Einstein, 1971, p. 68

phenomena. 'The decisive point, however, is that in this connection there is no question of reverting to a mode of description which fulfils to a higher degree the accustomed demands regarding pictorial representation of the relationship between cause and effect.'[417] And here is another source of so many problems. Bohr was rejecting a naïve realist assumption that the micro world must be amenable to exact pictorial representation, which is really a positivist assumption that objective physical facts just somehow or other pop out of the world and into our brains. Bohr was saying that deeper developments must become even more abstract, more nonphysical. Hence, here again, he was not denying realism, he was denying materialism.

Through historical and philosophical analysis, Shorey clarifies relevant misconceptions about Plato's apparent disregard for the practical utility of mathematics. In fact, however, Plato rejected the use of mechanical models in place of mathematical reasoning,[418] which is exactly what the Copenhagenists argued as well. It was their rejection of mechanical models of the subatomic realm and reliance on mathematical relations that contributed to the common assumption that they were being antirealists when they were simply rejecting mechanistic materialism. Modern physics has emphatically shown that Plato and Pythagoras were essentially correct, and it is no longer possible for philosophical fashions (and prejudice) to perpetuate our ignorance of the vital role of this tradition for the continual development of foundational physics.

But if there really is nothing deeper than the Copenhagen view, as Bohr seemed to believe on other occasions, then there is little motivation to try to go beyond it.[419] Hence, even the instrumentalist who despises metaphysics, whether realist or antirealist, needs to admit the importance of motivational realism for the continuing development of science. It is worth recalling that Bohr was a 'remorseless fanatic' in attempting to convince Schrödinger of his views, which seems to indicate that he was at least powerfully motivated for his own views even if attempting to thwart any motivation to go beyond or disagree with him. Perhaps that is a bit harsh, perhaps not. But, regardless of such

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[417] Bohr, 1963, p. 6.
[418] Shorey, 1927, p. 181.
[419] Norris makes a similar case; see Norris, 2002-A, p. 40.

speculations, motivational realism would seem to be utterly barren if someone claimed that she were not really a realist but just pretended to be in order to be motivated to go to work every day (such as Rorty would claim). It would require another chapter (and probably another thesis) to investigate this topic properly, bringing psychological and sociological studies to investigate this possibility, but it certainly seems incongruous if not extremely psychologically taxing (if possible at all) to lie to oneself about seeking the truth in order to do one's research while truly believing that searching for the truth is a waste of time because there is no such thing.[420] It seems safe to say that the Copenhagenists and all scientists have to be motivational realists to some degree, and hence, must be realists to the degree that corresponds with the strength of their motivation. Such motivation would not necessarily entail a great physicist, but great physicists must have intense motivation, indeed be a bit fanatical, and so must be highly motivated, and so must really be realists (or dangerously schizophrenic).[421] But they should never believe that they have discovered the absolute and final truth.

It is the relentless drive to discover truth that permeates the Platonic dialogues. Consider what Socrates says to Meno:

> One thing that I would fight for to the end, both in word and deed if I were able – that if we believed that we must try to find out what is not known, we should be better and braver and less idle than if we believed that what we do not know it is impossible to find out and that we need not even try.[422]

There can hardly be a better example of motivational realism.

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[420] Cf. Polanyi: 'there is no purpose in arguing with others unless you believe that they also believe in the truth and are seeking it.' (Polanyi, 1964, p. 70.)
[421] Per Sandin, however, seems to think that 'it might be reasonable to go on searching for a true, complete description of a phenomena, while admitting that there is no such thing.' (Sandin, 2006, p. 31.) Sandin's point can be true in one sense because we can never physically actualize the ideal (which is even more real than the physical), but not true if we really believe that the ideal is nothing but a mere fiction.
[422] Plato, 1956, p. 51. *Meno* (86c)

Summary

We have seen how there is an overabundance of versions of realism, although by following Norris's general account of realism it was possible to get a clear direction. There are various difficulties with realist assumptions, which I clarified, sometimes qualified, and defended. By showing how quantum theory is broad realist, abstract realist, factual realist, and motivational realist it became apparent that quantum theory is Platonic realist because Platonism accounts for all these aspects of realism. For example, structural realism is only one aspect of abstract realism, for it is concerned only with the mathematical relationships but is silent about the entities involved in the relationships. Factual realism splits into theory dependent facts and theory independent facts, which is bifurcation accounted for by what I have referred to as scientific Platonism (which entails mathematical Platonism, although not necessarily vice versa). The motivational aspect, which is essential for the sciences, is also a fundamental part of Platonism in general, as was seen clearly by Socrates' desire to fight to discover what is unknown. And everybody is a broad realist.

CHAPTER SIX: Antirealism and Idealism in Quantum Theory

Introduction

Quantum theory is assumed to be antirealist, but the most basic mistake in the reasoning of those who hold such a view can be stated succinctly: just because there must be a limit to what physics can tell us about reality, it does not follow that there is no reality beyond such limitations. Moreover, just because it may be the case that physics apparently cannot say anything at all about physical reality apart from our means of measurement, it does not follow that there is no physical reality beyond our measurements. This mistake in reasoning seems to be so obvious that it is hard to see how so many philosophers and physicists have missed it, yet all quantum antirealist claims ultimately rest upon these misguided assumptions. After all, the laws of physics themselves are beyond measurement and physics has told us something about them, which is to say something about nonphysical reality. Ontology is not obliterated by epistemology and metaphysics is not overthrown by physics. Only prejudice can sustain the assumption that physics (or any other discipline) is the final arbiter of reality. Any attempt to eliminate ontology or metaphysics is immediately permeated with ontological and metaphysical assumptions; as already shown in Chapter Three, metaphysics is the foundation of physics.

In this chapter, I first briefly discuss the general character of antirealism before analyzing those few comments made by Bohr and Heisenberg that seem to be antirealist. I then argue against a selection of extreme antirealist views before offering some reflections on the possible dangers of antirealism.

What, really, is Antirealism?

There is not enough space to give a comprehensive account of the various incarnations of the general antirealist position, such as idealism, emotivism, materialism, behaviourism, phenomenalism, constructivism, operationalism, verificationism, instrumentalism, nominalism and pragmatism.[423] Vision has included materialism among this list, though materialism has most often been assumed by many realists, but maybe he was correct to do so since materialists deny the reality of the nonphysical; so in that sense perhaps we could say that they are 'nonphysical antirealists' (assuming such a position could make any sense at all). There are many forms of antirealism as there are different kinds of realists, but one of the important goals of this thesis is to show that *quantum* antirealism is false, and in doing so we will have to confront some of the above versions of antirealism. The most important one to consider, however, is idealism, specifically the distinction mentioned in the thesis Introduction between ancient and modern idealism. Ancient idealism, such as Platonism, assumed a greater reality to the unchanging intelligible realm responsible for the creation and direction of the physical cosmos. Modern idealism, on the other hand, entails that reality is nothing other than a construct of the 'mind'.

According to ancient idealism, which is Platonic realism, nonphysical, eternal and unchanging laws (and notions such as Beauty and Justice) have more reality or being than the perpetually changing physical universe. But the later post-Cartesian and especially post-Kantian idealism declares that reality can only be constituted by mind, whether a human or Divine Mind, depending on the philosopher, although this distinction too is vital. If all reality is dependent upon a human mind or human minds, then that is contemporary antirealism. However, if reality depends upon the mind of God, such as Berkeley famously argued for, then that would ultimately be realist because the ultimate nature of reality is not dependent upon any creature whatsoever. The objective nature of reality is only constituted by God. Plotinus similarly argued that the intelligibles are not outside the Divine Mind, which is still realist because the Platonic Forms or Ideas have eternal reality outside all human or any sentient creature's perceptual or cognitive

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[423] Vision, 1988, p. 3.

limitations.[424] Via Soul, it is possible for us to have limited access to the Divine Mind, but the reality of the Divine Mind is what it is independent of us and so is ultimately realist. Even more so, the One, which is beyond even the Divine Mind, is independent of everything, and so it is the grounding of all realist beliefs.

Taylor defines idealism as the doctrine that all reality is mental, although it is never really clear what such an assertion is supposed to mean. He defines realism as the 'doctrine that the fundamental character of that which really is, as distinguished from that which is only imagined to be, is to be found in its independence of all relation to the experience of a subject. What exists at all, the realist holds, exists equally whether it is experienced or not.'[425] There are two separate claims here, although they appear to be identical, and once we see their subtle distinctions we can better appreciate another reason quantum theory has been assumed to be antirealist. The claim that reality exists (or *is*) whether or not it is experienced, is importantly different than saying that reality *can be found* in its independence of all relation to the experience of subject. The second distinction, that reality exists (or has being) equally whether it is experienced or not was endorsed by Bohr, Heisenberg, and Pauli. Without any doubt they believed this about the relevant nonphysical aspects of reality, but there is some ambiguity about their exact position with respect to physical reality (especially between the micro and macro). But all their views taken as a whole entail scientific Platonism. However, the more recent stronger antirealists, such as Lindley, B. Allan Wallace, and Karl Rogers, even deny this point in the face of obvious logical and rational contradiction, which I discuss later in this chapter.

But it is the first distinction that has seemed to evoke the claim that quantum theory is antirealist. Since quantum theory has shown us rather forcefully that all aspects of reality are interdependent, then ultimately it may seem impossible for reality to exist (or *be*) independent of all relation to the experience of the subject, the perceiver, the experimenter. Since the observer and the observed have become intermingled in quantum

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[424] Plotinus writes that 'if one grants that the objects of thought are as completely as possible outside Intellect, and that Intellect contemplates them as absolutely outside it, then it cannot possess the truth of them and must be deceived in everything it contemplates. (Plotinus, 1984, pp. 159-160; Ennead V.5, 50.)
[425] A. E. Taylor, 1936, p. 67.

physics, it is easy to see why antirealists have claimed that realism is dead (when realism is defined as implying the absurd position that everything exists independently from everything else and has no relation with anything else), because the holistic nature of reality necessarily implies that reality cannot exist independently of the experience of the perceiving subject.

The important though relatively trivial (in one sense) truth of this *prima facie* antirealist claim is merely to recognize that in our search to know physical reality we must in some way be in relation to what it is that we are studying, otherwise there would be no way of obtaining any information. If I want to know the temperature of water in a glass, then I use a thermometer, which then interferes with the temperature of the water and so the measured result is the temperature of the water + thermometer (+ glass + table + floor etc.). We cannot find the temperature of the water in isolation from our methods of measuring it nor in isolation from the totality of reality of which it is an aspect. All distinctions and limitations are imposed by the experimenter for practical purposes but they are not logically defensible demarcations. Although many philosophers and scientists apparently believed that reality could be known with absolute objectivity by the impartial experimenter, which metaphysically is a false assumption *a priori*, quantum theory, with nonlocal effects of entangled particles and the uncertainty principle, etc., has emphatically shown that physicists *qua* physicists cannot know reality with absolute objectivity if such objectivity implies that the discovered aspects of reality have absolutely no relation to the experimenter whatsoever. Thus, the claim that reality can be found in independence of all relation to the experience of the subject is false according to quantum theory, and according to pure metaphysical reasoning, for all knowledge is only known when it is appropriated by an intellectual subject capable of such cogitation, but it does not follow that *we* are *creating* that which we now know. Therefore, if realism is defined as being nothing other than the claim that reality can be known absolutely and with complete objectivity without any reference to the experimenter or observer, then realism is false. (However, as I discussed in Chapter Five, we *may* have absolute and complete knowledge of certain facets of reality, but we could never know absolutely and completely that we did.) But we may just as well define realism as being the doctrine that

all dogs are not dogs and then call realism false. Realism does *not* entail that everything exists in absolute independence of everything else. But realism *does* entail that reality does what it does whether or not we experience it.

What we have seen so far is that the antirealism of the Copenhagen founders may have amounted to nothing more than recognizing the limits of the physicist's ability to tell us in absolutely precise terms about the nature of reality. If that is the extent of their scepticism, then they were not really antirealists. However, sometimes their comments seemed to be saying that there is no quantum reality beyond our measurements, which *is* a denial of the realist position. To the degree that they had intended such antirealist insinuations, to that degree their views are incompatible with their overwhelming realist views outlined in the previous chapter. More succinctly; such views are simply wrong, and they have unfortunately led to even greater, wholesale antirealist proclamations.

Dummett claims that for antirealists in general it makes no sense to posit objective truths independent of our best attainable knowledge. Norris continues his paraphrasing of Dummett: 'we cannot—or should not—make claims about truth or reality beyond whatever can be borne out by the evidence to hand.'[426] This is what the Copenhagen interpretation seems to have said, and so would appear to be antirealist as well, but, as we should be accustomed to by now, things are not so straightforward. First, the claim that we *cannot* make claims about reality beyond our best evidence is importantly different than saying that we *should not*. To say that we 'should not' is merely to offer an admonition, a warning, but to say that we 'cannot' make any ontological claims is either a trivial demand or a powerful statement that is itself ontological. If the former, then we are merely asserting that we will not accept any such statements. For example, I can say that I am a woman, I can *say* it as much as I like, but, the fact is that I am not, so although I can say it, it is not true, and so I should not say it, and so, if I wish to be truthful, I *cannot* say it. But this desire to be truthful leads to the stronger ontological claim that I cannot make any ontological statements beyond epistemic warrant because such statements would be false or perhaps just meaningless. If they are false, then,

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[426] Norris, 2002-A, p. 24.

paradoxically (as usual) the antirealist is claiming to know that there is some sort of truth beyond epistemic warrant, which they deny in their attack on realists. But if any such claims are meaningless, then that statement too is not at all clear.

'Meaninglessness' either entails that there is no fact of the matter because there is no truth of the matter, which is the antirealist claim, or it simply implies uselessness—it is not useful for practical experimental activity in some cases to make ontological claims beyond epistemic warrant. A possible example of the first case could be offered by an antirealist who claims that there is no fact of the matter about the number of planets being odd or even until we have established what will count as a planet, which is a question related to a point about the classification of Pluto that I will discuss shortly. However, this claim is a theory-dependent fact. The fact of the oddness or evenness of the number of planets does in fact depend upon our classificatory system. But the number of entities in the sky corresponding to what we have conventionally decided to call planets does not change as soon as we classify them, nor do they come into existence merely through our verbal acts. Thus, there must be theory-*in*dependent facts of the matter.

The very charitable interpretation of the following views from the Copenhagen founders, however, is to assume that they thought of it as useless in the second sense for physicists to posit intrinsic properties to quantum systems apart from our measurements. But their ambivalence here paved the way for full blown antirealism, critiqued in the next section below, which has assumed the first meaning of 'meaninglessness'; namely, that there is no fact of the matter beyond epistemic warrant.

With his denial of the reality of historical facts that are unable to be verified, Dummett is endorsing the strongest form of antirealism.[427] This view is highly similar to full blown quantum antirealism and it is subject to comparable obvious criticisms. As far as Dummett's historical antirealism is concerned, a brief counterexample example shall suffice. At a particular moment in time, Dante, for example, either kicked a wall or he did not, even though we will never know. But to claim that there is simply no fact of the

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[427] See Norris, 2002-A, pp. 30-31.

matter about whether or not he kicked a wall just because we do not happen to know that fact is indeed crazy or at least unbelievably arrogant for it amounts to saying that reality is nothing other than what I happen to think or know or wish it to be.

Ambivalent Antirealists

Bohr and Heisenberg did make statements that seem to be antirealist. According to the Copenhagen interpretation, 'it is not meaningful to regard a quantum particle as having *any* intrinsic properties independent of some measuring instrument.'[428] The related notions, that a quantum particle has no intrinsic qualities distinct from our measurements and that deterministic description is rendered impossible even in principle, are what upset Einstein. He demanded that 'every element in the physical theory must have a counterpart in the physical reality.'[429] Einstein is right and wrong. He is right that the Copenhagenists were wrong to claim that quantum particles have no intrinsic properties apart from being measured, for given their own assumptions they cannot make such an assertion about the nature of quantum aspects of reality. Only metaphysical reasoning (applied and pure) can lead us to postulate intrinsic qualities apart from measurements. And he was right to reject their dismissal of absolute determinism because physics cannot prove or disprove this notion, for it too is metaphysical. But Einstein was wrong to demand that every element in physical theory have a counterpart in physical reality. Or, if he was not wrong, he was nevertheless asking for what seems to be impossible. Theory and observation never correlate absolutely, and, even if they did, it seems impossible to know with absolute certainty that they had.

But Bohr held two essential ideas that propelled antirealist interpretations by overlooking his obvious realist beliefs as outlined in the previous chapter. Bohr said famously: 'There is no quantum world. There is only an abstract quantum physical description. It is wrong to think that the task of physics is to find out how nature is. Physics concerns what we can say about nature.'[430] Perhaps, on the most charitable interpretation, he was saying that physics has epistemological limits and cannot make ontological claims, although he seems not to have taken his own advice because he made numerous ontological claims. Given such an interpretation, we need only say that the diehard antirealists have misappropriated Bohr's comments. On the other hand, those four very brief sentences,

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[428] Baggott, 2004, p. 105.
[429] Einstein, 1954, p. 334.
[430] Bohr in Baggott, 2004, p. 109.

taken in isolation from his realist commitments, do lend credence to wholesale antirealism.

Bohr was right to stress that how we conduct our measurements has an influence on the result, but he was wrong to assume that there are no intrinsic properties *just because* when we measure something *then* we 'see' its properties. Either the properties are intrinsically part of the quantum particle, or we are creating the properties (and the particles themselves) out of nothing, or there are no determinate properties because each particle already harbours all possible, perhaps infinite properties from which our measurements select one or some limited number. Whatever the truth is regarding these possible interpretations, there would still be a truth about the matter, and whatever interpretation we believe would still be rooted in our metaphysical predispositions because we cannot experimentally prove one version over the other.

If it is true that quantum particles have no intrinsic properties until we measure them, and further that there is no way for quantum theory (or perhaps any theory) ever to penetrate any deeper into reality and discover that these particles do, after all, have intrinsic properties independent of our measurement, then this fact would still be a fact independent of what any of us happen to believe about the matter and so also support realism. But there is no way to prove empirically that the quantum particles do not have intrinsic qualities until we measure them. Both the belief that they do or do not have intrinsic properties before we measure them cannot be purely experimentally decided, and recognizing this fact brings out clearly the metaphysical nature of this confusion. Given his other realist commitments, it is safe to assume that Bohr did not believe that we actually create quantum particles from absolute nothing with our measurements or observations. He believed that *something* was there prior to our measurements or observations, albeit something indeterminate and unknowable in itself, but still something. However, either we measure *something* or *nothing*, but we cannot measure *nothing* so we must measure *something*, even if we cannot ever know what that something is in and of itself apart from our measurements, and so wholesale antirealism would be false according to Bohr.

When Bohr claimed that we cannot know quantum reality because there *is* no quantum reality outside of our measurements, he is partly right and seriously wrong. It is surely not incorrect to demonstrate our epistemic limitations, such as those imposed upon us by Heisenberg's uncertainty principle, but we are neither philosophically nor scientifically justified in then making the ontological claim that there is *no* quantum reality. Consider the example of the glass of water discussed above. The only way we can directly measure the temperature of some water in a glass is by placing a thermometer in the water, but, of course, this act will alter the temperature of the water (unless the thermometer is *absolutely* the same as the temperature as the water, which we can never know). But to say that our epistemic limitations inherent in interfering with the water that we are measuring entails that the water simply has no actual or definite temperature until we measure it is an ontological claim that is not at all justified by the working metaphysical assumptions of science.

Besides making clear the distinctions between ontological and epistemological assertions, my example is akin to the example of Schrödinger's cat, for both show the problematic nature of applying the Copenhagen assumption (that subatomic particles have no intrinsic properties until measured) to macroscopic objects or events.[431] It is strikingly bizarre to say that the glass of water has no intrinsic temperature, no particular temperature, until it is measured. The water must be some particular temperature at any particular moment whether or not I measure it. The claim that the water never has any definite temperature could mean either that the water has no temperature at all (which is surely bizarre), or that its temperature is constantly changing at every moment. Strictly speaking, of course, the temperature of the water probably is changing, however slightly, every moment, and, therefore, we cannot know exactly what the temperature of the water was prior to measurement or what it will be after the measurement. We can only know what it was at

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[431] I will not discuss the well known paradox of Schrödinger's cat except to say that the thought experiment excludes the conscious awareness of the cat. Surely the cat is aware, even if it is not aware that it is aware, but being aware of its own body by seeing or feeling it should be enough to collapse its own wave function. If it is dead and so not aware (unless having disembodied existence), then it cannot know that it is dead and therefore cannot be dead, unless someone else looks. But that implies that we too cannot be dead until someone else happens to look at us, and so, if nobody ever looks at me, and I don't look at myself, then I should never die....

a particular moment, and even then we only know the temperature of the water + thermometer (+ glass + rest of the universe), which forces us to admit the holistic nature of physical (and nonphysical) reality. Perhaps we sometimes slip into antirealism unwittingly when we defend a holistic account. The erroneous slip occurs when we move from the metaphysical realisation that no physical thing could exist unless in relation to other things to the false conclusion that therefore nothing at all has any existence. Thus, in one sense nothing could have a temperature unless in relation with other things, so nothing ever has an exact temperature of its own independent of everything else. However, at the very least, the temperature of the water (plus the rest of the universe), despite constantly changing from moment to moment, nevertheless must be some particular temperature and at the precise time of T.

Moreover, given no other relevantly major changes to the surrounding environment, the temperature will not suddenly be 50 degrees more or less than the instant before, or perhaps even be evaporated, frozen, or disappear into oblivion. There are limits, and such limits are defined by the intricate interplay of innumerable factors all abiding by the same laws of physics; and likewise with subatomic particles, which make up the atoms and molecules of the water.

When a particle (wave) is measured it is not suddenly going to become a pink elephant. It will have a particular manifestation at a particular time, which can be predicted with extraordinary accuracy, and it would surely have been and be something similar prior to and after measurement. However, this point raises another odd problem. Electrons are supposed to be identical, completely identical. Thus, they must all have completely the same lack of intrinsic properties in the same way, which does not seem to make any sense. The claim that all electrons are identical is an assumption about their underlying nature, as is the Pauli Exclusion Principle, which says that it is impossible for two electrons to occupy the same energy level. If either claim is true, then we are making statements about the nature of quantum reality, which quantum theory is not supposed to be able to do, but which it does anyway. Bohr may be correct that physicists *qua*

physicists cannot make such claims about the quantum world, but they still make those claims and build physical theories upon them.

Gibbins writes that 'our best description of the world does not lead to propositions which are true or false and whose truth or falsity is independent of the means we have for determining them.'[432] This would make Bohr an antirealist if Gibbins' interpretation is correct, although his writing is sometimes almost as obscure as Bohr's. Again, physics itself cannot tell us that its measurements and theories are partial aspects of the whole, for such an assumption is purely metaphysical. Yet, the metaphysical notion of wholeness, of inseparability of subject and object, experimenter (or measuring device) and the system being measured, has led to the antirealist conclusion that there is no reality independent of the mind of the observer. But admitting that everything in the universe is interdependent in some way does not mean that electrons do not have properties or do not even exist until we measure them. Bohm, too, would be considered to be an antirealist on Gibbins' interpretation, since Bohm also advocated the notion of wholeness. Bohm says that wholeness is not simply an ideal towards which we should strive; rather,

> what should be said is that wholeness is what is real, and that fragmentation is the response of this whole to man's action, guided by illusory perception, which is shaped by fragmentary thought. In other words, it is just because reality is whole that man, with his fragmentary approach, will inevitably be answered with a correspondingly fragmentary responses.[433]

It seems that Bohr would have accepted this view, where Bohm is saying that the wholeness of all reality is what is ultimately real and our theories and perceptions are less real ('illusory') because they are fragments of the whole. Thus, no theory could ever be absolutely true, but only ever partial. The first point to note here is that Bohm is actually being a realist by claiming that there is ultimate reality underlying our limited theories and experiences; however, he has not explicitly indicated that he is using metaphysical reasoning to arrive at his conclusion. If all of physics is partial, and that is all the

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[432] Gibbins, 1989, p. 56. See pp. 54-56.
[433] Bohm, 1980, p. 7. This notion of wholeness also resonates with Schrödinger's claim that consciousness is universal and singular.

knowledge that we are capable of, then we could never know (a) that our knowledge is partial or (b) that there is an underlying reality of unbroken wholeness. Only by seeking out the metaphysical implications, eventually landing in pure metaphysical reasoning, can Bohm reason his way to the conclusion that there must be an underlying, absolutely real reality of unbroken wholeness.[434]

Both Bohr and Bohm held similar views in this respect and both were being Platonic realists in the same respect by attributing more reality to the underlying absolute wholeness of the totality of reality, although they were not clear about the distinctions between abstract realism (with the unchanging laws of physics) and physically interconnected wholeness. Unfortunately, Bohm uses the term 'illusory' when he should have said that we are *deluded* when we assume that our partial theories and perceptions are direct representations of the totality of all reality. The term 'illusory' can have antirealist implications but, as just noted, he then uses metaphysical reasoning to lead us to understanding that there *is* a true reality underlying our illusory experiences, which ultimately makes him (and Bohr) realists.

I may think that reality is not undivided wholeness but rather a chaotic motley chance mutations and colliding objects, but Bohm would say that my view is wrong. There is a reality, and this reality is undivided wholeness. How he *knows* that this is reality is a different question. Probably following Krishnamurti's influence (or at least encouragement),[435] he wants to say that by understanding the fragmentary nature of our thought itself we can come to understand or perceive the reality of wholeness underlying

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[434] Bohm thinks that our partial, fragmentary, perhaps illusory theories that are never actually true or false but only clear in certain domains (Bohm, 1980, p. 4) can still 'point to or indicate a reality that is implicit and not describable or specifiable in its totality.' (Bohm, 1980, p. 17.)

[435] For example, see Blau, 1995. The degree of Krishnamurti's influence on Bohm is debatable, but what Bohm himself made clear is that his thought deeply resonated with Krishnamurti's notion of the unity of the observer and the observed, which is what Bohr also believed. And, of course, this idea is also Platonic. Plotinus: 'For the soul keeps quiet then, and seeks nothing because it is filled, and the contemplation which is there in a state like this rests within because it is confident of possession. And, in proportion as the confidence is clearer, the contemplation is quieter, in that it unifies more, and what knows, in so far as it knows – we must be serious now – comes into unity with what is known. For if they are two, the knower will be one thing and the known another, so that there is a sort of juxtaposition, and contemplation has not yet made this pair akin to each other, as when rational principles present in the soul do nothing.' (Plotinus, 1967, p. 379 *Ennead* III.8, 10-25)

our fragmented thought. I have no disagreement with this proposal, except that further clarification is required. We may be able to experience or know directly this undivided wholeness of reality, but as soon as we reflect upon this experience, or talk about it, or build a theory, then necessarily we must create a fragmentary description. The absolute unity of perceiver and perceived (or as Bohm usually says, between the observer and the observed) may be possible, but as soon as any thought about this experience-knowledge whatsoever occurs, then necessarily there is fragmentation. This is why I think Bohm has become confused when he speaks as if he were an antirealist about the truth or approximate truth of theories.[436] Of course theories cannot be absolutely true (except that a theory may be as true as possible within a limited domain). But it does not at all follow that one theory cannot approximate more closely than another theory the ultimate nature of reality. For example, Bohm would have to admit that Newtonian physics is not as accurate a representation of undivided wholeness as quantum theory, which means that the latter has more approximate truth than the former. Therefore, Bohm must either relinquish his realism regarding undivided wholeness, or allow that some theories are closer to underlying reality than others. And I am sure that he would not give up his notion of unbroken wholeness.

Heisenberg too made some comments that are hard to defend against the charge of being antirealist. For example, although it may be true that the laws of physics formulated mathematically in quantum theory no longer allow us to speak of (physical) nature in itself, but only 'nature exposed to our methods of questioning,'[437] it does not follow that there is no reality beyond what physics can tell us. Saying that the mathematical clarity, which relies upon the truth of abstract realism, entails that we cannot have completely objective knowledge of quantum systems does not mean that it is no 'longer possible to ask whether or not the particles exist in space and time objectively.'[438] Heisenberg has here made the obvious error of assuming that there is no way of knowing reality other than through science, which is a positivist assumption, despite his vehement rejection of

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[436] Bohm: 'as pointed out earlier, however, this means that our theories are to be regarded primarily as ways of looking at the world as whole (i.e. world views) rather than as 'absolutely true knowledge of how things are' (or as a steady approach toward the latter).' (Bohm, 1980, p. 5.)
[437] Heisenberg, 1958-A, p. 58.
[438] Heisenberg, 1958-B, pp. 15, 24.

the limitations of positivism and apparently forgetting his mystical experience of understanding cosmic unity—an experience attained beyond scientific methodology. This problem can be set aside easily because he has simply reduced ontology to epistemology, the common error of quantum antirealism and antirealism in general. However, he seems to have made a stronger antirealist claim.

Gibbins notes that Heisenberg claimed that 'if no experiment is available to measure a physical magnitude then it is meaningless to assert that it has a value at all.'[439] Heisenberg also states that

> quite generally there is no way of describing what happens between the two observations and that therefore the electron must have described some kind of path or orbit even if it may be impossible to know which path. This would be a reasonable argument in classical physics. But in quantum theory it would be a misuse of language, which, as we shall later, cannot be justified.'[440]

The first problems concerns the meaning of 'meaningless', which I have already analysed in the introduction to this chapter so will not discuss further here except to remind us that he is either making a trivially true statement or an antirealist claim. It seems that he was denying physical reality beyond measurements (which is a violation of scientific Platonism and so would be antirealist), but he unambiguously never denied mathematical Platonism. Thus, Heisenberg was sometimes though not always falling into the antirealist trap in a similar way as the antirealist interpretation of structural realism, which I have already argued against. The second problem results from the following confusion: there is a difference between saying that (a) physics cannot describe what happens between any two observations, (b) nothing happens between any two observations, and (c) nothing *determinate* happens between any two observations. It is never really clear what Heisenberg or any other physicist means by such assertions. I have already dealt with the first possibility, for physics is not the limit of our knowledge potential, and so even if physicists cannot describe what happens between event A and event B, it does not necessarily follow that nothing happens. The second possibility, however, seems just as

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[439] Gibbins, 1989, p. 51.
[440] Heisenberg , 1958-A, p. 48.

wrong. If *absolutely* nothing happens between any two observations, entailing that even the passage of time has ceased, then the physical universe would be in a sort of temporary eternal suspension until we happen to see the second event. But there could only be a second event if in fact something happened (changed) since the first event, so *something must be happening between the observations*. One could reply that perhaps nothing is actually happening to X, to that which we are observing, between observations, but this view fails or is at least highly improbable. First, we cannot *know* that nothing happens to X between observations, so any such claim requires an ontological account. Second, if *nothing whatsoever* happens to X then it must be outside all time and space and so could not even continue with the orbit of the earth, which makes it hard to imagine how we could ever make a second observation of it. Here, however, one is immediately reminded of nonlocality, but that explanation for entangled particle states differs significantly from claiming that nothing whatsoever happens between observations. Physicists think that something is happening, that there is some sort of nonphysical causality in nonlocality, but defending that view would take us farther away from our immediate goal. The point to note here is that if indeed nothing happens to X between observations then X enters into a timeless and motionless state after the first observation and then in order for a second observation to occur X must re-enter time and space, which necessarily entails that X has done something between observations; namely, moving from the timeless and motionless to the time-bound and perpetually changing realm of physical reality. It is worth stressing that the claim about what does or does not happen between observations is, once again, an ontological claim beyond the epistemic limitations of physics, which the Copenhagenists said we are not justified in making while continuously stating such proclamations themselves. The third possibility seems to be what Heisenberg generally had in mind, but even that is unclear.

Regarding this third possibility, it is impossible ever to set up absolutely identical initial conditions for any two experiments because every physical thing in the cosmos would have changed, at least with respect to space-time co-ordinates if nothing else, and since everything is interrelated then absolutely identical initial conditions are impossible. Thus, any claim that we could or could not achieve absolutely identical results from any two

experiments, whether supporting or negating strict determinism, could never in principle be proven empirically beyond any doubt. Therefore, the quantum antirealist is not permitted to say that physics has disproved strict determinism because physics *qua* physics could never prove or disprove determinism. The only option would be for the physicist to say that the mathematical equations necessarily entail one or the other. But that assumption too is Platonic realist and ultimately grounded in faith because we have to assume that the equations actually represent aspects of the fundamental nature of reality. Perhaps they do, but again, that belief is purely metaphysical and so must rely upon metaphysical reasoning. Quantum theory can no more disprove strict determinism than classical physics could prove it. Thus, it is not clear what Heisenberg was trying to say.

In the end, the realist must accept the limitations of our knowledge of reality through the restricted lens of physics, yet antirealists are wrong to assume that such epistemological limitations apply to reality itself. Physics is not the only route to knowledge, and physicists and positivist philosophers who assume that it is continually make metaphysical assumptions and dogmatic proclamations beyond physics, making their positions as internally untenable as they are incompatible with everyday confrontations with physical reality.

Finally, the familiar 'paradox' of the falling tree is relevant to all the above considerations. If a tree falls in the forest and no sentient creature with auditory apparatuses perceives the sound when it hits the ground, then is there any sound at all? If by 'sound' we mean tautologically that perceiving ears must hear it or else it is nonexistent, then there would be no sound in this case. But, according to the faith of all scientists (at least in practice), of course there must be a sound, as all scientists must believe if they are to be consistent with their other fundamental scientific beliefs. When object x (the tree) falls at velocity v and strikes another object y (the earth) then the result will be a release of energy E that is emitted at a certain frequency f corresponding to what we call a sound wave. If any auditory receiving apparatus, whether of a machine or sentient creature, is around to detect this sound wave, then it will be experienced as

sound. The paradox can only exist when we unjustifiably eliminate ontology through epistemological limitations; therefore, there is no paradox. As Psillos reminds us, 'yet, in scientific practice, an object is not supposed to have a property only when the test conditions S actually occur. For instance, bodies are taken to have masses, charges, temperatures and the like, even when these magnitudes are not being measured.'[441] Reality is what it is despite our total or partial lack of knowledge of it and regardless of our limited capacity to experience and understand it.

[441] Psillos, 1999, p. 6. See Spencer 2007 for a rebuttal of the antirealist denial of such claims.

Diehard Antirealists

We have seen how the Copenhagenists, as well as Bohm, have been ambivalent antirealists despite obvious and overwhelming (explicit and implicit) realist commitments. Other physicists with overwhelming realist commitments, such as Eddington, have also fallen into similar traps,[442] but what is of interest here is the wholesale quantum antirealism of Lindley, Rogers, and Wallace. The conclusion of Lindley, an astronomer, aptly indicates how antirealism has developed from the Copenhagen interpretation.

> It makes no good sense to talk of an objective world of real facts if those facts cannot be apprehended without altering them in the process. There is no longer any meaning to be attached to the idea of a real objective world; what is measured, and therefore known, depends on the nature of the measurement.[443]

Lindley is espousing views akin to Wheeler, and he seems to have forgotten that he also *admits* the importance of an objective external world: 'Some things in the end can be determined only empirically, by looking at the world and figuring out how it works.'[444] Lindley is an striking example of a metaphysically confused scientist. He denies the reality of an objective world that he also appeals to in deciding how things actually work. Bohr did claim that we cannot know the objective facts of the properties of quantum particles until we measure them, but he did *not* believe that there were no real facts, as I have already shown. This metaphysical confusion stems from conflating antirealism regarding intrinsic properties of physical objects beyond measurements with an antirealism regarding any knowledge whatsoever, which is to move from quantum antirealism to antirealism in general.

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[442] For example, see Eddington, 1935, pp. 292-296.
[443] Lindley, 1993, p. 63.
[444] Lindley, 1993, p. 6.

Planck makes the following highly relevant remarks.

> Now reason tells us that if we turn our back upon a so-called object and cease to attend to it, the object still continues to exist. Reason tells us further that both the individual man and mankind as a whole, together with the entire world which we apprehend through our senses, is no more than a tiny fragment in the vastness of Nature, whose laws are in no way affected by any human brain. On the contrary, they existed long before there was any life on earth, and will continue to exist long after the last physicist has perished. It is considerations of this kind, and not any logical argument, that compel us to assume the existence of another world of reality behind the world of senses; a world which has existence independent of man, and which can only be perceived indirectly through the medium of the world of the senses, and by means of certain symbols which our senses allow us to apprehend. It is as though we were compelled to contemplate a certain object in which we are interested through spectacles of whose optical properties we were entirely ignorant.[445]

It seems as if Planck was anticipating the development of the sort of antirealist conclusions espoused by Lindley because he has here offered a sufficient rebuttal. Planck also recognized the distinction between logic and reason (or rationality), as discussed in chapter Two, because although reason tells us that physical objects exist when we are not looking at them we still cannot logically prove that assertion—the world is reasonable though not necessarily logical, although not illogical either. Moreover, his position also supports my more detailed philosophical explication and argumentation that although we must admit that each individual is an integrated part of the cosmos, despite being such a tiny fragment of the whole, the laws of Nature existed (he should have said 'have being') independently of us, which is obviously Platonic. He also admits the important role of sensory experience without giving in to empiricism because the symbols that are necessary for physics represent the nonphysical laws of Nature, aspects of reality that are forever beyond naïve sense experience and must be intuited (if first discovering them and perhaps when also trying to understand them) with a mode of apprehension beyond discursive reasoning, as discussed already.

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[445] Planck, 1931, pp. 8-9. Cf. Schäfer: 'In the same way, viewed from the outside, it may not be possible to prove the existence of an **objective outer reality**. However, whenever that body which is associated with this (in some sense) independent self-conscious mind takes part in a process of that outer reality, **experience by the mind of this interaction** leaves no doubt that an objective outer reality exists.' (Schäfer, 1997, p. 89. Original bold.)

Lindley has confused the representation of physical facts with physical objects, and he has conflated nonphysical facts, such as the laws of physics, with physical processes. As discussed thoroughly already, we seem unable to avoid interfering with the quantum systems that we are measuring, but it does not follow that our acts of measuring interfere with the *laws* themselves, which dictate the actions of such a system. Moreover, when I measure the length of my kitchen table, I am sure (well, almost sure) that I have not altered its length with my act of measuring. The table seems to be the length that it is regardless of whether or not I measure it. At the subatomic scale of course the table may be constantly changing in length to some minuscule degree, but such changes seem to have nothing to with my measuring it since they would be occurring whether or not I hold up a measuring tape beside the table. It seems that quantum effects, if applicable to macro objects, are essentially negligible and usually undetectable empirically. The crucial point here is this: in following quantum antirealist reasoning, if we cannot measure quantum macro object effects, then no such effects have taken place. And, if no effects have taken place, then the postulate that our measurements alter reality is false, and so the conclusion that there is no objective reality is false. If quantum antirealism is true, then it is false.

The next antirealist to consider is Karl Rogers. I have argued against his views at length in another publication so will here offer a succinct version only.[446] Steeped in Heidegger, Rogers ends up denying the reality of electrons, but apparently for different reasons than for Mach's denial of the reality of atoms. Rogers says that it does not matter whether an electron is 'real and out there' because its reality cannot be 'divorced from the socio-technical processes in which it is stabilised and utilised.'

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[446] Spencer, 2007-A.

> On this account, the electron of scientific discourse does not need to have any scientific reality outside of the technological framework of research because if it were to have ontological independence from the technological framework then these facets of its being will not be utilisable as standing-reserve and, consequently, be inaccessible to scientific research. It would be outside the technological framework.[447]

If electrons exist only when we measure them, then they do not exist anywhere except where they are currently being measured, which seems to be *prima facie* absurd, or they do *now* exist everywhere retroactively as soon as a machine has measured them. Either option is going to face far tougher challenges than those that could ever possibly haunt the naïve realist. First, however, given the recent debate amongst astronomers concerning whether or not Pluto is a planet,[448] it seems appropriate to consider the following possible argument on Rogers's behalf. It may seem plausible that there are no such things as planets in nature because the term 'planet' is entirely socio-technical, so what makes electrons any stronger a case for realists? My reply is that of course the *term itself* is a matter of convention. If the majority of astronomers agree to call Pluto a planet, then Pluto is a planet, in the same way that whales are mammals instead of fish. It depends entirely on *our* classificatory system. But the trivial point of recognising that the symbols we use for things are inevitably human inventions does not in any way endorse the implausible jump to the conclusion that there are really no such things as planets and whales until we name them. The big chunk of stuff in the sky that corresponds to what we conventionally call Pluto is still flying around in its orbit no matter what we call it, and the whales are swimming around (and being illegally hunted) regardless of whether we classify them as fish, mammals, or planets. To confuse the symbol with the existence of what the symbol refers to would be to make an elementary mistake, so we shall set aside this possible objection.

Many arguments could be given to show the absurdity of assuming that electrons cannot have any 'reality outside of the technological framework', but we need only consider the familiar notion of radicals in biology. 'Radicals are compounds that have a single

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[447] Rogers, 2005, p. 172
[448] See BBC, 2006 and Cook, 2006.

electron, usually in an outer orbital. Free radicals are radicals that exist independently in solution or in a lipid environment.'[449] There are several 'dietary free radical scavengers', such as vitamin E, ascorbic acid, carotenoids, and flavonoids. For example, Vitamin E is an 'efficient antioxidant and nonenzymatic terminator of free radical chain reactions, and has little pro-oxidant activity.... The Chemistry of vitamin E is such that it has a much greater tendency to donate a second electron and go to the fully oxidised form.'[450] There are also several 'disease states' associated with free radical injury, including cervical cancer, alcohol-induced liver disease, diabetes, aging, Alzheimer's disease, multiple sclerosis, and Parkinson's disease.[451]

Biological cells are made of molecules, which are made of atoms, which consist of numerous subatomic entities (whether conceived as waves or particles or both or neither), and these entities include electrons. Many, and perhaps all, biological and chemical processes ultimately require theoretical physics as part of their explanations, and these explanations include assuming the reality of electrons existing independently of the 'socio-technical processes.' The theory of evolution, despite various scientific and philosophical inadequacies,[452] requires the existence of cellular life to have been evolving for millions if not billions of years, and these cells, according to our best biological and chemical theories, consist of many subatomic particles such as electrons. If electrons did not really exist outside our ability to detect or create them with current technology, then no life would exist anywhere in the universe.

> If electrons did not obey the [Pauli exclusion] principle, all elements would exist at the ground state and there would be no chemical affinity between them. Structures like crystals and DNA would not exist, and the only structures that would exist would be spheres held together by gravity. The principle allows for chemical bonds, which, in turn, result in the hierarchy of structures from atoms, molecules, cells, plants, and animals.[453]

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[449] Smith, C., et al, 2005, p. 67.
[450] Smith, C., et al, 2005, p. 591.
[451] Smith, C., et al, 2005, p. 439.
[452] See Clark, 2000-A, 2000-B.
[453] Nadeau and Kafatos, 1999, p. 34

Consequently, if Rogers is correct, then either no life exists anywhere, or life could only have come about retroactively once an electron emerged within the technological framework. But the only way we could have allowed the emergence of the technologically dependent electron is if we existed prior to our ability to create the relevant technology, which would require our biological bodies, and therefore electrons, to exist before electrons could have existed. Surely it is reasonable to conclude that assuming electrons have no existence independent of the relevant technology leads to absurdities. Rogers states unambiguously that it is irrelevant whether or not electrons are 'real and out there', but I hope it is obvious to most of us that it *is* relevant whether or not electrons are real and out there. If they were not real and out there, then no life could exist anywhere.

Rogers would probably reply that electrons are simply abstracted from experiences, the same way he assumes that mathematics is abstracted, and so electrons are not *causes* of anything. Talking about electrons would be a useful basic description that is only possible within a particular socio-technical context. We then project this description backwards merely for explanatory purposes, but without ever believing that electrons really exist or existed. Such a response, however, is untenable. It is possible that our current understanding of what electrons and other such entities are may change, or they may not be *exactly* as we think they are, but all reasonable evidence and rational arguments point to the fact that something very much resembling what we call electrons must exist, and they must exist independently of the measuring apparatus and of the observer, even if our epistemological limitations imply that we cannot have absolute certainty about the ontological status of electrons until they are measured. We do not know everything about Pluto or even about the earth or ourselves, so whatever we do know about these entities is necessarily partial, but it does not follow that therefore planets and human beings exist only once we have created the relevant technology to measure ourselves, and likewise with electrons. Electrons as now conceived, or something very much like electrons as now conceived, are real, even if their reality is not limited to the physical, as quantum theory implies. It is hard to find a scientist today who would follow Mach's overzealous empiricism and deny the reality of atoms, but if we deny a socio-technological

independent reality to electrons, then there is no good reason to stop us from denying the reality of atoms, molecules, cells, whales, and planets. As Barbour noted in Chapter Five, dinosaurs are not considered to be convenient fictions to explain the fossil data, but since they were made of cells, molecules, atoms, and subatomic particles, which apparently have no existence outside the technological framework invented in the last century, then dinosaurs must be fictions. The consistent antirealist (if such a person could actually exist) may deny that any life ever existed anywhere until we measured electrons, and I too can play such games and deny any reality to anything other than myself, but, again, this inane scepticism becomes pointless: more pointless than positivism. We do not know exactly and unambiguously what a gene is, but that does not mean that we have no idea whatsoever what it is or that DNA does not exist outside modern biology laboratories, and, again, similarly for electrons.

Perhaps the most extreme quantum (and wholesale) antirealist is B. Alan Wallace. Wallace spent many years studying Tibetan Buddhism and is the interpreter for the Dalai Lama. He also studied physics at Amherst College and has a PhD in religious studies from Stanford. But his erudition has not saved him from offering us untenable (if not dangerous) antirealist conclusions based on only a couple of passages from Bohr and Heisenberg (and sometimes from Einstein), passages that I have already discussed in the previous section. While completely ignoring the obvious Platonic realist commitments of his Copenhagen mentors, Wallace offers us what he calls the 'centrist view', which relies upon Buddhist metaphysics.[454] It is impossible, however, to do justice to his Buddhist view in such a short space, but fortunately we need only consider two of the most relevant points. First, Wallace takes the general Buddhist position that nothing at all, not even minds or the laws of physics, have any inherent existence. The argument, in essence, runs as follows: everything has arisen in interdependency from the void (Emptiness, 'Sunyata'), therefore nothing exists independently of anything else and therefore nothing exists separately from anything else, therefore everything exists only in 'conventional' reality but nothing exists in 'ultimate' reality; therefore there is no objective reality. The conclusion may not seem to follow, and indeed it does not, but that

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[454] Capra, 1991 and Zukav, 1980 also argue for parallels between Asian metaphysics and modern physics.

is the essence of the argument. All I want to note here is that Plotinus also makes explicit the view that all things that exist do so interdependently. Sara Rappe writes that 'Plotinus provisionally seems to suggest that we can understand the universe as a kind of mutual coming-to-be, or interdependent causal nexus: sentient beings all arise together as manifestations of a World Soul or universal form of life.'[455] This view is similar to Buddhist doctrine, except that what is called conventional reality by the Buddhists is not unreal for the Platonists. According to Platonism, this less than perfect world of constant change really exists and it really matters what we do here while we are alive in preparation for what comes after death. The subtle distinction is that in Platonism this everyday reality is not a mere *illusion*, as is often proclaimed in Buddhism (and Hindu philosophies) but rather we are *deluded* when we believe that this everyday reality is all there is and that there is no greater reality behind the appearances. Planck would certainly agree with the Platonists. Furthermore, in Platonism the ultimate nature of reality is the One itself, which is what it is independent of all things, and thus is ultimately realist in every sense (and we could make the same argument about Buddhist Emptiness - but that would be another thesis because most Buddhists would deny this claim[456]).

While Wallace admits that most mathematicians hold a Platonist conception of mathematics,[457] nevertheless, he still criticises Platonism as reification, which means attributing a real existence to mere fictitious concepts. The Platonist has not yet fully grasped the ultimate nature of reality, which is Emptiness. Of course, if the mathematical laws of physics are mere concepts with no reality outside any particular human mind, then they do not have any power and are thus reduced to mere descriptions of miraculous constant conjunctions, and so Wallace's view would fall prey to the same sorts of criticisms I offered in Chapter Five regarding the laws of physics being only descriptions. The basic philosophical error that Wallace makes in this context is to assume that just because I, for example, could not exist without oxygen, water, food, the earth, and the universe, it does not follow that I do not exist at all, which, perhaps surprisingly, is a

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[455] Rappe, 2000, pg. 42.
[456] Although Thich Nhat Hanh (1995) would probably agree with me.
[457] Wallace, 1996, p. 122. See also Sriraman, 2004.

common Buddhist conclusion.[458] The same sort of mistaken reasoning applies to structural realists, as argued in the previous chapter. The mathematical laws of physics, which are intangible yet productive relationships, are more fundamental than the ever-changing phenomena, but things must actually exist in order for them to be in relationships. Just because nothing can exist without the rest of the universe, as quantum theory tells us as well, it does not follow that what we believe exists is only an illusion, which brings us to the second relevant point.[459]

Wallace latches on to the most conspicuous antirealist comments from Bohr and Heisenberg, neglecting their overwhelming realist commitments, to argue for the inane conclusion that there is no objective reality, making his view no different philosophically than the spiritual marketing scams discussed briefly at the end of this chapter. Wallace writes that 'those who continue to adopt a realist interpretation of quantum theory continue in the age-old attempt to conceive of physical reality as it exists independently of our systems of measurements.'[460]

> Experiment does not inform us of the ontological status, or intrinsic nature, of microobjects as they exist apart from measurements. Given one system of measurement, results are produced that suggest the presence of a wave phenomena; given another system, the "same" measured object seems to be a particle. In the absence of any system of measurement, we have no evidence of waves, particles, potential, or anything else. We may conclude, according to the above principle, that an electron existing as an independent entity is in principle unknowable; therefore this independent entity does not exist as potentiality, for it does not exist at all.[461]

Here, perhaps, is the best example of the dangerous mistake that Norris has argued against in his defence of realism; namely, the unjustifiable elimination of ontology by

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[458] Wallace: 'there is no intrinsic, personal self, nobody that stands apart from the constant fluctuation of mental and physical events' (Wallace, 1993, p. 124). Tulku Thondup Rinpoche: 'However, *self is an illusion*, because everything in the experience of samsara is transitory, changing, and dying. Our ordinary mind thinks of self as something that truly exists as an independent entity. But in the Buddhist view, *self does not truly exist*.' (Thondup, 1996, p. 18. Emphasis added.)

[459] The Buddhists make a vital point against the egoistic assumption that what we do has no effect on anything else, which keeps us trapped in suffering because in reality everything is mutually interconnected, but the antirealist spin put on this ancient tradition by Wallace is not the answer.

[460] Wallace, 1996, p. 74.

[461] Wallace, 1996, p. 76.

epistemology. Whatever *we* happen to know is the limit of reality, for nothing can exist beyond our knowledge. But there can be no experience of absolute nothing, so something must have some sort of reality in order for us to experience it. But perhaps I am hallucinating, so what I think I experience does not actually exist. In that case, at least *something* must exist prior to my delusion in order for me to have the delusion in the first place, as I have already argued. Second, because the object of our experience appears to behave in two different ways (particle/wave) depending on the experimental arrangement, it does not follow that it can behave in *any way whatsoever*, and so there must be belief- and mind-independent constraints in reality. I will argue this point in more detail in the next chapter when discussing the duck/rabbit example.

Approaching even deeper pure metaphysical territory, perhaps sentient creatures can exist as disembodied entities prior to the manifestation of the physical universe, in which case they could bring about the universe through their minds. But even such creatures ultimately require an account of how they came to be, and so on back to the supreme, ultimate nature of reality, whatever that may be: Aristotle's' prime mover, Abraham's God, the Platonic One, or Buddhist Emptiness. Concluding that electrons do not exist because we cannot know of their existence without performing relevant experiments is patently absurd, both in its implications, as just outlined, and in and of itself. Wallace has at minimum admitted, as Rogers does too, that electrons exist as part of the system of measurement, as part of the wholeness of quantum phenomena, which includes the entire experimental procedure, but if they exist at all then he cannot consistently say that they do 'not exist at all'.

The pinnacle of his argument, on my reading, occurs when Wallace states that his centrist view proposes that 'phenomena are brought into existence through the processes of verbal and conceptual designation.' and so 'their very nature is defined by language usage: the relationship between an object and its attributes is determined by the way we speak and think about them.'[462] This point has obvious affinities with Judith Butler's position briefly discussed at the end of this chapter, and both are susceptible to similar

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[462] Wallace, 1996, p. 122.

criticism. If Wallace is really correct (and no consistent antirealist position can really be correct) then various absurd consequences follow. If phenomena are brought into existence through the process of verbal and conceptual designation, then, clearly, there can be no reality for (most) animals.[463] Indeed, there can be no phenomena for anything or anyone—from infants to bacteria—except those humans with adequate linguistic capacities. How can I prove that phenomena exist for animals and babies? Perhaps I cannot, for I am not sure what would count as a proof here. What we can point out is that on Wallace's account, babies exist only because we have words and concepts for them, but nothing can exist from the baby's perspective because it has no words for anything. These results must surely strike most people as absurd, but they are simply straightforward consequences of the antirealist position.

Further, consider that the average person in Hiroshima on 6 August 1945 most likely knew nothing at all about the concept of atoms. According to Wallace's view, atoms could not have existed for those people because they would not have had any such verbal or conceptual designations. But, the horrific reality is that the atomic bomb did explode and it obliterated the city and its inhabitants. On this antirealist account, someone with a clear conceptual understanding of the atomic bomb would have to have witnessed the explosion in order for the explosion to have occurred. But the paradox, or absurdity, still remains, for the explosion could *not* have occurred for those who had no such knowledge of atomic energy because they would not have had the ability to bring the phenomena of atoms into existence through the processes of verbal and conceptual designation. If, however, Wallace were to reply that the explosion could occur because at least *some* people had such knowledge, then there are facets of reality that are at least independent of *some* human minds. Such an admission would leave open the door for the realist to say that only speciesism or ethnocentrism (Rorty) can force us to say that reality is limited to what we humans or some particular person (such as a tyrant or perhaps 'The Party') can conceive. But Wallace's position is stronger, for our concepts are supposed to bring all things into existence. This certainly sounds like amazing magic.

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[463] I thank Ryoko Spencer for offering this point.

A couple of more examples of difficulties for quantum antirealists will suffice to show the untenability of such a position. For example, as Gibbins writes, it is claimed that 'when a quantum system is not subject to measurement by an observer its state evolves deterministically in accordance with an equation – Schrödinger's equation – just as the state of a classical particle in classical particle mechanics evolves according to Newton's second law of motion.' But when a measurement is taken 'its state is presumed (in practically all cases) to jump discontinuously and acausally into another state.'[464] But quantum antirealism disallows *any* claims to be made about a particle (or quantum system) when it is not being measured and, therefore, we cannot say that the particle is evolving deterministically because we are not measuring it at that time. We cannot know what it is doing when we are not measuring it and, therefore, we can make no claim about it whatsoever. Further, assuming that it actually is evolving deterministically, then that is to admit an underlying determinism. The response would be to say that when a measurement is made it then jumps 'acausally', which is called the collapse of the wave-function. But this too is problematic in various ways. First, it is not at all clear what it means to say 'acausal' because it is the act of measurement that *causes* the particle to abandon its strictly determinate evolution, and, therefore, there is a cause. Second, when the wave-function collapses, it collapses within certain highly probabilistic parameters. It cannot collapse just anywhere in the entire universe but must be within specific determinate ranges, even if such ranges cannot be given absolutely definite values. Nevertheless, the possibilities are highly restricted and so still determinate to some important degree.

Moreover, if *all* data, and therefore all reality, are really theory laden, as the antirealists claim, then they are caught in another question-begging trap. The theoretical interpretation of the data is that the particle cannot have definite position and momentum, which is an explanation that tries to make sense of the data. But the data apparently cannot make sense without a prior theory, even though the theory they are using to bring about the data is somehow retroactively being applied to make sense of the data that arose from classical assumptions and the use of macro-object machines and measuring

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[464] Gibbins, 1989, pp. 11-12.

devices, which is part of the difficulty that Bohr himself acknowledge about being caught in the concepts of classical physics. Maybe those concepts are not so absurd after all.

Is Antirealism Dangerous?

Not only is antirealism a hindrance to deep understanding and progress in physics, its tentacles have reached out into other disciplines and society in general, often with an appeal to physics for support.[465] Vision writes that

> The very possibility of successfully delineating our relation to a mind-independent reality is now widely doubted. A strong anti-realist tendency has flourished in this intellectual climate – not only among Anglo-American and Continental philosophers, but also among writers in various disciplines.[466]

He argues that some of the most well-known antirealists, such as Wittgenstein, Kuhn, Dummett, Putnam, Goodman, and Rorty have been successful, not only in enlisting many converts, but 'more importantly in the fact that they have managed to define the issues in their own terms.'[467] We need not accept their rules.[468]

Butler asks a question that is relevant to this thesis: 'Is there a "physical" body prior to the perceptually perceived body? An impossible question to decide.'[469] But how can it possibly be impossible to decide? She is saying that it is impossible to know whether or not there is physical body before we perceive the physical body, which is essentially the same mistake as made by the antirealists just discussed. She uses her antirealism to attack the heterosexual male who has violently imposed his conception of gender upon women, lesbians, and gays. The irony is that Butler seems to be assuming that there are *real* categories of 'man' and 'heterosexuals' who have oppressed all others. But she cannot both say that the categories of 'woman', 'homosexuals' and others are nothing but social constructs created by men because she is then assuming that there is really a category of 'men' that is not socially constructed, and so her antirealism, upon which all of her arguments rest, fails. However, she may respond by admitting that the categories of 'men' and 'heterosexuals' are also socially constructed fictions, but then she has two

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[465] The later Putnam, for example, turned away from realism because quantum theory is supposed to be antirealist. (See Norris, 2002-A, p. 39).
[466] Vision, 1988, pp. xi-xii.
[467] Vision, 1988, pp, xiv.
[468] For a critique of van Fraassen's antirealism, see Norris, 1997.
[469] Butler, 1990, p. 114.

further problems. It seems impossible to avoid a realist account of (a) how mere socially constructed fictions ever began to exist in the first place in order to create further such fictions, and (b) how she can legitimately claim that some socially constructed categories are better or worse or more deserving of attention than others. The danger in Butler's position is that if heterosexual men are the evil creators of the socially real (and hence reality), then those who have been created have little or no hope of escape. But if we *all* accept responsibility, then there is hope of creating a better society.[470]

We can also see antirealism creeping into popular culture in many areas, but I will only bring our attention to one small aspect, which is directly related to quantum antirealism. There are numerous 'quantum healing' purveyors, and those who jump on the quantum antirealist bandwagon aim to convince us that there is no such thing as objective reality so we can create any reality we want. We can achieve endless money, fame, whatever we desire. All of our wishes can come true, but first we have to buy expensive computer software that teaches us the objective way to understand that there is no objective reality. These ideas may seem harmless except for beguiling the foolish out of their pocket money, but as such antirealist ideas pervade our society, especially when the vendors are quoting from physicists for support, then some people are really going to believe (and already believe) that we can fulfil any evil desire we may have because if there is no such thing as objective reality we can create any reality we wish without 'really' harming any one else. Perhaps the worst abuser is a company called Dream Manifesto, which conspicuously rests its whole business on quantum (and extrapolated to general) antirealism in order to scam people out of money.[471] These points lead directly to my criticisms of Rorty, whose ideas offer frightening support for the current political climate in America.[472] My criticisms are based purely on revealing the logical implications and internal rational and logical inconsistencies of his own position.

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[470] Luce Irigaray makes even more misplaced criticisms, especially of physics, calling $E = mc^2$ a 'sexed equation' because 'it privileges the speed of light over other speeds that are vital to us,' thus privileging 'what goes the fastest.' (See Sokal and Bricmont, 1998.)

[471] Dream Manifesto:
(http://www.dreammanifesto.com/wizard?gclid=CP_k7fnB5YsCFQyIPgodVGllTQ).

[472] Rorty recently passed away and various academics and others have been writing about how he influenced them. Richard Posner, judge on the United States Court of Appeals, writes that he owes 'much to Rorty's pioneering work' where we need not be concerned with 'a secular theology preoccupied with

First, Rorty sees no epistemological differences between theoretical physics, literary criticism, or astrology, which means that we should be able to rewrite the story of physics *any way* we choose.[473] He even goes so far as to demolish the Platonic distinctions between knowledge and opinion, and truth and appearances, for all such 'dualisms' should be 'dissolved'.[474] But if there is to be no distinction between knowledge and opinion, then we may as well consult a librarian when we are sick and a medical practitioner when we want to buy plane tickets to Spain, or get a literary critic to build nuclear reactors. Such antirealist thinking is harmful to science, philosophy, and society in general, but it is certainly convenient for a political administration that is intent on manipulating language to say that 'enhanced interrogation techniques' are not 'torture': just change the word to change reality.[475] It is precisely the sort of antirealism endorsed by Rorty that George Orwell masterfully unfolds in *Nineteen Eighty-Four*. O'Brien is simply carrying through with the implications of antirealism when he is torturing Winston in the Ministry of Love, trying to get him to succumb to doublethink and completely submit to the party by his 'own' act of will.

> You are here because you have failed in humility, in self-discipline. You would not make the act of submission which is the price of sanity. You preferred to be a lunatic, a minority of one. Only the disciplined mind can see reality, Winston. You believe that reality is something objective, external, existing in its own right.[476]

Rorty also goes one to say that his 'anti-representationalist' stance claims that the controversy between idealists and realists is 'pointless',[477] which is to say that my entire

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abstractions such as truth and meaning.' (See Metcalf, 2007.) It should be frightening to have a judge openly admitting that he is not concerned about meaning and truth.

[473] Rorty, 1991, pp. 1,8.

[474] Rorty, 1991, pp. 21-24, 31 (footnote), 40, 90.

[475] Ross and Esposito, 2005. Rorty also says that 'an objective value sounds as mythological as a winged horse.' (Rorty, 1991, p. 36.) Ignoring the fact the developments in genetics could actually allow such a creature to come into existence, his wholesale antirealism is frightening. Norris, a moral realist, strongly opposes such dangerous antirealism, and has recently criticized George Bush when arguing that unless there are objective standards beyond the response-dependence notion of merely appealing to the highest human authority (where his argument finds its roots in Plato's *Euthyphro*) then we seem to be unable to criticize Bush in all the ways we must. (Norris, 2002-A, pp. 189-190).

[476] Orwell, 1972, pp. 199-200.

[477] Rorty, 1991, pp. 2-3.

thesis and all the relevant thoughts and arguments of the greatest pioneering physicists who developed classical, relativity, and quantum physics have been a colossal waste of time. As Rorty notes approvingly, Wittgenstein refused 'any longer to be tempted to answer questions like "Is reality intrinsically determinate, or is its determinacy a result of our activity?".[478] Thus, one of the most important questions in quantum theory has been pronounced as futile by Rorty, and was even refused a hearing by Wittgenstein, as they saw it as being too philosophical for their anti-philosophical agendas. Thus, followers of Rorty and Wittgenstein are in principle incapable of discussing any of the philosophical issues that have so confounded physicists.

Ironically, Rorty has characterized the realist versus antirealist debate as one of the 'pseudo-problems' that have plagued philosophy for long enough and should be dissolved. However, a pseudo-problem is something that only *appears* to be a real problem but in *reality* it is not a real problem. This means that Rorty has just made a distinction between reality and appearances, between what is true and false, yet his own stance forbids any such distinctions. His position is thoroughly incoherent and can only be sustained by an immense effort of will to double (or triple) think ourselves into ignoring or actually believing blatant logical and rational contradictions.

Rorty also says that antirepresentationalists believe that we should not try to do the impossible of seeking something beyond ourselves: 'we should not look for skyhooks, but only for toeholds.' A toehold, however, is something to rest your weight upon, a foundation, but his whole project is to do away with foundations, so he must do away with toeholds. We will be left floating in the air, like a soap bubble. And when Winston asks O'Brien whether or not he is *really* floating in the air, he will be tortured further because he will not have understood that such questions should not even be asked. Antirealists and those like Rorty who pretend not to be antirealists because they do not even allow such debates and critical thought to occur, share one common desire: they

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[478] Rorty, 1991, p. 7.

want never to be wrong.[479] So long as there is no real truth of the matter, then no one can ever really be wrong. But as Clark aptly notes, 'the price of never being wrong, of course, is never being right.'[480] It is precisely because realists admit to the possibility of being wrong that we can engage in fruitful argumentation in order to clarify further problematic assumptions.[481] The realist, as Norris states, allows her 'beliefs to be put to the test rather than hedged around with protective disclaimers.'[482] Clark is justified in his bluntness: 'Those who say there is no Truth are liars; those who say we cannot find it out admit they have no reason for what they say.'[483]

[479] Jürgen Habermas thinks that Rorty's program to do away with all philosophy 'seems to spring more from the melancholy of a disappointed metaphysician, driven on by nominalist spurs, than from the self-criticism of an enlightened analytic philosopher who wishes to complete the linguistic turn in a pragmatist way.' (Habermas, 1998, p. 345.) Thanks to Vivienne Boon for this source.
[480] Clark, 1995. Cf. Harris: 'Relativism is inextricably entangled with scepticism. The denial of objectivity is the denial of truth, and that cannot but infect the asseverations of the relativist and the skeptic themselves.' (Harris, 2000, p. 4.)
[481] As Polanyi writes: 'it is logically false to deny the existence of truth since the very statement asserting this is based on the assumption that truth can be established.' (Polanyi, 1964, p. 78.)
[482] Norris, 2002-A, p. 45.
[483] Clark, 1998, p. 23.

Summary

In this chapter, we first saw how antirealists tend to set up the terms of the argument such that realism by definition is impossible. Just because everything in the universe is ultimately interconnected, it does not follow that the entities that are in such relationships do not exist. The charitable interpretation of the ambivalent quantum antirealists leads to the conclusion that they were simply recognizing the limits of physics in reaching into and describing reality. But sometimes they made comments that paved the way for full blown quantum and general antirealism, and I criticised such arguments. The diehard antirealists have capitalized on these unfortunate antirealist comments made by Bohr and Heisenberg, and I argued against these views as well, showing the absurdity of taking seriously the notion that there is no objective reality independent of our conceptual and linguistic activities. I also clarified some of the dangers in general antirealism, which has often directly or indirectly been supported by quantum antirealism. By showing how for the most part the original quantum pioneers were explicitly and implicitly endorsing Platonic realism, and by aptly showing the flaws in their reasoning when in fact on a few occasions they did endorse antirealism, we are now able to open the way to deep understanding and progress in physics, and we have taken the wind out of the sails of all those who wish to push an antirealist agenda in our society. As Clark writes, 'if anti-realists are (absurdly) right, there is no harm following Plato's example; if they are wrong then something very much like Platonism is correct'.[484] And, indeed, contrary to what these antirealists have pretended to believe, Platonic realism continues to provide the metaphysical foundation of physics.

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[484] Clark, 1990, 21.

CHAPTER SEVEN: Platonism and the Laws of Physics

Introduction

In this final chapter, I will argue the following points:

(a) the metaphysical concept of unity is foundational to physics, and physicists seek simplified and unifying abstract principles;

(b) these principles and laws must be nonphysical and eternally unchanging (even if having relatively limited applications that can be arranged hierarchically);

(c) the wholeness presupposed by quantum physics, where the observer and the observed (or measuring and measured) cannot logically (or metaphysically) be separated, presupposes a fundamental role for the observer (which I argue was also implied in classical physics);

(d) the fact that we can have knowledge of both nonphysical mathematical laws and the changing physical world implies that there is something about us that can grasp the changing and unstable and the eternally stable; and

(e) all the above points entail that quantum theory (and all of physics) is Platonic.

Simple Unity Simply Stated

No doubt the classicists will continue to debate the issue of what exactly constitutes Platonism, but Gerson has recently provided a thorough evaluation of the relevant texts and has offered excellent reasons for his claims concerning the essence of Platonism. I will not repeat his arguments here but will provide in detail two of the seven essential aspects of Platonism, which are based upon the interpretation of Aristotle and Plato by the Neoplatonists, whom he believes were essentially correct. Platonism, thus understood, must predate Plato because it points to the eternal, and the eternal is timeless and therefore *always is* for every creature at any point in time before or after Plato.[485] They simply believed that Plato stated this perennial philosophy in the most sublime way, although the writings of Plotinus and Proclus among others equal Plato's genius in their own ways. The first two essential aspects that are foundational to all of Platonism are the following:

> 1) *The universe has a systematic unity*....The hypothesis that a true systematic philosophy is possible at all rests upon the assumption of cosmic unity...These philosophers held that the world is a unity in the sense that its constituents and the laws according to which it operates are really intelligibly interconnected. *Because* the world is a unity, a systematic understanding of it is possible.
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> 2) *The systematic unity is an explanatory hierarchy*. The Platonic view of the world—the key to the system—is that the universe is to be seen in a hierarchical manner. It is to be understood uncompromisingly from the top down. The hierarchy is ordered basically according to two criteria. First, the simple precedes the complex, and second, the intelligible precedes the sensible. The precedence in both cases is not temporal but ontological and conceptual. That is, understanding the complex and the sensible depends upon understanding the simple and the intelligible because the latter are explanatory of the former. The ultimate explanatory principle in the universe, therefore, must be unqualifiedly simple. For this reason, Platonism is in a sense reductivist, though not in the way that a bottom-up philosophy is. It is conceptually reductivist not materially reductivist.[486]

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[485] Emerson writes that 'there is one mind common to all individual men. Every man is an inlet to the same and to all of the same. He that is once admitted to the right of reason is made a freeman of the whole estate. What Plato has thought, he may think; what a saint has felt, he may feel; what at any time has befallen any man, he can understand. Who hath access to this universal mind is a party to all that is or can be done, for this is the only and sovereign agent.' (Emerson, 1941, p. 1.) Heisenberg experienced such insight when he knew directly for himself what Plato had been pointing at in the *Timaeus*. Also recall again Schrödinger's belief that consciousness is universal and singular.

[486] Gerson, 2005, pp. 32-34. The other five are:

Whatever else Platonism may be, the above two principles are among the essential ingredients. It does not make any difference to my arguments if an historian or classicist disagrees with Gerson's exposition of the essential or foundational aspects of Platonism. I would still argue for the eternal truth of these metaphysical principles regardless of whether or not there was any historical precedence, and, in any case, I can simply stipulate that I am assuming such metaphysical principles to be the foundation of Platonic realism. But it is a significant fact that a scholar of Gerson's stature has argued compellingly for such historical understanding, and there is also historical precedent for these views permeating the thoughts of the founders of modern science. Moreover, these principles are still assumed by physicists to be true, whether explicitly or implicitly.

In the next section, I will consider the views of two philosophers who deny unity, but all that needs to be noted here is the obvious fact that if there were no such thing as unity then physics would not be possible. Nothing would even be able to exist, as Proclus argued so clearly in proposition one of his *Elements of Theology* (1963). If nothing partakes in unity then it could not be unified and so would never become a whole, a something. Only by being unified, by becoming a one something—whether an electron, elephant, universe, or mind—can anything ever exist or be.[487] It is not possible to object to this reasoning because any objection presupposes that there is something unified in one's objection, otherwise it would not be an intelligible response. In other words, if an objection had no unity, no rational way of bringing different words, concepts, and thoughts into a coherent whole, then the objection would not make any sense. Moreover, the objector would either exist or not exist. If she exists, then she is unified to some degree, bound into a whole that is in relation to but (at least to some appreciable degree) separate from other wholes, which necessarily presupposes the prior principle of unity because unity is presupposed by the very process of her objection and the fact of her

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3) *The divine constitutes an irreducible explanatory category.*
4) *The psychological constitutes an irreducible explanatory category.*
5) *Persons belong to the systematic hierarchy and personal happiness consists in achieving a lost position within the hierarchy.*
6) *Moral and aesthetic valuation follows from the hierarchy.*
7) *The epistemological is included within the metaphysical order.*

[487] See Spencer, 2006, for an introduction to this principle and way of reasoning.

existence. If she does not exist then she could not even make an objection, and so arguing coherently against this reasoning is not possible without immediately stating an absurdity. One could object, however, by admitting discrete and partial or relative unities while denying any overarching principle of Unity, what Newton called IT. But a denial of a supreme Unity makes it impossible to give a rational metaphysical explanation of an infinite number of relative unities because, after all, as modern physics itself implies, all things are interrelated, which is to say that all relative and partial unities throughout the universe are part of the great cosmic or universal unity. Yet, even this unity of all *physical* phenomena in the universe either exits because of pure chance or due to some intelligible prior principle. I will argue below against the notion of pure chance, which seems to leave us only with the option of admitting some prior intelligible principle of Unity. The burden of proof lies in the hands of those who would deny this supreme Unity to explain how any relative unities are possible without resorting to pure chance, which would make science impossible. If Frege could not define truth, and unity is presupposed by and so metaphysically *prior to* truth, then it seems impossible to define unity in the way we can define a concrete noun, such as a house or banana (and even those definitions are difficult). But we can argue apophatically (or negatively) in the sense of what must be the case if unity were not real, and we can turn to the assumptions of physics itself. Both ways have found expression in Platonism.

John Taylor, professor emeritus of mathematical physics at the University of Cambridge, is straightforward about the fundamental importance of unity in physics.

> The unity here [of electricity and magnetism] is hidden, because at first sight there seemed to be no connection between the two. The invention of the electric battery at the beginning of the nineteenth century ushered in a new period of research that showed that electricity and magnetism are interconnected when they change with time. This did not mean that electricity and magnetism are the same thing. They are certainly different, but they are two aspects of a unified whole, 'electromagnetism'. In general, it makes no sense to talk about one without the other. This pattern of unification is fairly typical. Every time such a unification is achieved, the number of 'laws of nature' is reduced, so that nature looks not only more unified but also, in some sense, simpler. More and more apparently diverse phenomena are explained by fewer and fewer underlying principles.[488]

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[488] J. C. Taylor, 2001, p. xi. Cf. Barr: 'Symmetry contributes to the artistic unity of a work, to its balance, proportion, and wholeness. The connection between symmetry and unity is exceedingly important and

Electricity and magnetism, although at one time apparently unrelated phenomena, turn out to be intrinsically connected, and taken together they compose the electromagnetic spectrum. Physicists must continually seek to uncover such hidden unities, and they have always made deep progress when they discover how apparently disparate phenomena, such as the flow of the tides and the falling of an apple, are interconnected and unified. Thus, if physicists seek to understand the laws of nature, which provide greater explanatory and predictive power the more simplified and unified they are, which is to say the more hierarchically prior they are to the complexity of physical diversity, then the rational ultimate goal is to seek the most simple and most unified, which is the absolute simplicity and unifying power of what the Platonists call the One. As Heisenberg has noted, 'the Search for the 'one,' for the ultimate source of all understanding, has doubtless played a similar role in the origin of both religion and science.'[489]

The Platonists tended to emphasize the discovery of metaphysical unity underlying all of physical reality with the aim of personal transformation in our quest to know ourselves and 'become like God' so far as possible. Physicists, on the other hand, are generally more concerned with discovering and understanding the physical manifestation of this underlying unity expressed according to unifying laws, but they are less apt *qua* physicists to seek the metaphysical unity that makes the physical laws and the physical universe possible. Yet, Heisenberg's point remains valid. The pioneering physicist is seeking ultimate unity, the final principle upon which all of physical reality depends, and even the experimentalist assumes and relies upon such underlying unity even though not needing to explore the metaphysical depths in order to carry out technical research in a specific physical domain. Thus, it is not that Platonism per se is identical with modern physics, but that modern physics rests upon the same essential assumptions of metaphysical hierarchical unity as Platonism. And it is only in Platonism that we find a

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applies also to symmetry in physics....Symmetry requires all the parts of a pattern to be present, and is therefore a unifying principle' (Barr, 2003, pp. 97-98).
Rowlands: 'Many of the principles used, such as the conservation laws and the irreversibility of time, appear to be intrinsically simple, and suggest that simpler theories are more likely to be inherently true than complex ones.' (Rowlands, 2003.)

[489] Heisenberg, 1974, p. 117.

proper metaphysical defence of these foundational beliefs, which are not given a proper defence by physicists but are simply assumed to be true. Indeed, if these Platonic realist axioms were not true, then physics would not be possible.

What is most interesting with respect to Taylor's work is that he is quite (though not totally) unconcerned with philosophy. This point is significant because he has outlined some of the most essential aspects of Platonic metaphysics purely through studying the way physics has developed. Rowlands has also made the similar point that this way of thinking is the only way that has ever proved fruitful in foundational physics, from its inception four hundred years ago until today. Of course, the most simple is not physical, which is also another point that is difficult for many contemporary philosophers to grasp. As Rowlands writes, 'the truth is that simple facts are not concrete and concrete facts are not simple.'[490] For example, it would take an infinite amount of time (assuming it possible in principle even with infinite time) to describe in absolutely complete and precise scientific detail any concrete object such as a table, yet $E = mc^2$ is very simple but has no concrete reality; it is an abstract equation that symbolizes a relationship that itself is not physical. Harris also notes that Einstein and Infeld believed that the simpler our picture of the world 'the more facts it embraces and the more strongly it reflects the harmony of the universe. The criteria they recognize and seek are those of comprehensiveness and coherent unity.'[491] Einstein writes that an important, subtle motive for the desire to devise new theories 'is the striving toward unification and simplification of the premises of the theory as a whole (*i.e.*, Mach's principle of economy, interpreted as a logical principle).'[492]

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[490] Rowlands, 1992, p. 21. Whitehead makes a similar point: 'The history of seventeenth century science reads as though it were some vivid dream of Plato or Pythagoras...the paradox is now fully established that the utmost abstractions are the true weapons with which to control our thought of concrete fact' (Whitehead, 1953, p. 41).

[491] Harris, 2000, p. 242.
'Evolution is proceeding in the direction of increasing simplicity of the logical basis. In order further to approach this goal, we must resign to the fact that the logical basis departs more and more from the facts of experience, and that the path of our thought from the fundamental basis to those derived propositions, which correlate with sense experiences, becomes continually harder and longer.' (Einstein, 1954, p. 322.)

[492] Einstein, 1950-B. As already noted, this positivist-inspiring belief is deeply akin to Platonic realism but lacking the metaphysical muscle to support it.

Planck had a similar belief:

> The idea of potential is superior to that of force, partly because it simplifies the laws of physics, and also because the significance of the idea of potential has a far greater scope than that of force; it reaches beyond the sphere of mechanics into that of chemical affinities, where we are no longer concerned with Newtonian force.[493]

This idea of the simpler principle having greater scope and so being superior to that which reaches out to fewer phenomena is exemplified in Proclus.[494] 'The cause of more numerous effects is therefore superior in its being to that which produces fewer,' and since that which is the more powerful cause must have greater unity, then it more closely resembles the absolute simplicity and unity of the One, the ultimate originator of all. Another implication of these views is that there must be *degrees* of truth and reality. The closer a principle is to the One, the greater is its reality (or being) and truth. Thus, general relativity will be closer to the truth of the nature of gravity than Newton's theory. As Harris notes, 'if this testimony [from the great pioneering physicists] is accepted for the way in which scientific knowledge is progressively developed and supplemented, it carries with it significant implications for the much criticized doctrine of degrees of truth, another corollary of the coherence theory.'[495] Rowlands aptly brings together many of the above notions of abstraction, simplicity, and symmetry.

> It is clear that the search for a *unified* theory is essentially at one with the originally theologically-inspired project of the fourteenth and seventeenth centuries, and we now have a better understanding of what such a theory would actually look like. It would be certainly characterized by abstraction, simplicity and symmetry. It would also be, in principle, extreme, no compromise being allowed in the best theological tradition. There would be no mathematics, other than that being derived through symmetry principles, no model-dependent structures of any kind, and no arbitrary cosmology. It would certainly look different from any theory yet devised for a particular aspect of physics, yet these would all be ultimately deducible from it. Though purely secular in itself, such a theory would derive much of its power from the fact that its ultimate origin was in theology.[496]

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[493] Planck, 1931, p. 68.
[494] See Proclus, 1963, p. 59 (props. 60-62).
[495] Harris, 2000, p. 244.
[496] Rowlands, *Theology and Modern Physics*. See also Rowlands, *Physics: The Quest for Unification*. Original emphasis.) Moreover, as Rowlands adds, 'the universal law is an essential concept in physical

What further arguments are necessary to provide more support for this view accepted at least implicitly by the majority of physicists? Even the pure instrumentalist is unable to disagree because foundational physics has only ever proven most successful by seeking to unveil unification through symmetrical relationships, which have greater predictive power the more abstract and simpler they are. It is not necessarily the case that just any abstract, simple mathematical relationship must be true or more approximately true, but we can be sure that the greater the degree of approximate truth we may have discovered, the greater the degree of simplicity and abstraction of the mathematical law of physics. Harris states clearly what is required of philosophy if it is to be relevant to the sciences:

> Contemporary philosophy, to be in harmony with science, should expound a metaphysic holistic in type, and a logic of order, system and hierarchical structure. A pluralism devoid of any overarching principle of unity would be entirely out of keeping with the scientific trends, and an atomistic logic of propositions independently true or false would be irrelevant to physics.[497]

Harris is correct, except for two important caveats. First, while it is true that the sciences imply a hierarchical structure that requires an overarching principle of unity, he does not acknowledge that this metaphysics has been recognized and developed for millennia by the Platonists, or that the Platonic vision was vital to the development of modern science. Second, as previously mentioned, Harris sometimes seems to be arguing that this metaphysical view is *only* implied by the sciences instead of also being presupposed, which leaves open the possibility that further developments that apparently (and temporarily) seem to revert to a materialistic basis would then overthrow his metaphysics. As I have been arguing, not only is it true that modern physics (and the sciences in general[498]) imply this Platonic metaphysics, most significantly physics has

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unification, and it is its built-in component of inexhaustibility and infinite adaptability that provides the self-sustaining quality that is so recognisable a characteristic of Western physical science; but it was by no means an 'obvious' concept, and it is doubtful whether, without its prior existence as a component of mediaeval theology, the idea would ever have been discovered.' (Rowlands, *Physics: The Quest for Unification*.)

[497] Harris, 1983, p. 158.

[498] As Medawar notes, 'all the sciences that we judge to be mature have the kind of internal connectedness which Coleridge deplored the absence of in zoology. This kind of connectedness, or holding-together-ness, gives the sciences great stability and power to assimilate more information.' (Medawar, 1984, p. 4.)

had to *presuppose* its truth in order to make fundamental progress in understanding and developments. I am arguing that this holistic metaphysics must be true for physics to be possible.[499] Perhaps Harris would also agree.

For example, a foundational assumption for Newton, and subsequently for all of science, is that physical laws are universal. This assumption holds in every science, even in quantum theory, for whatever happens at the micro level is assumed always to happen at the micro level in different experimental and natural situations. The statistical laws of quantum theory apply universally, at least at the micro level, possibly at the macro, but probably require a deeper theoretical structure to accommodate both. It is true that there seems to be a discrepancy between the micro and the macro, but the two ultimately must come together in some way in our theoretical understanding. Indeed, it makes no sense to maintain that there is a *real* discontinuity between the micro and macro, an unbridgeable disunity, because in actual physical reality there cannot be such a dichotomy. In actuality the macro is made of the micro and both continuously interact with one another. Macro technology allows us to penetrate into the micro, which is only possible if the micro and macro are somehow connected, if they are in some way always unified.[500] There is no disunity in reality between the micro and the macro. The problem is due to our inability to discover and articulate a more accurate theory that binds the two realms together in our thought.

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[499] Even terms such as 'holistic', 'organic', 'oneness', and 'illumination' are rooted in Neoplatonism. (Siorvanes, 1996.)

[500] Cf. Heisenberg cites Bohr as saying: '...we don't know where to draw the line between small and large objects' (Heisenberg, 1971, p. 107), but, despite this epistemological limitation, Norris notes that Bohr maintained the ontological belief that 'that there *must* be some cut-off point on the micro-to-macro scale at which quantum effects such as superposition or wave/particle dualism gave way to determinate (classically decidable) states such as position, momentum, or – *pace* van Fraassen – the physical necessity that a lump of enriched uranium will either explode or not explode depending on whether its compacted volume has reached critical mass.' (Norris, 2002-A, p. 41.) However, Bohr seems to have thought that quantum theory does indeed apply to the entire universe but that quantum effects for macro-object events are so minimal that they can be ignored and still permit highly accurate predictions, and it is only here on the macro-scale that pictorial representation can sometimes be useful as approximation. (Bohr, 1963, p. 2.) Moreover, if quantum physics does apply to the entire universe, and if, as von Neumann argued, physical manifestation requires a consciousness to collapse the wave function, then clearly a primordial, immaterial consciousness must have ontological priority to, and be responsible for, the collapse of the wave function for the entire universe, which is Goswami's (1993) basic argument.

But such talk about wholeness, unity, the One, metaphysical hierarchical structure and so on has received a horribly bad press through concerted misrepresentation of the Platonic tradition,[501] despite an growing amount of recent relevant scholarship. The Neoplatonists (who were simply Platonists) have been unfairly criticised often enough, where Plotinus, for example, is supposed to have used language that is too mystical in flavour and Proclus too analytical.[502] Such obvious contradictions reveal basic human prejudices, which will ultimately have causes that we cannot examine here. The fact is that Platonic metaphysics is presupposed by physics, whether classical, relativity (neo-classical), or quantum, in the most essential and foundational way. Indeed, as Goswami argues, quantum theory needs to be reformulated and understood according to the demands of Platonism.[503] If quantum theory is 'deeply mysterious', it is an even greater mystery as to why the majority of contemporary philosophers have ignored the Platonic tradition and why some philosophers feel compelled to take the absurd and self-vitiating position that argues *against* unity.

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[501] For example, see Arieti & Wilson, 2003.
[502] Proclus has also often been criticised for being only a systematizer rather than an original thinker. This claim is as false as it is hypocritical. Indeed, those who accuse Proclus of unoriginality tend to be merely commentators on commentators of commentators of ancient 'commentators'.
[503] Goswami, 1993, p. 57, 61. Goswami calls Platonism 'monistic idealism' and he is not wrong in doing so as Whittaker (1928) also refers to Plotinus' system as being 'immaterialist monism', which, as I have already shown, is ancient idealism that is really extreme realism.

The Unity of Disunity

Steve Clarke (not to be confused with Stephen Clark) quotes Nancy Cartwright: 'nature is complex through and through; even at the level of fundamental theory, simplicity is gained only at the cost of misrepresentation.'[504] Cartwright seems to confuse the idea of difficulty with complexity, and facility with simplicity. To use Clarke's example, understanding that $E = cp$ is equivalent to $E = c\sqrt{m_o^2c^2 + p^2}$ when the rest mass equals zero requires only basic maths. However, understating the significance of this fact, which allows us to 'conclude that the relation between energy and momentum is the same for a plane electromagnetic wave as for a particle of zero rest mass', may not be so easy. But this simple mathematical relationship allows us to predict and unify a wide range of seemingly disparate phenomena. It is comparatively easy to see distinctive phenomena in the world: apparently animals can do so, as my cat can tell the difference between her bowl of food and a bath tub. There is great neurological complexity involved in the process of perception, but, nevertheless, creatures with rudimentary sensory apparatuses can distinguish between wide varieties of phenomena. To understand the underlying unity of these phenomena, and to be able to express this unity in mathematics or metaphysical propositions, is a different matter. Such intellectual work is not easy. Cartwright's worry seems to be that simple laws of physics do not represent with absolute accuracy the way things actually are in the physical world. As already noted, her worries are misplaced and she seems to misunderstand the nature of the relationship between ideal mathematical laws and measurements of the physical quantities. *All* measurements of anything are only ever approximations, as I have argued already. Moreover, even the very assumption or recognition of the fact that we have only approximations necessarily entails that there is some correct answer to which the approximation is compared; otherwise, we could never evoke the concept of approximation and must accept the absurd corollary that all measurements of X, no matter how great any discrepancy, are equally true. Of course, this conclusion follows from antirealism.

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[504] Cartwright in Clarke, 1998, p. 35. Gibbins also notes that 'Cartwright thinks of physics as factoidal, as less like logic and as more like drama documentary.' (Gibbins, 1989, p. 169, footnote.)

It was by seeking the ideal that modern science was born and it is what sustains modern physics.[505] What is the alternative? Should we simply have a colossal database of perpetually increasing tables of measurements of various phenomena without any semblance of connectedness between them? Again, as already noted, if such data collection is all that science amounted to, it would not be any science at all. Physics and all the sciences are guided by and seek to uncover unity. Cartwright and Clarke argue otherwise, rather ironically, especially since Cartwright apparently 'is concerned to describe the process of scientific explanation as it is practised rather than as it might ideally become.'[506] Well, *which* scientific practice? The practice of Bohr 'fanatically' trying to convince everyone that he is right; the metaphysical debates he had with Einstein; Planck's correct observation that we cannot prove empirically or logically the existence of an external world though we must have 'Faith' that it really does exist? To reiterate, there is the *everyday* practice of science, where we have to take measurements, build machines, clean test tubes and so on, and then there is fundamental or theoretical science that attempts to guide the way for the experimentalist and bring understanding to what we are measuring and observing, which allows us to make accurate predictions about novel phenomena, especially phenomena that we may not be able to observe or measure directly. And then we have *pioneering* fundamental science. The scientific pioneers are a different breed of scientist altogether. It is this group of physicists that I have been mostly concerned with in this thesis, because without them science would evaporate.

Since Cartwright and Clarke think we should take heed of how science is practiced, and since science would be impossible without the pioneers, then we should consider carefully how they did science and what they believed about what they were doing. Of course, they all believed in the unity of the laws of nature. However, Clarke writes that

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[505] Cf. Koyré: 'Perfection is not of this world: no doubt we can approach it, but we cannot attain it. Between empirical fact and theoretical concept there remains, a will always remain, a gap that cannot be bridged. That is where imagination appears on the scene. It cheerfully closes the gap. It is not embarrassed by the limitations imposed upon us by reality. It 'achieves' the ideal, even the impossible. It operates by means of theoretically perfect concepts, and these are the very concepts that are brought into play by the imaginary experiment. The part played is thus the intermediate between the mathematical and the real.' (Koyré,1968-B, p. 45.)

[506] Clarke, 1998, p. 35.

'for a long time scientists have shown us how to make do without the presumption that the world is unified. It is time for philosophers to follow their lead.'[507] The claim that scientists have shown us how to 'make do' without the implied assumption of unity is emphatically false. *What* scientists? We are never told. Without those who can uncover the unity between the phenomena, science would reach its end. Even the self-proclaimed positivist Hawking[508] seeks mathematical equations and laws that unify his observations in ways that allow him to make predictions. Sometimes the example of the discrepancy between relativity and quantum theory is used to convey the feeling that physics can get by without unity, but this rhetorical claim also confuses epistemology and ontology. *Our* limitations create the confusion between the two theories, but nature does what it does and does it perfectly well and so there cannot be any disunity in reality. The apparent disunity is in our own theories not in nature, and it is this disunity that drives physics forward in its search for clarifying the underlying unity. Remove the notions of unity, harmony, and symmetry from physics, and the discipline would no longer exist.

What Clarke and Cartwright confuse is the necessity of there being an underlying and pervasive unity with our over-eagerness to assume that we have found exactly what that unity is. It is true that we must remain open about what the underlying order is or how best to express it, but we cannot deny order or unity without immediately running into self-contradiction. Furthermore, Clarke has written that scientists *qua* scientists 'do not make metaphysical presumptions about the content of the world,'[509] but, again, this remark is patently false. It is precisely in the capacity of being scientists that they *must* make metaphysical presuppositions because they are not generally in the business of explicitly doing metaphysics, which I have already discussed in detail in Chapter Three.

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[507] Clarke, 1998, p. 122.

[508] Hawking in Penrose: 'Basically, [Penrose is] a Platonist believing that there's a unique world of ideas that describes a unique physical reality. I, on the other hand, am a positivist who believes that physical theories are just mathematical models we construct, and that it is meaningless to ask if they correspond to reality, just whether they predict observations.' (Hawking in Penrose, 1997, 169.) But either our observations are of nothing, or something that is an illusion, or of something that is reality (more or less). Our observations cannot be of pure nothingness so must be of something. If they are of something that is pure illusion, then scientists are wasting their time trying to predict observations of an illusion. It makes most sense to say that we are trying to predict observations of certain aspects of reality, and then it is entirely appropriate to ask about the relationship between observations, theory, and reality underlying our partial observations.

[509] Clarke, 1998, p. 122.

Cartwright and Clarke are simply being antirealists, and, more colloquially but just as aptly, unrealistic. They have seriously misrepresented the views of most scientists, and especially of the pioneers, upon whom all physics depends.

Eternal Laws of Physics

In order to address the fundamental question that concerns us here, I have no choice but to ignore the subtle differences between laws, theories, and equations. For example, there is the law of conservation of energy,[510] a theory such as quantum theory, which is comprised of various and sometimes apparently conflicting components, and equations such as $E = mc^2$ or the Heisenberg Uncertainty relations $\Delta p_x \, \Delta x \geq \hbar / 2$. It is easy to get lost in the details of analyzing any specific law, theory, or equation, but what I am going to do here is to provide an abstract analysis of their fundamental nature in so far as concerns whether they have eternal and unchanging ontological reality or are simply human constructs. I will argue that we actually discover laws, theories, and equations, which implies that they must have *prior* existence or being. For simplicity, I will refer to all the above as laws, for in an important sense they are: if they are true (at least within their applicable domains) then they cannot be broken and so deserve to be called natural laws.

Physicists themselves are not consistent in clarifying exactly what they mean by a law. For example, the conservation laws seem to be more akin to metaphysical principles, for it is not possible even in principle ever to verify whether or not the law of conservation of energy is valid throughout the entire universe unless someone measures every bit of energy in the entire universe simultaneously, including the energy of the measuring apparatus and the experimenter. But it is still a fundamental law that acts as a light in the dark when encountering new or previously inexplicable experimental or natural phenomena. Moreover, as Rowlands, Taylor, Einstein and many others have shown us, physicists must assume the prior reality of the principles of symmetry, abstractness, simplicity and, ultimately, absolute unity, but such notions are metaphysical in nature although they are the driving force and fundamental assumptions of the mathematical

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[510] The four Conservation Laws are the foundations of physics (Newtonian, relativity, and quantum)

1) Conservation of momentum
2) Conservation of angular momentum
3) Conservation of energy
4) Conservation of charge

From private correspondence with physicist Nick Blanchard, 2004. And as Houlden (2006) emphasizes, 'The whole entangled system [of nonlocally correlated particles] must also obey the same conservation laws.'

laws that must obey them. Thus, to repeat for clarity, we can argue about what exactly are the differences between a mathematical or metaphysical law, or a physical theory, even though there appears to more similarity than dissimilarity, but arguing about their distinguishing details seems to be irrelevant if they are all just fictions. Here I want to argue that they *all* must have ontological priority over the physical universe, which is the only option that can both make sense of the success of physics and accommodate realist assumptions. I am here using the phrase 'natural law' (symbolised as 'L' or 'L_1' etc.) to refer to all the above, which unify and connect the symbolic relations in the equations and fundamental metaphysical principles of physics, and therefore dictate the behaviour of physical phenomena.

The only way in which phenomena may appear to violate law L_1 is if in fact there is a deeper more abstract and pervasive law L_2 that accommodates L_1 and explains the behaviour of the phenomena that L_1 could not. Classical physics is an example of a special limiting case that is embraced within the deeper, more abstract and powerful quantum theory. Classical physics is not wrong, as is sometimes falsely assumed by non-specialists.[511] It is just less accurate than quantum theory and cannot be applied in the subatomic realm, which is beyond its limitations, but the very nature of the sciences is to seek that which is deeper and more unifying, and so quantum theory too must eventually be superseded. If it is not, then our science will stagnate. Based on what is already known we will be able to innovate for quite some time yet, but sooner or later our innovative capacity will run dry so we will need to go much deeper than we can presently even imagine. For example, classical physics permitted and still permits to some degree variously applied innovations, but until the insights of Planck sparked quantum theory, much of the technological wizardry that we take for granted today could never have come to be.

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[511] And relativity theory still demands absoluteness: 'It is a common mistake to suppose that Einstein's theory of relativity asserts that everything is relative. Actually it says: 'There are absolute things in the world but you must look deeply for them. The things that present themselves to your notice are for the most part relative.' (Eddington, 1935, p. 34.)

Given any law of physics L, either it is something that is discovered or invented or somehow a mix of both. If it is purely invented, then either in principle there can be an infinite number of equally good Laws L_1-∞ or some L are better than others, where 'better' at minimum means more useful because producing desired results, but ultimately 'better' entails 'more approximately true'. The first problem that arises here may be made clear through the well known duck/rabbit example. A picture may be drawn whereby it looks like a duck from one perspective or a rabbit from another perspective.[512] Kuhn argues that 'what were ducks in the scientist's world before the revolution are rabbits afterwards.'[513] The antirealist claims that because there are two equally valid ways of perceiving the picture, then there cannot be one correct way of seeing the picture, and therefore there is *no* correct way, and therefore realism is incorrect. This argument is also the essence of the challenge of underdetermination, and my reply equally applies to both.

The (apparent) problem of underdetermination results from recognizing two or more competing theories that appear to explain the phenomena equally well. A good example in the history of science concerns Ptolemy's and Copernicus' astronomical theories. Copernicus' revival of Aristarchus of Samos' [c. 310-230 BCE] heliocentric view was no more successful at prediction than the epicycles of Ptolemy.[514] What prompted the acceptance of Copernicus' system, against theological and scientific objections, was that the Copernican view '*threw the facts of astronomy into a simpler and more harmonious*

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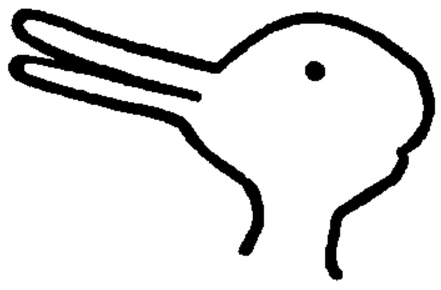

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513 Kuhn, 1970, p. 111.

514 See Harris, 2000, p. 15. Actually, 'Ptolemy used three basic constructions, the eccentric, the epicycle, and the equant.' (Rice University, 'The Galileo Project'.)

mathematical order.'[515] My reply to both Kuhn and those who believe that apparent underdetermination overthrows realism is quite simple but sufficient.[516] Just because two or more theories may appear to explain observations equally well, it does not follow, as the antirealist would have it, that, therefore, no theory can ever be true. We simply may not yet have enough data to decide. The claim that there is *no* true theory is more ontologically speculative than the realist's belief that there *are* true theories. The realist's belief is at least inductively grounded upon past historical successes in the sciences, where a succeeding theory explains all the data accounted for by the prior theory and more with greater accuracy, simplicity, and unifying power.

It may be helpful to offer a further example related to the duck/rabbit. The argument against realism fails as soon as I exclaim that I do not see a duck or rabbit but, rather, I see an elephant, or a whole circus, or my grandmother's shoes. If the antirealist admits that my perspective is just as 'valid' or just as 'true' as any other view, then full-blown relativism has thrown us into incomprehensibility and the success of science is now either a perpetual miracle or due to magic. I make such a claim confidently because if literally anything goes, if there are no constraints *whatsoever*, then anything should be possible, including the possibility of my turning the earth into a baseball and throwing it across the universe. I will not pursue this absurd line of thought because most antirealists (inconsistently) would not admit to this being a real possibility, and certainly no scientist *qua* scientist believes such an absurd suggestion. However, what antirealists miss is that placing *any* constraints *whatsoever* either amounts to magical tyranny or to realism—there is no other choice. This strong claim is justified in the following way. First, if there are any constraints whatsoever, then either those constraints are human-independent constraints that are real constraints placed upon us whether we like them or not, or the constraints are simply inherent to the logical implications of our randomly accepted axioms, or some (or at least one) of us are able to impose our will upon the entire

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[515] Burtt, 1925, p. 26. Original emphasis. Although Clark has stated to me that 'Copernicus had at least as many epicycles as Ptolemy.'

[516] Various analytic philosophers have contributed to the debate surrounding underdetermination and realism; however, I do not wish to enter into the obtuse details of such debates for my own argument is enough to vindicate realism and allow us to move on to other issues. For a realist defence concerning underdetermination, see Boyd, 1973; apparently realist, Laudan and Leplin, 1991; antirealist, Douven, 2000; apparently antirealist, Hoefer and Rosenberg, 1994.

universe. I will set aside the last alternative because no antirealist that I know of has yet to test this claim by jumping out of a window of a thirty-storey building and changing the law of gravity so that he does not fall. They do test their realist faith, however, every time they fly in a plane or believe that their child exists when they are not looking at her.

If the first case is accepted, where there are real human-independent constraints, then we are realists. The second possibility, however, is more subtle. In the case of the duck/rabbit picture, if I really believe that I see an elephant then the rest of the world either has to redefine what they mean by elephant to match the pattern of lines drawn on the page, and redefine what they mean by ducks and rabbits to have some other meaning, or they have to say that I cannot literally see an elephant. Metaphorically or symbolically it may be possible, and such a metaphorical or symbolic perspective may be inspirational and meaningful, but I cannot *literally* see an elephant or anything else except a duck or a rabbit (unless we walk into full-blown relativism). The same is true with physics, where it is sometimes assumed that underdetermination undercuts realism, but even if more than one theory could possibly explain and predict the same results, it does not follow, and is not believed to follow by any physicist, that *any haphazard theory whatsoever* could have equal predictive and explanatory success. Hence, there are constraints placed upon us by the way things are, and the way things are is independent of our beliefs and actions, and so realism is true. Given that there are constraints, then some L are better than others, which is tantamount to saying that the better law somehow or other more closely corresponds to the way things really are.

L_1 and L_2 may explain the data equally well but $L_{3-\infty}$ are meaningless at least for the reason that they are useless because they give us no practical results. (However, some of these other laws may in fact be true or more accurate than L_1 or L_2 even if we do not yet know them.) But to the degree that L_1 and L_2 provide useful results, the reason can only be because they most closely match the way things are in some way.[517] Perhaps the

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[517] One may wish to imagine an absurdly contradictory, patently false theory that still (somehow) allows us to make accurate predictions of relevant physical phenomena, but even such an imaginative case would not harm the realist position. On the contrary, such a theory could only be considered false or absurd if there were some objective truth of the matter about which the theory is mistaken.

discrepancy between L_1 and L_2 is simply the fact that we have not yet found L_p, the law prior to L_1 and L_2 that is more accurate and unifies them both. But it still may not be possible to know absolutely that L_1, L_2, or the more unifying L_p is in fact the most accurate description of reality. But regardless, the laws of physics cannot simply be inventions, social constructions, or due to the whims of pure chance. Even Dawkins and Hume admit that ultimately chance is ruled out.[518]

In the end, if absolute or pure chance is permitted, then there is no way to assume that the laws of physics remain constant for longer than any moment, and thus it would be only by an absolute miracle that the laws of physics remain constant so that we can do science and indeed so that anything can exist at all for any length of time. Faith in an intelligible First Cause is far more rational than believing that by pure randomness or absolute chance the universe is actually ordered, unified, consistent, and not absolutely random or a perpetual succession of pure chance.

Now, it could also be argued that the laws of physics actually evolve or simply change over time even if such changes could only be perceived by a creature who existed for a billion years. Somewhat surprisingly, Smolin tries to make this argument. In a different article, he argued that physicists need to think much more philosophically, especially at the foundational level, and that deeper developments are stagnating because of the general antifoundational stance of much of the physics community, despite their admitting to the necessity of philosophy.

> It was felt that while a philosophical approach may have been necessary to invent quantum theory and relativity, thereafter the need was for physicists who could work pragmatically, ignore the foundational problems, accept quantum mechanics as given, and go on to use it.[519]

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[518] Hume claims that the apparent connection between our correspondent impressions and ideas shows that 'such a constant conjunction, in such an infinite number of instances, can never arise from chance' (Hume, 1978, p. 4.) And Dawkins admits that the notion of chance is 'just a word expressing ignorance. It means 'determined by some as yet unknown, or unspecified, means' (Dawkins, 1989, p. 218).

[519] Smolin, 2006-A.

Smolin is correct, which is why I was surprised to read his other recent article that belittled the role of philosophy while trying to use philosophy to argue that the laws of physics change.[520] The only point I will consider here is his claim that the laws of physics evolve according to 'cosmological natural selection'. He briefly notes the 'obvious' but nonetheless devastating objection that 'even if a law turns out to evolve in time, there is always a deeper, unchanging law behind that evolution.'[521] Again, quite astonishingly, he *does not respond to the objection* but instead immediately moves on to another topic. On his behalf, however, I will consider a possible version of the changing laws position, but his desire to subject the laws of physics to biological evolution has the whole process backwards, and is ruled out by the assumptions of modern biophysical chemistry.[522] While in some contexts it may be possible to find a way of extending natural selection beyond the biological realm, nevertheless, physics is more fundamental than biology and claiming that the laws of physics follow biology is as if the proverbial tail wagged the dog.[523]

There are really only two options: either the evolution of the laws of physics is governed by some further law (or laws) or it is not. If it is not, then it is only by chance that the laws evolve in the extraordinarily precise way that they do, which again is akin to accepting moment-to-moment miracles keeping the universe in order, with no guarantee that the miracle will continue.[524] Or we must accept that the ultimate laws that govern the

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[520] See Smolin, 2006-B.
[521] Smolin, 2006-B, p. 33.
[522] Recall Bergethon, 1998.
[523] During Smolin's keynote address at the British Society for the Philosophy of Science Annual Conference, University of Kent at Canterbury, July 8-9, 2004, I asked him about the status of the laws of physics, about whether or not he believed that physicists are discovering laws or merely inventing them. Of course he answered that they are discovering them. Then I asked him to tell where they are and how they could have dictated the fate of the universe if they did not exist until after the universe had already started unfolding. If before, then where are they (and were they) and were (and are) they susceptible to change, and how did (and do) they relate to the physical universe? It is interesting that two years later he publishes an article on this topic and, in much the same way that he evaded answering the objections in his article he also avoided answering me by throwing his hands in the air and saying 'I don't know, I'm just a working man!' We all laughed, but my questioned slipped away into the darkness, perhaps from fear of facing these metaphysical difficulties.
[524] It is interesting that Charles Babbage noted that the apparent change in the order of the sequence of the numbers being generated by his Difference Engine were simply due to deeper laws implicit since the commencement that we may at present have no way of knowing or foreseeing. He also thought that some similar scenario has been unfolding in the fossil record. (See Babbage, 1838.)

evolution of lesser laws are actually eternal and unchanging. This conclusion seems unavoidable because if they change then either there is or is not a law guiding their changes. If not, then pure chance is the guide (which is no guide at all and would make all meaningful predictions impossible) and we have to say that only by pure chance the laws act as if they were not ruled by pure chance, which is absurd or miraculous. Or, the changing laws are ultimately guided by deeper unchanging laws. Only God's continuous interference with the universe could make sense of an ordered universe existing by pure chance, but if it were God's will then it would not be by chance after all.

If absolute chance is not a rational option, then there must be some sort of unifying order to account for the systematic harmony of the laws of physics. Recall Pauli's point that there is no logical way to link our concepts with sense perceptions and that the only way to understand this link satisfactorily is to postulate 'a cosmic order independent of our choice and distinct from the world of phenomena.' Given that there are real constraints upon us, it seems most reasonable to conclude that we cannot merely be inventing natural laws; we must actually be discovering them in some way.

We are unveiling laws, whether statistical or strictly determined, to ever closer degrees of accuracy to the ideal.[525] We invent the symbols but not the relationships between the symbols, and, even if we do invent such relationships in the sense that our limited cognitive abilities and idiosyncratic insights allow us to conceive of only one particular limited perspective, it would still be the case, as I have argued, that such 'invented' laws must correspond to some appreciable degree to the way reality actually is, or else the invented 'law' will be useless because it will not be a law at all. But, to the degree that any possibly 'invented' law corresponds to the way things actually are, then it is not

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[525] I am not here concerned with whether or not we are in a virtual reality controlled by aliens or in a dream-world created by an evil genius, or even with a universe with God because there would still be constraints placed upon us, constraints that are independent of human beliefs, and if we wish to succeed in (or escape) the virtual reality that we may be trapped in, then we had better figure out the rules as best as possible. Nick Bostrom (2003) provides interesting reasons for believing that we are all currently living in a computer simulation. But even if that were true, some creature had to write the program and build the computer, which has to exist somewhere (which is an obvious objection against Tipler's argument about virtual resurrection). And these points presuppose that other things exist, which all must have constraints or conditions imposed upon them. Realism is true even if we are nothing but ones and zeros projected into cyberspace.

really invented because the nature of reality is already such that it is abiding by the law that we may believe that we have invented. I can invent a light bulb and innovate a great variety of different bulbs, but they work only when I am following the laws of physics. Similarly, I can walk, drive, run, sail, or fly anywhere on earth I choose (or even to other planets), but at all times I have no choice but to obey the external constraints of physical laws. Thus, in the end, we have to be discovering the laws of physics, and all other options are incoherent.

What is important now, given that we know that the laws cannot be fictions but must be real, is to establish whether the laws of physics are ontologically prior to the phenomena or arise from or after the interactions of the phenomena. Despite its obvious shortcomings, the following analogy may be helpful. Imagine trying to play a game with three other people where each person gets a random number of chestnuts. Then you turn to one of the participants and say, 'okay, let's play!' But we cannot just start playing because we have no idea (literally there is no idea) about how to play. There are no rules to tell us what to do. Should I put a chestnut forward (perhaps as if making a bet) and if so, then what should my opponent (partner) do? What if I decide to go first and throw a chestnut over my shoulder, what should the others do? It seems rather obvious that in order to play, there must first be a set of rules about how to play, which means that the rules are necessarily ontologically and conceptually prior to the interactions that arise in the playing of the game. Analogously, the rules of the behaviour of all the phenomena in the universe must, in order to rule out absolute chance, be the sort of rules which literally dictate how the phenomena will behave.

One could object that we could make up the rules as we go along, and so there would seem to be no need to have ontologically prior rules. She could say that if she puts a chestnut on the table then that means that I must either dance the tango or hit myself in the nose, but if she puts two pieces down then I must tell some secret about myself. I could agree and add that, therefore, the object of the game is to gather as much secret information about each other as possible. She could object and say that we should really try to embarrass each other by making the other person dance the tango or get black eyes

from hitting ourselves in the nose. I am using this silly example to make the point that even if we start to invent the rules rather than receiving already designed rules, we still cannot do anything until we have decided upon rules to guide our behaviour; we cannot make any sense of anything (and not even have constant conjunctions) if we just keep randomly throwing chestnuts followed by totally random acts. Even if we allow for the possibility of making up rules as we go along, we would still need conceptually prior implicit rules for how to go about making and agreeing upon subsequent rules, such as the rules of grammar and logic. Thus, fundamentally we cannot begin without prior rules. Of course, this analogy is limited in many ways, but I hope that it is illustrative nonetheless.

Those who hold that the laws of physics are nothing but 'convenient' abstractions that are mere fictions must admit that they have no explanations for why things are as the way they are, or behave the way they behave. (And, as Rowlands says, there is nothing at all 'convenient' about abstract mathematics.) They can only say that things behave the way they do because things behave the way they do. Only if there are real constraints given by real laws of physics that impose themselves upon the phenomena (and so must be prior to and distinct from the phenomena yet intimately interconnected with them) could we be justified rationally in believing that the past behaviour of phenomena will be the same in the future. Similar conditions yield similar results only if there are real constraints and rules which dictate the behaviour of phenomena.[526] The very fact that a law can be deduced or discovered in a closed system and then used to predict the behaviour of completely different phenomena in another closed system or in the open system of the rest of the universe is good enough reason to believe that the phenomena in both systems is obeying the same law. If the laws were mere descriptions of events that happened by

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[526] Morris: 'It appears, therefore, that we exist in a very improbable kind of universe, one that was fine-tuned to an accuracy of one part in 10^{15} at a time of one second after the big bang. In fact, this fine-tuning was even greater at earlier times. At some point, when the universe was only a fraction of a second old, it would have been not one part in 10^{15}, but one part in 10^{50}. If this fine-tuning had not taken place, we would not exist.' (Morris, 1990, p. 53.) 'Turtles all the way down' makes more sense than saying that by pure chance the universe is highly (if not absolutely) ordered. As Morris continues: 'Scientists distrust coincidences. When they find that a number is that close to a critical value, they are generally unwilling to believe this could have happened by chance. They are not satisfied until they find a reason for why the fine-tuning should be that exact.' (Morris, 1990, p. 54)

chance, there would be no good reason for supposing that the same descriptive law would hold equally well with other phenomena in different systems. In other words, science would not be possible.

Thus, it is at least plausible to claim that the universe began the way it did because it has followed the laws of physics, and these laws of physics, therefore, must pre-exist the physical universe. They could not exist (or have being) after the creation of the universe because then the universe would not follow them because the universe would have already started to act in some way without the laws, which would be to act according to absolute chance, an option that we have already ruled out. The laws could also not arise simultaneously with the big bang (or however the universe 'began') for the analogous reason given above concerning the silly game with chestnuts. If the laws arose simultaneously with or after the beginning of the universe, then the beginning of the universe and its way of unfolding would have been by pure chance. The point is that the laws must be prior to physical reality. And, since these laws cannot change then they certainly cannot be physical because everything physical in space and time is susceptible to change. Thus, these laws are ideal, and due to their productive and unchanging nature they must be considered as being more real than the physical phenomena that obey them.

Mathematical Platonism

In Chapter Five I briefly discussed how Maddy tried to account for mathematical objects by adhering to the antirealist position she called thin realism and I suggested that any rejection of the reality of mathematical objects and their relations is a rejection of the laws of physics and all accompanying natural laws of the sciences in general. It is not reasonable to say *both* that the sciences give us some sort of facts about the world *and* that mathematics ultimately amounts to a fictitious human convention because, in the end, the sciences are dependent upon mathematics. If the sciences point to something true about the world, then so do the relevant mathematical relations. One may pretend to hold a Rorty-like belief that science is no more a matter of fact than literary fiction, but I have already criticised this view. And Mark Balaguer's claim that there are no good arguments for or against mathematical Platonism is merely a revelation of his inability to think of a good argument,[527] so I will here give a concise but plausible argument in favour of mathematical Platonism.

P1) Appropriate aspects of mathematics are applied successfully in the sciences to control and predict (to a limited extent) physical reality.[528]

P2) Mathematical objects and their relations have no physical reality (i.e. you cannot locate *one* itself or any mathematical relations as such).

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[527] I am not going to discuss Balaguer's *Platonism and Anti-Platonism in Mathematics* (1998) beyond a few points given immediately below because I think his book is fundamentally flawed and it ignores essential relevant concepts of modern physics. 'The central viewpoint that I am trying to motivate in this book is that we don't have any sound arguments for or against Platonism, let *alone* the necessity or impossibility of that view.' (Balaguer, 1998, p. 167.) Well, there are no sound arguments for or against Balaguer's arguments that there are no sound arguments for or against Platonism in mathematics, and so on is own terms there can be no fact of the matter about his arguments. As I have written elsewhere (Spencer, 2007-A), Balaguer's claim is in principle no different than someone arm wrestling with himself and being unable to win or lose claiming that there are no facts of the matter about winning or losing.

[528] Rowlands, for example, believes that the physical world just is mathematical, so it is not really correct to say that mathematics is applied. But his Pythagorean/Platonism is little understood by most contemporaries and could be seen as question-begging. Therefore, I am starting with the initial and incontrovertible assumption as given in P1. Cf. Laszlo: 'The world, said Heisenberg, is built as a mathematical, and not as a material, structure. In consequence, there is no use asking to what the questions of mathematical physics refer—they do not refer to anything beyond themselves.' (Laszlo, 2004-A, p. 72.) This claim may seem antirealist, but it is really the Pythagorean/Platonic notion that all physical reality is mathematical.

P3) Given (P2) Either mathematics, in the extreme cases

a) has substantial Being beyond the physical (i.e. always being just what it is without change)

or

b) is nothing but a constructed fiction.

P4) If we accept (P3b) then we must conclude that either

a) the sciences are based on pure fiction and need not match reality (so the sciences should be subsumed under the Department of Literature)

or

b) some fictions match reality and others do not.

P5) If we accept (P4a) then, beyond evoking magic or the arbitrary and unpredictable whims of God (or the Gods), we cannot account for why, for example, $E = mc^2$ works but my random equation $E = mc^3 + 2$ does not.

P6) The demands for explanation in (P5) are impossible to achieve without resorting to absolutely pure chance, which would make science impossible.

P7) Science is not impossible, therefore, (P4a) must be false.

P8) If we accept (P4b) then this presupposes that there is a reality, a way things are, that is independent of us and cannot change and thus must always be just what it is (because if mathematical relations match reality in some way, and mathematical relations do not change, as argued above against Smolin and elsewhere throughout the thesis, then *a fortiori* the reality that they represent cannot change).

P9) (P8) reduces metaphysically to a similar assertion as (P3a).

P10) It is a fact that if mathematical equations could be valid one moment but not the next, then we could not rely on them in any way whatsoever.

P11) Given (P1), we can rely on mathematical equations to remain valid, within their inherent limitations.

P12) (P11) entails that valid mathematical equations are always valid, metaphysically reducing to always being just what they are.

C) Given (P9) and (P12), (P3a) must be true, or at least is much more likely to be true than (P3b), so it is more reasonable to be a mathematical Platonist than any other option.

As can be seen, we must either accept or reject the claim that the sciences when correctly practised (i.e. not fraudulently) can inform us of certain true albeit limited aspects of reality. If we reject this claim, then there is not much I can say except that perhaps those who pretend to maintain this scepticism should stop using their computer, travelling in planes, and stop depending on the rotation of the earth, etc. But, as most of us readily admit, science does attune us to certain truths about reality (although not the only truths and often not the most important ones), and since mathematics is an inextricably foundational aspect of the sciences, then an account of mathematics is necessary. But that is not the highest realm, as I discuss briefly in the next section.[529] Eugene Wigner noted that our ability to use mathematics may be a 'miracle,'[530] and unless something very much like Platonic realism is correct, then it seems quite impossible to account for how often the mathematics is already waiting for the physicists to discover some way of using it.[531]

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[529] Penrose also argues for the necessity of the 'Platonic world of mathematical forms' (Penrose, 2004, pp. 12-17) in a way that would have made Proclus proud.
[530] Wigner, 1960.
[531] 'It is remarkable that just as Einstein found ready prepared by the mathematicians the Tensor Calculus which he needed for developing his great theory of gravitation, so the quantum physicists found ready for them an extensive action-theory of dynamics without which they could not have made headway.' (Eddington, 1935, p. 180.) And sometimes physicists develop the mathematics that they need, which then is applicable for the mathematicians.

The Role of the Observer

I find it extraordinarily hard to comprehend how we have been able to pretend for centuries that we— the observers, experimenters, and theoreticians—apparently can be excluded from the scientific enterprise while simultaneously believing that we are thus being objective and giving as full account as possible of whatever aspect of reality we are investigating. It is true, amazingly true, that we can still produce theoretic and practical feats while ignoring ourselves, as if we had no role to play and we mere mindless automatons following some program (that is often too easily assumed has no writer). But as soon as we begin to analyze rationally what is really happening in any experiment, then we cannot help but conclude that we are centre stage in the entire scientific drama. To the degree that we ignore this fact, to that very degree we are not being logically or rationally consistent.

Schrödinger and Eddington, among other physicists, have conspicuously accepted the importance of the self (or the observer) in physics. In essence, we act as the final measuring apparatus in any experiment. Contemporary physicist Shimon Malin writes:

> After all, scientific evidence is based on human experiences; the human mind is the ultimate measuring apparatus. Yet the nature of the Subject of Cognizance is never raised as a scientific issue! This is like using a telescope to investigate the heavens and never bothering to inquire what it is.[532]

Malin is not completely correct in one strict sense because the role of the observer has been raised as a scientific issue by some physicists and philosophers, but he is correct in general because many representatives of both disciplines do dismiss this question as being anti-scientific and therefore meaningless, which is mere positivism. But considering the role of the observer is neither meaningless nor anti-scientific. If we look

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[532] Malin, 2001, p. 230. Malin was clearly influenced by Schrödinger on this point, as I mention on page 232. Cf. Harris: 'Although the importance of observation was stressed by the scientists, no account was taken, or could be given, of the place of the observer in the scientific panorama. The observer was set apart from the scene that was being surveyed, a scene viewed from the outside, as it were, through a telescope or a microscope, or at least through the portals of the senses.' (Harris, 2000, p. 97.) But surely if empirical evidence is essential to the sciences, then observation is essential, which makes the observer essential. All this seems so obvious it feels silly having to stress it. But the point must be stressed because we have ignored ourselves in the scientific enterprise for centuries.

at stars through a telescope, we need to know how the instrument functions in order to be sure that we can rely upon it as means for discovery. Yet, although the physicist is the most fundamental instrument for all experiments and theorizing, we still generally believe that it is not necessary to know anything about our fundamental nature, which is tantamount to saying that we have no idea what a telescope is or how it works, and therefore have no way of knowing whether or not it is broken, and yet unquestioningly rely upon it to give us important empirical data. One could object that to a limited extent some psychologists, psychiatrists, and philosophers do aim to provide an explanation for what we humans are, yet seldom do we get fruitful collaboration, and when it does happen the work is usually ignored, as it has been with Pauli and Jung.

There is no consistent way to avoid including ourselves in our scientific descriptions. It does not follow that we must give a full (or even any) account of the self when conducting every (or even most) scientific studies, any more than a treatise on epistemological justification of the possibility of knowledge should be required before attempting to answer any and all questions. But when we enter into hazy conceptual territory, whether in the sciences or law and morality, it is often important to re-examine fundamental assumptions. For example, when psychologists boast arrogantly about the 'scientific fact' that imbecility is inherited and therefore forced sterilization requires legal sanction, as happen in the twentieth century in the United States,[533] then we need to demand a rational, consistent account of fundamental assumptions concerning mind, intelligence, human rights, etc. And when logic and science are supposed to be at odds with mysticism, then I would demand as full account as possible of all three terms. In the end, however, I cannot see any logically consistent alternative to Renee Weber's point:

> It is mysticism, not science, which pursues the Grand Unified Theory with ruthless logic – the one that includes the questioner within its answer. Although the scientist wants to unify everything in the one ultimate equation, he does not want to unify consistently, since he wants to leave himself outside of the equation. Of course, with the advent of quantum mechanics, that is far less possible than it was in classical physics.[534]

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[533] See Colman, 1987, p. 21.

[534] Weber in Radin, 1997, p. 273. Moreover, 'Berkeley, Hume, Kant, Fichte, Hegel, James, Bergson—are all united in one earnest attempt, the attempt to reinstate man with his high spiritual claims in a place of importance in the cosmic scheme.' (Burtt, 1925, p. 11.)

Norris has sometimes dismissed mystical intimations, and yet his own belief that we can gain access to nonphysical objective truths in both mathematics and morality is clearly something mystical, at least in the way I have been using the term throughout this thesis. However, it seems that Norris is objecting to the idea of the mystical in at least two ways. I will discuss the second way below, but the first concerns the dangers to intellectual development when preferring to leave some unanswered question as a dark mystery, and I certainly agree with him here. We must attempt to uncover and understand what we do not know, which Socrates fervently compelled and implored his fellow citizens to do. But the mystical aspect in another sense arises when we attempt to define exactly what we mean by any fundamental concept and when we investigate exactly what it is that we creatures are that are engaging in this endeavour. There is no concrete way to pin down the 'Subject of Cognizance'.[535] As Schrödinger says, 'the reason why our sentient, percipient and thinking ego is met nowhere within our scientific world picture can easily be indicated in seven words: because it is itself that world picture. It is identical with the whole and therefore cannot be contained in it as a part of it.'[536]

We are the subject of our own study, which induces insoluble paradoxes for the materialist because it is impossible for any material body to be self-cognizant, impossible to reflect upon itself. A rock cannot be aware of itself. As Proclus argues in propositions 15, 83, and 186, only nonphysical entities are capable of self-reflections, of uniting knower with known (an essential aspect of the wholeness of quantum theory), but I will discuss the immateriality of the observer shortly.[537] And this point is also connected to the second way Norris would seem to dismiss mysticism, specifically his conception of how Platonists must account for knowledge of nonphysical objective truths, which I will discuss shortly. For the moment, however, I wish to continue with my arguments for the importance of the observer.

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[535] Schrödinger uses the phrase 'Subject of Cognizance'. (Schrödinger, 1967, p. 127.) And Eddington discusses the same point but refers to the observer as 'Mr. X'. (Eddington, 1935, pp. 252-263.)
[536] Schrödinger, 1967, p. 138.
[537] Proclus, 1963, pp. 17, 77, 163. 'In Neo-Platonism, cause and effect, known and knower, are mutually implied.' (Siorvanes, 2000, p. 54).

Bohr claimed that 'the unambiguous account of proper quantum phenomena must, in principle, include a description of all relevant features of the experimental arrangement.'[538] But it seems an impossible task to give a completely *unambiguous* description of *all* relevant features. And who decides what is relevant or ambiguous? If anything is relevant, surely the observer who discovers or postulates or uses a theory, designs the experiments, and reads and interprets the results is most relevant. Take away the observer and there is no experiment.

We do not need to evoke the holistic nature of quantum theory to prove this point about the importance of the observer. We need only look at the role of the observer in relativity and Newtonian physics, as well as my metaphysical arguments presented above, where it is simply a logical inconsistency to exclude ourselves from what we are studying since we are the central aspect of the interconnected relations between all the relevant phenomena. In relativity, the observer is also of central importance for scientific reasons as well. As Harris states, relativity depends upon an act of thought—'the choice of a frame of reference.' Since the motion of an instrument or other body cannot be determined absolutely, then a conscious being must make a logically arbitrary choice that constructs boundaries for a frame of reference. Thought is necessary.[539] Harris then makes the unfortunate remark, however, that therefore 'physical fact is and can only be what thinking makes it.' It is true in one very qualified sense (if thinking is done by the Divine Mind) but also misleading as construed by the antirealist. The act of thought does divide up our perceptions, whether in the moment of making a measurement in physics or even simply looking at a tree. But my act of making a choice for a frame of reference that determines the physical theory-dependent fact in that particular instance, which is like a snapshot of a perpetually flowing, dynamically interconnected reality—the unbroken

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[538] Bohr, 1963, p. 4. He also writes that 'in atomic physics, where we are concerned with regularities of unsurpassed exactness, objective description can be achieved only by including in the account of the phenomena explicit reference to the experimental conditions, emphasizes in a novel manner the inseparability of knowledge and our possibilities of inquiry. We are here concerned with a general epistemological lesson illuminating our position in many other fields of human interest.' (Bohr, 1963, p. 12.) And, again, Bohr is correct that our knowledge of any experimental data is inextricably connected with the entire experimental arrangement, which must include ourselves, but it does not then mean that ontologically speaking there is no reality beyond our cognitive, perceptual, and theoretical limitations, as I have argued extensively throughout the thesis.

[539] Harris, 2000, p. 35.

wholeness suggested by Bohm—does not *create* reality. It merely determines which partial facts of reality will become accessible to me, but the reality itself is what it is, which is why experimental results are repeatable (at least to extraordinarily accurate approximate degrees).[540]

Another example comes from Newtonian physics because calculus is required, which, as is well known, was developed by both Newton and Leibniz. As Rowlands explains,

> to convert from relations involving rates of change [in calculus] to simple and direct relations between the original quantities (which is described as 'solving the equations'), one has to reduce the general equation to a particular case by imposing what are called 'boundary conditions' and this is essentially a process of approximation.... In effect, general and exact laws could not give us direct knowledge; to obtain the latter, we had to reduce the infinite number of possible solutions to a particular and individual case using some kind of approximation.[541]

First, the point about approximations strikes at the heart of Cartwright's harangue against the 'lying' physicists—there is no way to avoid approximation, but it does not follow that the laws are lies. It is the very fact that we have ideal laws that makes physics powerful by allowing us essentially unlimited potential applications. More importantly here, however, is that some conscious being is required to solve the equation, to impose boundary conditions, in order to accomplish any sort of practical knowledge or facts in physics. Thus, again, it is not merely the obvious (but still neglected) fact that we need some conscious being to exist in order for any knowledge to be possible, since knowing is inextricable from consciousness, but that the act of solving equations in the experimental process requires a conscious choice, a sentient observer. All that quantum physics has accomplished in this respect is that the extraordinarily high level of abstraction, intricacy of subatomic experiments, and unifying essence of the relations

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[540] Harris notes two further points in relation to the significance of the relation between theories and experiments. First, all quantitative measurements presuppose that a relevant question has been asked, which itself can only arise out a pre-existing body of scientific knowledge, all of which depends on conscious beings. (Harris, 2000, p. 88.) Second, in any situation the possible observable facts are essentially infinite and even if a tightly focused experiment is arranged there are still innumerable relevant facts, from which we must consciously select those that serve our purposes as best as possible, as various scientists, from Darwin to Einstein, have in principle agreed. (Harris, 2000, pp. 88-89.) All these points inevitably point to the fundamental role of the observer.

[541] Rowlands, *Physics: The Quest for Unification.*

between the experimenter and the experiment (or the observer and the observed) has made it much harder (indeed logically impossible) to deny the essential role of the conscious intentions and awareness of the observer. It does not follow that my intentions alone dictate the workings of any aspect of physical reality, but my intentions are still an intimate part of the scientific process. Again, I stress that what physicists seeks are those aspects of reality that are what they are independent of any sentient creature's intentions. But which aspects we see largely depends upon our own choices and creativity. When physicists started to acknowledge the holistic nature of quantum theory they often tended to abandon the notion of objectivity, which had falsely been associated with realism, and so we have another reason for the apparent rise of antirealism based on another false conflation of concepts.

However, Bohr and Heisenberg tried to overlook the rather obvious implications that the consciousness of an observer must also be taken into account, and tried to say that only measurements taken by some sort of appropriate instrument were necessary.[542] Schrödinger, however, makes the apt remark, which Malin built upon: 'for our organs of sense, after all, are a kind of instrument.'[543] Obviously they are a kind of instrument. We cannot have any scientific knowledge, theoretic or experimental, unless there are conscious minds capable of all that is required. However, the antirealist falsely extrapolates from these observations to the conclusion that the human mind *creates* all of reality, which I have already argued against in detail. But the realist cannot consistently ignore the fact that we—the humans who discover physical laws, devise theories, invent instruments, design the experiments, and read and interpret the resulting data—are one of the most relevant aspects of the entire scientific process. Nor is it logically or scientifically warranted to cast aside the role of consciousness, which is now a respected

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[542] Heisenberg cites Bohr as stating that 'Naturally, it still makes no difference whether the observer is a man, an animal or a piece of apparatus, but it is no longer possible to make predictions without reference to the observer or the means of observation.' (Heisenberg, 1971, p. 88) And Heisenberg claims that the 'transition from the 'possible' to the 'actual' takes places as soon as the interaction of the object with the measuring device, and thereby with the rest of the world, has come in to play; it is not connected with the act of registration of the result by the mind of the observer.' (Heisenberg, 1958-A, pp. 54-55.)

[543] Schrödinger, 1967, p. 18.

area of research.[544] Indeed, according to Geoffrey Chew and Bohm, consciousness and matter are part of an undivided whole.[545] And Baggott writes that von Neumann, who provided 'an unassailable mathematical foundation' for quantum theory and an approach to the interpretation of quantum measurements that 'shaped virtually all subsequent thinking on the subject'[546] carried the Copenhagen interpretation to its logical conclusion by claiming that the 'wave function collapses when it interacts with a consciousness.'[547] But if the machine or sentient creature making the measurement or observation is also susceptible to the same quantum laws, then they too will have been actualized by some other sentient creature or a machine, which in turn must have been susceptible to the same laws.

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[544] Recall Solso (2003). It seems impossible to prohibit humans from studying consciousness, as it is most fundamental and immediate to our experience, a point repeatedly emphasized by Eddington: 'All I would claim is that those who in the search for truth start from consciousness as a seat of self-knowledge with interests and responsibilities not confined to the material plane, are just as much facing the hard facts of experience as those who start from consciousness as a device for reading the indications of spectroscopes and micrometers.' (Eddington, 1935, p. 278.) Further, he writes that 'in comparing the certainty of things spiritual and things temporal, let us not forget this—Mind is the first and most direct thing in our experience; all else is remote inference.' (Eddington, 1929, p. 24.)

[545] Cromwell, 1997. As Eddington has also argued, we 'do not quite attain that thought of the unity of the whole which is essential to a complete theory' without understanding the relationship between the 'pointer readings' (or measurements), the physical laws, and the background behind such symbols with the isolated consciousness that also resides in that background. In other words, 'no complete view can be obtained so long as we separate our consciousness from the world of which it is a part.' (Eddington, 1935, p 317.)

[546] Baggott, 2004, p. 83.

[547] Baggott, 2004, p. 243.

Cf. Harris: 'What the measuring instrument registers, however, has meaning as a value only when (and as) read by the investigator. Hence observer and observed are united in the experimental result, which, according to Eugene Wigner, occurs only with the observer's consciousness of it. Thus matter and mind can no longer be treated as separate.' (Harris, 2000, p. 100.)

No Soul...No Science

I am acutely aware of the controversial territory I am entering in this last section, which is one reason I belaboured my (sometimes possibly trivial) arguments for the essential role of the observer—for us conscious, intelligent entities—in the scientific process. But we have not only belittled and tried to extricate ourselves in the seeking of objective scientific truths, we are even more likely to balk at any suggestion that *soul* has some role to play. But I am not afraid to use the word 'soul', which is also the root of psychology (*psyche* -ψυχη- meaning soul), and I am also in good scientific and philosophic company, as will be shown below. (If the word soul still sits uneasily, then simply substitute the word 'consciousness', 'self', or 'essential immaterial nature'.)

We must here consider aspects of Platonic metaphysics that can be perplexing for the contemporary reader who is not already deeply versed in this tradition, but I have argued extensively in the first half of the thesis for the importance of this sort of pure metaphysical reasoning. In no way are my arguments in this section less rational than my prior arguments, but the way of reasoning and the required terminology in pure metaphysics can be unfamiliar and so may appear to be more speculative. In one sense, I am engaging in more speculation, but on the other hand I am here providing in succinct form the Platonist conception of the cosmos that acts as the foundation for all realist beliefs. The only other option is to 'say nothing' in defence of the realist faith in the order, simplicity, and unity of the cosmos along with verification-transcendent truths and our epistemological access to them.

The difficulty here becomes evident when we begin to try to provide rational grounds of warrant for the deep questions we have looked at throughout the thesis because very quickly we end up engaging in pure metaphysics, which is easy to pretend has little to do with the practical applications of science. But, as I have been stressing, the only way to avoid pure metaphysics is to refuse to offer a rational justification for our starting assumptions, which is to reject philosophical inquiry and allow scientific dogmatism to set in and prevent deeper, progressive understanding of the cosmos and ourselves. It is time for pure metaphysics.

Schrödinger says, 'Jung is quite right', that [quoting Jung] 'All science (*Wissenschaft*) however is a function of the soul, in which all knowledge is rooted'.[548] One of the most important physicists in history claims that all of science is rooted in the soul, but, astoundingly, his remarks remain ignored, cast aside as if they were uttered by a mere eccentric who somehow or other had fallen off the cart of pristine rationality into the mystical mud of obscurity. The fact is, although we should try to do science as far as possible even if we cannot scientifically describe the soul, it is a mistake to claim that any reference to the soul is *anti*-scientific and, therefore, nonsense. Questions of the nature of the soul may indeed be *extra*-scientific in the sense that we must go beyond the bounds of *everyday* scientific inquiry, but that does not make them anti-scientific or somehow inferior to the sciences. Schrödinger makes the following point:

> I consider science an integrating part of our endeavour to answer the one great philosophical question which embraces all others, the one that Plotinus expressed by his brief: τίνες δε ήμεις; -- who are we? [Enn. VI, 4, 14]. And more than that: I consider this not only one of the tasks, but *the* task, of science, the only one that really counts.[549]

All of the sciences clearly lead us to consider who we are, or what the soul is. Just as epistemology does not limit ontology, neither are scientific measurements and their underlying theories the limit to what is real or knowable. To claim that metaphysical reasoning is incapable of providing any valuable knowledge about reality is simply to repeat the errors of positivism. Yet, to claim that all we need is pure metaphysics at the expense of casting aside empirical science is to repeat a centuries-old error. We need both.

The phrase 'the observer' really refers to the self or soul. However, just like the notions of 'mass' and 'energy', terms such as 'consciousness', 'self', and 'soul' are notoriously difficult to define unambiguously. Nonetheless, for our purposes here we can consider

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[548] Schrödinger, 1967, p. 129. This position is thoroughly Platonic. As Taylor writes, 'the soul is the generator of mathematical forms, and the source of the productive principles with which the mathematical sciences are replete.' (T. Taylor, 2006, p. 3)
[549] Schrödinger, 1952, p. 51. Original emphasis.

Proclus' use of the word 'soul' as broadly synonymous with 'self'.[550] We need only recall Socrates' remark in *Alcibiades* 130c that a person is either nothing, or if something, then 'he's nothing other than his soul.'[551] Malin also notes positively that by 'soul' Plotinus means the 'self'; that is, 'he speaks about you and me.'[552] Even Heisenberg uses the word 'soul' to refer to 'the central order, to the inner core of a being whose outer manifestations may be highly diverse and pass our understanding.' (Heisenberg, 1971, p. 216.) In other words, through our own being we are able to apprehend the cosmic order, which, as Pauli mentions elsewhere, is independent of us. Yet, what they have both missed is the subtle Platonic notion that while such divine cosmic order, or symmetry or analogy, is what it is independent of whether or not we have any apprehension of it, nonetheless, we are able to apprehend it to varying degrees because we are part of the same cosmic order, which permeates our very being, the soul that we are. And as Gerson summarises for us, 'all Platonists accepted the view that in some sense the person was the soul and the soul was immortal.'[553] Claiming the importance of the soul, however, does not mean that science reduces to naïve phenomenology or subjectivity. As Siorvanes demonstrates, Proclus' philosophy is idealist in that reality resides in consciousness, since our knowledge of or ability to apprehend reality depends on us, but it is ultimately realist because our personal conceptions are validated by their correspondence to objective reality,[554] which is what I have been arguing throughout the thesis. This point, however, tends to be a major stumbling block for contemporary philosophers, since we are so conditioned to accept materialism as the default metaphysical backdrop against which we conceptualize reality.

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[550] Cf. Whittaker: 'Proclus saw quite clearly that Plato's theory of ideas, while it has psychological references, could not be understood as merely psychological. His own development has strikingly Kantian turns; and it may be said in his favour that, by his distinction between "soul" and "mind" [Proclus, 1987, pp. 284-285 (930)] (the associate of a particular body and the intellect in which it shares), he makes more clear than Kant did that it is not the merely individual intelligence that is conceived as "projecting" the forms of knowledge.' (Whittaker, 1928, pp. 257-258.)

[551] Plato, 1997, p. 589, *Alcibiade*s 130c.

[552] Malin, 2001, p. 219. 'In I, 1, 13 (1-3), Plotinus say that we *are* soul.' (Corrigan, 2005, p. 80.)

[553] Gerson, 2005-B, p. 34.

[554] Siorvanes, 1996, p. 50 (and his Chapter Two in general). See also Siorvanes 1998, 2000.
Cf. Whittaker (1928, pp. 225-226): 'Being thus intermediate, are mathematical forms and the reasonings [sic] upon them derivatives of sense-perception, or are they generated by the soul? In the view most clearly brought out by Proclus, they result from the productive activity of the soul, but not without relation to a prior intellectual norm, conformity to which is the criterion of their truth.'

Consider the following argument.

P1) Mathematical laws of physics are not physical and do not change (as I have already argued extensively).

P2) We are able to discover mathematical laws of physics (as Norris, myself, and numerous other realists have argued).

P3) We are able to perceive physical reality.

P4) Given P1-P3, we are thus able to perceive (in the widest sense of the term) both nonphysical, non-changing mathematical laws and the changing physical universe.

C) There must be something about our nature that is both akin to the timeless immaterial aspect of reality and the time-bound physical aspect of reality.

The conclusion is standard Platonism, but I have offered independent reasoning in support of it. It is a fairly straightforward and perhaps deceptively simple argument, but nonetheless a realist who believes in the objective nonphysical character of mathematical laws seems to me to be unable to escape this conclusion. We can discover nonphysical, objective, timeless truths even though we usually only partake in physical, relative, and ever-changing modes of perception. Thus, either we are abstractionists, like Aristotle (in some moods), who believe that we merely extrapolate from physical experience to an ideal but nonetheless fictitious realm of mathematical laws, which would make us mathematical antirealists, or we believe that we are somehow or other discovering aspects of objective reality. Norris, of course, believes the latter, but because of a misconception concerning the ancients, he has assumed that Platonism is incapable of providing us with a tenable epistemology capable of explaining how mathematical knowledge is possible. To reiterate, I am in complete agreement with Norris' realism, especially the claim that there are nonphysical objective truths in mathematics (and in

morality, as he also argues), but we need to clarify a misconception of Platonism. Norris believes that it is a relief for the realist once the 'Platonist burden' is dropped; once we are free from 'the impossible task of explaining how our minds achieve quasi-perceptual contact with a range of purely abstract [mathematical] entities.'[555]

> This aspect of Plato's idealist metaphysics – its reliance on sublimated sensory metaphors in order to promote a doctrine of truth that should properly require no such appeal to that inferior mode of cognition – has drawn a good deal of critical attention among commentators from Aristotle down. In particular it has prompted philosophers of mathematics, notably Gödel, to protest that one can indeed espouse a realist – even, in some cases, a Platonist – position on the objectivity of numbers, sets, functions, truth-values, etc., without buying into such a hopelessly confused or unworkable epistemology.'[556]

Norris is certainly correct that such an explanation is extraordinarily difficult, and even though Proclus argues that the mathematical entities and relations imitate the true excellences of the Ideas (Beauty, Intellect etc), which are superior, he does not tell us exactly where the mathematical realm resides,[557] but I do not think that we should say it is impossible. More importantly, given his current understanding of Platonism and Aristotelianism, Norris' conclusion about the impossible epistemological task is well-founded. However, as I have already shown, it was *Aristotle* who was in fact the antirealist about mathematics and natural laws, and it was *Plato* who was the realist. Furthermore, in some of his writings, in order not to offend his readers any more than necessary, Gödel may have tried to downplay his Platonism. But it was Russell who, after engaging in private discussions, called him the 'unadulterated Platonist.' Even more significantly, Gödel's 14 philosophical theses (which I provide in the footnote) have been ignored by almost everyone. It would be a very difficult task to find a set of beliefs more Platonic than those that Gödel espoused.[558]

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[555] Norris, 2002-A, p. 50.
[556] Norris, 2002-A, p. 137-138.
[557] See Rosán, 1949, p. 164.
[558] Gödel's philosophical beliefs (Gödel quoted in Wang, 2001, p. 316):
1) The world is rational
2) Human reason can, in principle, be developed more highly (through certain techniques)
3) There are systematic methods for the solution of all problems (also art, etc.)
4) There are other worlds and rational beings of a different and higher kind.
5) The world in which we live is not the only one in which we shall live or have lived.
6) There is incomparably more knowledge a priori than is currently known.

If mathematical laws of physics have an objective existence, as Gödel, Norris and all serious realists believe, then we need to be able to provide some sort of rational epistemological account of how we may have such knowledge. As I have already argued, in the end we either create mathematical fictions through some sort of Aristotelian abstractionism or we are discovering real nonphysical objective truths as the Platonists have argued. Norris has thus rejected Platonist epistemology but accepted its ontology, and I hope I can show how there are at least good reasons for believing the epistemological part as well.

All that is required is to reject materialism and accept that what is most real is the nonphysical and eternal, and by following the reasoning of the physicists, it is not hard to reach this conclusion. The theoretical physicist searches for the most unifying, simple, and abstract (nonphysical) principles that underlie the physical aspects of reality, and, therefore, as Heisenberg has noted, the ultimate principle would be the One itself—the ultimately simple, unifying, abstract principle of the cosmos. Thus, if the world operates according to such nonphysical mathematical laws of physics, which logically and rationally entails that their existence (or being) is prior to the physical world, then the nonphysical realm is ontologically superior to the physical. The mathematical laws of physics in turn require a metaphysical account for their existence, which is impossible to do here except to outline in the briefest way what the Platonists have argued. Whittaker notes that for Plato 'the objects of mathematics and the faculty of understanding (διάνοια) that deals with them come between dialectic and its objects above, and sense-perception and its objects below.' He then continues by reminding us how for Proclus, 'the mathematical forms and the reasonings [sic] upon them...result from the productive

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7) The development of human thought since the Renaissance is thoroughly intelligible....
8) Reason in mankind will be developed in every direction
9) Formal rights comprise a real science.
10) Materialism is false.
11) The higher beings are connected to the others by analogy, not by composition.
12) Concepts have an objective existence.
13) There is a scientific (exact) philosophy and theology, which deals with concepts of the highest abstractness; and this is also most highly fruitful for science.
14) Religions are, for the most part, bad—but religion is not.

activity of the soul, but not without relation to a prior intellectual norm, conformity to which is the criterion of their truth.'[559]

What Whittaker is saying is that dialectical reasoning, which leads to the nature of the forms or Ideas and ultimately to the One itself, is higher than the mathematical laws of physics.[560] And Proclus, like Jung fifteen centuries later, argued that the mathematical forms are rooted in the productive activity of the soul. But the reason that these laws are rational and intelligible and powerful is because they themselves are products of the higher principles (also called 'the gods' by Proclus). According to Platonist reasoning, the One, which is also the Good, produces everything without diminishing in its inconceivable power.[561] Nous, also known as the Divine Mind, is the first metaphysical

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[559] Whittaker, 1928, pp. 225-226.

[560] Cf. Wedberg: 'Plato envisages the possibility that the theorems of the mathematical sciences may obtain a foundation in Dialectic [Republic 510c-511e, 533a-d]. Thus, it seems that, in its final stage, Dialectic is here a deductive science which is the logical basis for the entire field of rational knowledge and which derives all its conclusions from a first self-evident principle, expressing the supreme insight into the Idea of the Good.' (Wedberg, 1955, p. 44.)

[561] See Proclus, 1963, pp. 2-17, propositions 1-13. Whittaker writes the following helpful comments about Plotinus' Platonist metaphysics:

'Apart from a unifying principle, nothing could exist. All would be formless and indeterminate, and so would have properly no being. A principle of unity has already been recognized in the soul. It is not absent in natural things, but here it is at a lower stage: body having less unity than soul because its parts are locally separate. In soul, however, we cannot rest as the highest term. Particular souls, by reason of what they have in common, can only be understood as derived from a general soul, which is their cause but is not identical with all or any of them. Again, the general soul falls short of complete unity by being the principle of life and motion to the world, which is other than itself. What it points to as a higher unifying principle is absolutely stable intellect, thinking itself and not the world, but containing as identical with its own nature the eternal ideas of all the forms, general and particular, that become explicit in the things of time and space. Even intellect still has a certain duality, because though intelligence and the intelligible are the same, that which thinks distinguishes itself from the object of thought. Beyond thought and the being which, while identical with it, is distinguishable in apprehension, is the absolute unity that is simply identical with itself. This is other than all being and the cause of it. It is the good to which all things aspire; for to particular things the greatest unification attainable is the greatest good; and neither the goodness and unity they possess, nor their aspiration after a higher degree of it, can be explained without positing the absolute One and the absolute Good as their source and end.' (Whittaker, 1928, pp. 53-54.) And he continues:

'The primal One from which all things are is everywhere and nowhere. As being the cause of all things, it is everywhere. As being other than all things, it is nowhere. If it were only "everywhere," and not also "nowhere," it would *be* all things. No predicate of being can be properly applied to it. To call it the cause is to predicate something, not of it but of ourselves, who have something from it while it remains in itself. This is not the "one" that the soul attains by abstracting from magnitude and multitude till it arrives at the point and the arithmetical unit. It is greatest of all, not by magnitude but by potency; in such a manner that it is also by potency that which is without magnitude. It is to be regarded as infinite, not because of the impossibility of measuring or counting it, but because of the impossibility of comprehending its power. It is perfectly self-sufficing; there is no good that it should seek to acquire by volition. It is good not in relation to itself, but to that which participates in it. And indeed that which imparts good is not properly to be called "good," but " the Good" above all other goods....Any inconsistency there might appear to be in making

principle emanating from the One, and it is the home of all the Divine Ideas, such as Beauty, Justice, and Reason.[562] The World Soul (better phrased as the 'Universal Soul' because it gives birth to, permeates, animates, and binds together the entire physical cosmos) is the product of Nous, and individual souls are partial aspects of this Universal Soul, like a micro-macro cosmos analogy.[563] (And recall how Gödel believed that all the higher principles are bound to the lower through analogy, which is the same or at least very similar notion to symmetry in physics). The World Soul and individual souls are not *in* bodies, bodies are *in* the soul.[564]

At first glance it may appear as if Platonism is antirealist because all that can be known must be contained in Nous (the Divine Mind),[565] which makes it seem as if all knowledge is mind-dependent, but such an interpretation is perilously misleading. The claim that Nous must possess its own intelligible objects, such as the Ideas, does not mean that reality is a construct of a merely human mind, as the antirealists want us to believe. Whatever is thought by Nous as it reflects back on its source is what is most real, it is what Socrates refers to as Beauty itself: 'Being and Intellect and Beauty are the same.'[566] Everything in the physical and metaphysical aspects of the universe is arranged in a

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assertions about the One is avoided by the position that nothing—not even that it "is" any more than that it is "good"—is to be affirmed of it as a predicate. The names applied to it are meant only to indicate its unique reality.' (Whittaker, 1928, pp. 57-58.) See also Forrester, 1972 and Dodds, 1928.

[562] John Norris (1657-1711), for example, followed Malebranche 'in asserting that humans have not only empirical knowledge of nature but also direct access to ideas in the divine mind.' (Nartonis, 2005, p. 437.) And Eddington writes that 'the idea of a universal Mind or Logos would be, I think, a fairly plausible inference from the present state of scientific theory; at least it is in harmony with it.' (Eddington, 1935, p. 324.)

[563] Sometimes 'Nature' is inserted between the universal Soul and the physical universe, though it has never been really clear to me what that meant. Also, for Plotinus the World Soul is another individual soul, so is more like our older sister than our mother. In this case, soul manifests in multiple viewpoints of around the objective truth of Nous and the One. But this later development in Platonism does no harm to my arguments.

[564] 'Plotinus often cites the famous saying from the *Timaeus* (36a) that the soul is not 'in' the body, but body rather 'in' soul.' (Corrigan, 2005, p. 40.)

[565] 'Plotinus argues in treatise V, 5 (32), *That the ideas are not outside the intellect and on the One*, that intellect must possess its own intelligible objects, for otherwise they would have to be brought in from outside, and then the intellect would not be a thinker in virtue of itself. So for Plotinus the 'paradigm' [to which the demiurge in Plato's *Timaeus* looked when ordering/making the physical universe] becomes intellect's vision of the One as its own thought.' (Corrigan, 2005, pp. 35-36.) But, as Clark (1997) notes, 'even realists may hesitate to follow Plotinus' on this point. Why must we posit the real existence of an Intellect that is distinct from our own intelligence? But, of course, if there is nothing beyond our own intellect, then we fall immediately into the antirealist (and response-dependence trap) that Norris, Clark and others have worked so hard to steer as away from.

[566] Clark, 1998, p. 5.

dynamic hierarchy, where everything is driven by power and guided by pure rationality that through love is turned towards the highest good, which is the One itself.[567] We, as individual souls, can turn our attention to the Universal Soul, and thus to Nous and to the degree we are able even to the One itself. Or we can focus our attention on physical matter, to what is below us, and attempt to bring about an ordered, just, harmonious way of life (always with room for the breakthrough of trans-rational intuition, what Plato calls 'divine mania' which is the greatest gift when sent from the Gods[568]). We are to become like God, the One, so far as we are able. The Universal Soul is the animating life force of the cosmos, the immaterial principle that pervades the cosmos keeping every part unified, which could help to make sense of instantaneous nonlocal correlations because the entire universe is in immediate communication with itself via the Universal Soul. And it is the Soul that is the mid-point between Nous and physical matter, bringing us to the crucial point in relating the individual soul with the mathematical laws of physics and physical reality.

In the same way that the Universal Soul is a mid-point so too are individual souls potential mid-points.[569] Mathematical objects and relations are also a mid-point between the Divine Ideas and the physical universe. Thus, it appears that such reasoning leads us to conclude that the mathematical laws of physics, which are the productively powerful guides of the physical universe, are contained within the Universal Soul, and thus individual souls have the potential to comprehend such truths, which find their objective reality in the corresponding norms in the Divine Mind (Nous). Those of us who are so

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[567] 'The basic character of the [Neoplatonic] metaphysical system was dynamic. Proclus saw things in continuous procession and return, driven by power.' (Siorvanes, 1996, p. 42-43.)

[568] Socrates says to Phaedrus that 'the greatest of blessings come to us through madness, when it is sent as a gift of the gods,' (Plato, 1914, p. 465, 244a.)

[569] As Gerard O'Daly states, for Plotinus 'the self is not a static *datum*, even if it exists potentially in its entirety: it is essentially a faculty of conscious self-determination, a *mid-point* which can be directed towards the higher or the lower.' (O'Daly, 1973, pg. 49, added emphasis on 'mid-point'.) Also see Proclus' proposition 190 'Every soul is intermediate between the indivisible principles and those which are divided in association with bodies' (Proclus, 1963, p. 167.) This idea is also reminiscent of Proclus telling us how Socrates and Plato were the bridge between the lower and the higher philosophies: 'The philosophers of Italy, as I have often said, concerned themselves with the study of the really existent Forms and touched but slightly on the study of the objects of opinion, while those in Ionia gave less attention to studying the intelligible world but examined nature and nature's works with great thoroughness. Socrates and Plato shared the interests of both groups, perfecting the lower philosophy, and expounding the higher.' (Proclus, 1987, p. 48.)

inclined to discover such truths regarding the mathematical laws of the physical universe must not only seek clues by looking below to see how the physical world actually operates, searching out apparent constant conjunctions, but must also look within ourselves to discover the laws that are responsible for how the physical world operates. This idea has been a guiding belief for many of our greatest physicists, and, indeed, the most profound theoretical discoveries of fundamental physics have not occurred in laboratories *but in the mind* of the contemplative theoretician—when they have acquired enough clues from the physical world that have aided them on their inward quest for such understanding by looking to the Universal Soul and above. Galileo believed 'fundamental laws of motion and of rest are laws of a mathematical nature. We find and discover them not in Nature, but in ourselves, in our mind, in our memory, as Plato long ago has taught us.'[570] And Thomas Taylor (1758-1835), the great Platonist and translator of so many works in the Platonic tradition, also insists that we must turn inward to discover mathematical and moral truths. 'It must be admitted, therefore, that the soul is the generator of mathematical forms, and the source of productive principles with which the mathematical sciences are replete.'[571]

Since mathematical objects and their relations have no physicality yet we are capable of discovering them, then it seems that the only way (or at least a rationally plausible way) to avoid Norris' criticism is to acknowledge that our ultimate nature is immaterial. Since knowledge of the physical world alone, which is based on nothing but sense perceptions, is merely an incoherent, chaotic and apparently random and meaningless motley of successive impressions with no obviously necessary unity or connection between them, then with no notion of unity we are stuck like Hume with no way to explain the unity of our own consciousness, or of anything else.[572]

For the Platonist, and the theoretical physicist (who holds at least implicitly the essential Platonic beliefs about physics that I have argued for already), real knowledge is of the

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[570] Galileo in Koyré, 1968-B, pp. 13, 42 & in Clark, 1990, p. 37.
[571] T. Taylor 2006, p. 3.
[572] 'But all my hopes vanish, when I come to explain the principles that unite our successive perceptions in thought or consciousness.' (Hume, 1826, p. 55.) In other words, he has no idea about how to understand the notion of unity.

ideal, the unchanging and nonphysical powers that are responsible for unfolding of physical reality. Even our relative knowledge of the flux and flow of the physical universe is still dependent on our self-reflective capacity to reflect upon and find meaningful connections between the continuous bombardment of external and proprioceptive perceptions. Therefore, if real knowledge is of and dependent on the nonphysical ideal, and we can in fact discover such ideals as realists believe, then there must be something about us that is not physical. As Gerson writes, 'for Plato, the falsity of materialism establishes the identity of the knowable as immaterial. Then, assuming that knowledge is at least possible, the way is open for an argument that it is only possible for a knower who is also immaterial.'[573] I cannot see any other way for realists to claim that we can discover nonphysical objective truths unless there is also something about us that is akin to that which we discover.

The belief that in turning inward we can make discoveries about reality is not a naïve rationalist assumption, for the empirical world is an excellent guide that leads to the higher truths and helps to validate them through seeing if they actually work (though that is not the only guide either because some laws of physics may be true even though we have yet no way of proving them empirically). What we find in our soul in relation to mathematical laws of physics (or art, morality, etc., which all follow similar modes of discovery but which cannot be discussed here) is only a genuine discovery (and not just our whimsical or insane fancy) when it correlates to the objective truths that are either in or are set by Nous. Personal conceptions are validated by their correspondence to the objective reality of Nous, which is independent of us.[574] One may wish to object that everything is still mind-dependent, even if dependent on the Divine Mind (Nous), but

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[573] Gerson, 2005[A], p. 268.
Cf. Whittaker: 'What is conclusive, however, as against the materialistic view, is that the soul cannot be described at all except by phrases which would be nonsensical if applied to body or its qualities, or to determinations of particular bodies. Once the conception of the soul has been fixed as that of an incorporeal reality, body is seen to admit of a kind of explanation in terms of soul—from which it derives its 'form'—whereas the essential nature of soul admitted of no explanation in terms of body....Within the soul, [Plotinus] finds all the metaphysical principles in some way represented. In it are included the principles of unity, of pure intellect, of moving and vitalising power, and, in some sense, of matter itself.' (Whittaker, 1928, pp. 42-43.) The inability to express non-physical reality in a language that appeases the materialist is in essence no different than the inability of physicists to express the subatomic realm in terms that satisfy our everyday experience of the macro world.
[574] Siorvanes, 1996, ch. 2.

even that will fail because ultimately the One is independent of everything imaginable and unimaginable, and it is the creator of the Divine Mind. It is the absolute reality, the grounding of all realist beliefs.

Summary

In this final chapter, I have shown how the metaphysical concept of unity is foundational to, presupposed by, and sought after by physicists. Contrary to the thoroughly unscientific assumptions of Cartwright and Clarke, the greater the unifying power of a principle or law of physics, the more abstract (nonphysical) and simple it must be, right up to the ultimate unifying simplicity of the One itself, which is itself actually beyond the reach of physics. All the laws of physics, which are discovered in the Universal Soul via individual souls but are validated by their correspondence to the objective reality of Nous, are eternally unchanging. The notion of wholeness, of the logical and physical inseparability between the observer and the observed, which I argued was also implicit in Newtonian physics and relativity and ultimately grounded in Platonism, entails that the observer is the foundational aspect of the entire scientific enterprise. We must be immaterial souls (or consciousnesses) in order to be able to explain how we can discover nonphysical objectively real truths about mathematical laws of physics (or morality, etc.). I also outlined the Platonic realist metaphysics that makes intelligible how individual souls find their place in the metaphysical hierarchy, which, no matter how difficult it may be for a materialist to conceive, provides a rational explanation for realist beliefs about discovering objectively real truths about the nature of both physical and ideal or abstract, nonphysical reality. In summary, this final chapter, which has built upon the material of the previous chapters, has clarified how quantum theory (and all of physics) necessarily implies and presupposes the metaphysics of Platonic realism.

Final Summary

The Introduction clarified, as far as reasonably possible, the essential aspects of both Platonism and quantum theory. Chapter One revealed how irrelevant much of contemporary philosophy is to the deeply embedded metaphysical questions arising out of experimental physics, while Chapter Two argued for the necessity of an interdisciplinary approach. Chapters Three and Four followed by showing how metaphysics and faith are inherent in the (implicit and explicit) assumptions and ways of thinking of physicists, including an important example of applied metaphysical reasoning that clarified how the uncertainty relations actually presuppose scientific Platonism. Chapter Five showed how the founders of quantum theory were overwhelmingly Platonic realists and Chapter Six clarified and argued against quantum and general antirealism. The final Chapter gave extensive argumentation to show how quantum theory implies and presupposes Platonic realism.

I will here summarize succinctly most of the fundamental ways in which quantum theory is Platonic. The first three are the most important.

1) The guiding beliefs of physicists (including positivists and materialists), compel them to seek abstract, nonphysical, eternally unchanging, powerfully unifying mathematical laws, theories, and principles, ultimately leading to the most unqualifiedly simple One itself, which necessarily implies and presupposes the most fundamental beliefs underlying all aspects of Platonism.

2) The founders of quantum theory were almost unambiguously scientific Platonists, except that errors in thinking led some of them in specific contexts to adopt a physical antirealist stance but while always maintaining mathematical Platonism. Yet, by correcting their reasoning errors and considering their beliefs as a whole, it is justified to claim that they were fully scientific Platonists as well. They had simply confused realism with materialism and naïve objectivity

3) Newtonian, relativity, and quantum physics all (at least implicitly) assume the importance of the observer (or the self), which must be taken into account both logically and when considering the experimental arrangement as whole. Among other essential requirements, the observer must be able to grasp nonphysical, eternally unchanging laws of nature while coherently experiencing the ever-changing flow of physical reality. Thus, it is reasonable to suppose that something about us is akin to both the eternal and nonphysical and to the time-bound and physical, which is the Platonic view that allows for a rational explanation for the 'unreasonable effectiveness of mathematics.'

4) The Platonic notion of the nonphysical Universal Soul animating the cosmos, somewhat more speculatively than my other arguments, could provide a way of understanding nonlocality, for the entire cosmos seems to be in instant communication with itself which cannot be accounted for by materialism.

5) The basic Platonic assumption that truth cannot be contradictory, and so all philosophical views must contain at least some aspects of the truth, helps to make sense of the actual way physicists think when adopting various positions while struggling in their research.

6) The Platonic dialectic of seeking similarities among different things and differences among similar things is presupposed by the physicists when they search for the unity underlying the variety and when making distinctions between those things that appear to be similar.

7) The Socratic appeal to seek for the truth, to discover and devote our lives to trying to understand what we presently do not know, is the psychological driving mechanism of the sciences.

8) The assumption of unity between observer and observed in quantum theory was shown to have Platonic origins.

These points do not necessarily exclude other possible additions, neither with respect to the content of my thesis nor the possibility of further research, but they are more than sufficient to support my claim that quantum theory is Platonic realist. When seeking the highest good, the beautiful natural harmony and mutual reliance between metaphysics and physics allow the philosopher and the physicist an opportunity to participate in divine service to the ultimate nature of reality—the One itself.

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