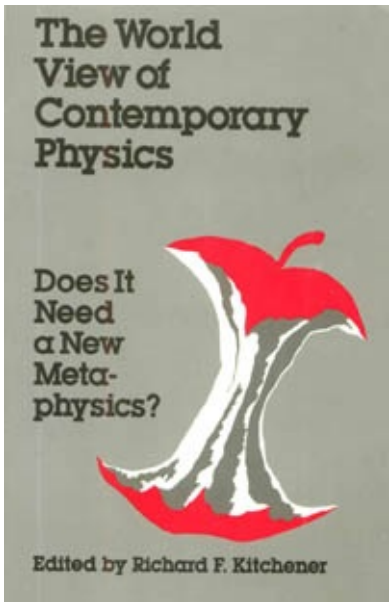

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The World View Of Contemporary Physics

Does It Need A New Metaphysics?

Edited with an Introduction by
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Contents

Preface

On September 15 through 18, 1986, a conference was held at Colorado State University on the theme "The World View of Contemporary Physics: Does It Need a New Metaphysics?" Nine internationally known scientists and philosophers presented papers at the conference, which are contained in the present volume (in their revised form). In editing these essays for publication, I have attempted to remove obvious traces of a conference setting, giving the essays a unity and coherence often lacking in conference proceedings by arranging them in a logical pattern and by editing them in the same format.

There was lively discussion between the participants and the audience, culminating in a stimulating panel discussion on the last day. Unfortunately, the speakers' comments and the panel discussion could not be published in the present volume; however, they are available on tape at Colorado State University.

This conference is the first in what we hope will be a series of conferences on the relationship between philosophy and science sponsored by the Endowment for Applied Philosophy and the Department of Philosophy of Colorado State University. The Endowment was established through the generous contribution of one individual who believes philosophy can and should be relevant to contemporary science. A series of conferences is only one of the ways in which philosophy can have some bearing on contemporary scientific theory and practice, and we are currently engaged in several other projects aimed at this end. Although he wishes to remain anonymous, all of us are grateful to him for his generosity and foresight.

This conference was made possible through the financial and personal efforts of numerous individuals and administrative units at Colorado State University. In particular, I wish to thank Pat McKee (chairman of the Department of Philosophy) who, perhaps more than anyone else, has been instrumental in establishing the Endowment for Applied Philos-

ophy and in giving it its characteristic orientation. For his help with the conference (and with all other matters pertaining to the Endowment), I am grateful. The following individuals at Colorado State University also contributed greatly to this conference: Frank Vattano and Bob Hoffert (dean and associate dean, College of Arts, Humanities and Social Sciences), John Raich (dean, College of Natural Sciences), Judson Harper (vice president of Research), Dean Jaros (dean, Graduate School), Gwyne Haddock (Office of Conferences), Linda Price and Carol Monthei (secretaries, Department of Philosophy).

Chapter 1
Introduction: The World View of Contemporary Physics: Does it Need a New Metaphysics?*

Richard F. Kitchener

Introduction

As long as thinking individuals have contemplated the nature of the physical world and their place in it, they have struggled to create a world view that is both cognitively adequate and personally satisfying. One of the many notable and long lasting effects of the Scientific Revolution was to raise this question of the relationship between philosophy and science and the correlative question of the part science would play in the construction and elaboration of a philosophically comprehensive and intellectually responsible view of the world. It is now something of a platitude to point out that our world view underwent a radical change

* I wish to thank Karen Strohm Kitchener, Pat McKee, and Bernie Rollin for reading and commenting on an earlier version of this paper. I also wish to thank Randel Fujimoto, librarian assistant at the Physics Research Library, Harvard University, for his valuable bibliographical assistance.

with the rise of classical Newtonian physics, its defeat of the Aristotelian world view, and the subsequence development of the Newtonian world view into the reigning paradigm. Not only did classical physics change our views concerning the nature and structure of physical reality, replacing an Aristotelian organismic view of nature with a "mechanistic" one, it also changed the conceptual categories through which we think about the world. Even more than this, it changed our views about the nature and existence of God, of the self, and society; 1 even the historical development of modern music and art was not immune from its influence.

It has appeared to many, therefore, that science has the function of telling us what things exist in nature, how they act, and how they relate to each other. Science thus gives us the latest news about the nature of reality and, hence, provides us, in some sense, with a metaphysics. It seems clear, therefore, that the results of modern science and, in particular, those of physics will play an important role in the elaboration of an adequate twentieth-century world view. Indeed, according to many individuals, recent results are so revolutionary in their philosophical import that an entirely new world view is required, one that is as different from the Newtonian world view as it is from the Aristotelian view of the world. The conference on which the papers in this volume are based was organized to determine these revolutionary implications and their bearings on our view of the world.

This conference is not the first time individuals have argued that the results of recent physics augur a new conception of the world. For many years individuals have made the point that "scientific common sense"the ordinary view of the practicing scientist (for example, the molecular biologist, the experimental psychologist, the solid state physicist, and so on)seems to contain a common scientific world view, roughly a Newtonian one. Based as it is on classical physics, this widespread world view of scientific common sense is in need of substantial repair. For example, as Leclerc, Harris, Capra, Capek*, and many others have pointed out, this Newtonian world view is committed, *inter alia*, to atomism, mechanism, reductionism, absolute space and time, efficient causality, and a reliance upon ordinary common sense notions about medium-sized objects (the megacosm); these basic features are still present in scientific common sense. As many individuals have argued, such a Newtonian world view is in serious empirical and conceptual error and should be replaced by a newer world view, one based on a more adequate theory of physics, incorporating the revolutionary impli-

cations of classical field theory, relativity theory, thermodynamics, quantum theory, and so forth. 2

Metaphysics

If the world view of contemporary physics is radically different from that of classical physics and if it needs to be reevaluated because of fundamental and radical changes in recent discoveries and theories of physics, it is on the issue of metaphysics that the discussion turns. For decades physicists and philosophers have suggested that something like a new scientific epistemology is needed largely because of the implications to be drawn from relativity theory and quantum theory. But because epistemology has traditionally been associated with logic and methodology of science and because issues of metaphysics have been suppressed by the reigning hegemony of logical empiricism, an explicit preoccupation with the metaphysics of contemporary physics was an intentional part of the conference.

It seems clear that if one is concerned with the nature of a world view, one will have to be concerned with issues of metaphysics, with questions concerning "the furniture of the world": What kinds of things exist; what is their nature; how are they related to each other; and so on. Until recently, most individuals would have agreed that science is concerned with metaphysics, with informing us about the furniture of the world. But two developmentsthe rise of logical empiricism and the "Copenhagen interpretation" of quantum mechanicshave made many individuals dubious about whether physics can or should make such pronouncements. As anyone familiar with the recent history of philosophy knows, the once popular view of logical empiricists that "metaphysics is meaningless" is no longer tenable; indeed, in retrospect it seems clear that the logical empiricists had a metaphysics and that what they were opposed to was a metaphysics that was *transcendent*, one that made claims about a supernatural (or "super-empirical") reality that could in no way be checked empirically (Kitchener, forthcoming a). When the contributors to this volume discuss the question of whether contemporary physics needs a new metaphysics, they do not seem to be using "metaphysics" in this sense (although D'Espagnat, 1983, apparently does).

The other movement leading to the "demise" of metaphysics in physics was

the "Copenhagen interpretation" of quantum theory, a strange

and perhaps incompatible mixture of the views of Niels Bohr, Werner Heisenberg, John von Neumann, and others. 3 Although a discussion of this school is far beyond the bounds of this introduction and is competently discussed by several of the contributors (for example, Stapp and Finkelstein), one can characterize this view (rather simplistically) as "what you see is what you get", or there is no reality *behind* quantum phenomena (data, observations). All that is required, according to this view, is (1) a set of correct mathematical formulae (for example, the Schrödinger equation[s]), and (2) a set of experimental data obtained in the laboratory. There is nothing more!

Although such an orthodox interpretation seems to be widespread among many practicing physicists, especially (as Hooker [1972] points out) among those who do not bother to read Bohr, it is not a view shared by most of the contributors. In contrast, their concern seems to be with the question, What must reality be like in order for quantum phenomena (for example, Bell's Theorem) to be possible? This includes the possibility that there is no reality, that the physicist "creates" the reality, that there are "many realities", that the reality is "spiritual", and so forth.4

A fundamental question that arises in this context, therefore, is what one means by *metaphysics.* As the reader will see, the contributors use this term in several ways: as the theory of ultimate reality, the theory of the most general features and principles of all things, or a set of basic assumptions. Historically, "*metaphysics*" has meant all of these things and more, which is part of the reason the question of "the metaphysics of physics" needs unraveling. In the received, Aristotelian tradition, it meant "after the [volume on] Physics" and this was interpreted subsequently to mean "beyond physics" or "beyond the physical." In this sense, then, metaphysics has come to mean the theory of ultimate reality, in the sense of what is beyond or behind the realm of appearances or experience. But, of course, if one doesn't believe there is anything "hidden" behind experience, one will not endorse this interpretation.5 One could still have a metaphysics, however, if one believed it was concerned with the theory of the most general principles and features of experience. Likewise, on another interpretation of metaphysics, the "ultimate reality" in physics is just the relevant set of mathematical equationsa version of Pythagoreanism.6 Such a version of Pythagoreanism is rejected by most of the contributors to this volume, who believe there must be something more palpable to reality than just the underlying mathematics, even if this

"something more" is just the correlative set of observational data gleaned in the laboratory.

In fact, one could interpret the followers of the "Copenhagen" school as being fundamentally concerned with metaphysics in the sense of a metaphysics of experience*experientialism*. Such a metaphysics can be found, for example, in many of the process philosophers, pragmatists, phenomenologists, ordinary language philosophers, positivists, phenomenalists, instrumentalists, contextualists, and so on, notably (in the present context) William James, A. N. Whitehead, and Henri Bergson.

In a widely held view concerning metaphysics and physics, physics gives us (or purports to give us) the correct picture of reality, where reality is something lying behind phenomena. This is the classical realism of the sixteenth and seventeenth centuries (for example, Galileo, Descartes, Locke, Boyle, and Newton), according to which there is a primary versus secondary quality distinction, a correspondence theory of truth, a representational theory of meaning, a metaphysical atomism, a "mathematization" ("geometrization") of nature, and so forth. Something like this is also present in the writings of Bertrand Russell (1948) and other modern "critical realists." To a lesser extent, it also seems to be the view of Einstein, Eddington, Jeans, Schrödinger, De Broglie, Bohm, and other physicists who could be called realists. One central metaphysical issue in contemporary physics thus continues to be realism versus experientialism or "Einstein versus Bohr."

"Realism versus experientialism" is not the only metaphysical issue underlying the papers in this volume, but it is a fundamental one. An equally important issue concerns the question, What kind of ontology is adequate for contemporary physics? In modern times (for example, Taylor, 1903), metaphysics has often been divided into ontology, cosmology, and rational psychology. *Ontology* is concerned with the theory of Being (in general), *cosmology* with the nature of (physical) nature, and *rational psychology* with the nature of life and the mind. It seems clear that the present discussion of the world view of contemporary physics has implications for all three areas. That it has much to do with the first two areas seems obvious. One of the main points to emerge clearly from the conference, for example, is that *elementarism* seems to be something squarely at odds with quantum mechanics and relativity theory, and hence needs to be replaced by some kind of *holism*. Likewise, a *substance* ontology (whether in its classical Aristotelian form or the more modern form of atomism) is clearly no longer viable; a *process* ontology involving (as the fundamental category) *events*, not substances, it more compatible with recent physics (both relativity theory and

quantum the-

ory). Such a view is championed, for example, by Capra and Stapp who follow the Smatrix ("bootstraps") approach of Geoffrey Chew (1971). According to this view, the primitives of quantum physics are events related via a network; it is from this network that things and even space-time are to be derived. On the other hand, it is equally true according to many (most notably Wigner, 1967), that recent work in physics has important implications for the nature of the mind, the relation between the mind and the body, and the place of mind in nature. This is evident especially in the essays by Capra, Costa de Beauregard, and Leclerc.

Recent Physics and its Revolutionary Implications

What are the recent developments in physics, developments that many believe augur a new metaphysics? Although certain results in the last two decades have had the most widespread publicity, revolutionary metaphysical implications have been drawn from physics as far back as Einstein's special theory of relativity (1905), his general theory of relativity (1917), and quantum mechanics (19051926). In fact, both philosophers and scientists were quick to see that these two new "paradigms" required radical changes in our world view, not merely abandoning the older concepts of a particular scientific theory but, more drastically, abandoning many of the concepts of "common sense" concerning the physical world.

That relativity theory has such metaphysical implications no one would doubt. Milic Capek * articulates in his contribution and elsewhere (Capek, 1961) what these implications are, especially in regard to space and time. After surveying certain classical views about space, time, motion, and matter, he then proceeds to show how these views need to be revised in light of recent physics. In particular, he points out how our ordinary megacosmic views and concepts are at variance with the macrocosmic and microcosmic worlds and, hence, need to be reevaluated. Capek is also critical of those who wish to "spatialize" time and thus, in some sense, to eliminate its inherent direction. Perhaps it is as true today as it was fifty years ago, that we have yet to fully assimilate Einstein's theory into our way of thinking about the world.7

Costa de Beauregard, although treating themes similar to Capek's and Prigogine's (Costa de Beauregard, 1963), comes to a different conclusion about "the arrow of time." According to him, there is no inherent irreversibility to time: Although there is "fact-like" irreversibility, there is no

"law-like" irreversibility. He illustrates his claim in this volume by

reference to the probability calculus and its "time-reversible" formulas. He shows how the probability calculus can be mapped onto Dirac's (1982) notation of "kets" and "bras" and then shows that quantal causality is time-reversible. Finally, he draws some important implications from this concerning psychokinesis and "backward causality."

Ilya Prigogine is also concerned with the nature of time and its metaphysical status in the natural world. Based on his work on nonequilibrium thermodynamics and dissipative structures, Prigogine has drawn far-reaching philosophical consequences concerning order, chance, the arrow of time, self-organizing systems, and so forth (Prigogine, 1980; Prigogine & Stenger, 1984). In his present contribution, Prigogine suggests that physics may be undergoing its "Darwinian revolution" in that time-dependent evolutionary patterns are being discovered among elementary particles, dissipative structures, and cosmology. (His views about cosmology represent especially provocative ideas.) In such an evolutionary world view, three elements are essential: probability, irreversibility, and coherence (structure). He, therefore, continues to stress the irreducible asymmetry of time and its power to organize and create new structures. Although order emerges out of chaos, Prigogine believes we have mistakenly identified order with equilibrium and disorder with disequilibrium. Clearly the question of whether there is an irreducible direction to time, together with a host of issues arising therefrom, requires considerably more discussion by scientists and philosophers. 8

Although the importance of the previously mentioned developments in physics for analyzing and evaluating the world view of contemporary physics cannot be overestimated, the quantum domain has been the center of attention in recent years. Beginning in the 1930s and continuing up to the present, philosophers and scientists have endlessly debated "the philosophical implications of quantum theory." Indeed, it is on the quantum level that one can most dramatically see why a new metaphysics is needed. The reason for this comes from "the quantum paradoxes": the double-slit experiment, the Einstein-Podolsky-Rosen thought experiment, Schrödinger's cat, Bell's Theorem, Aspect's experiments, Wheeler's delayed choice experiment, and so on.9

Most of the paradoxical aspects of quantum mechanics can be seen in the double-slit experiment. A screen is set up with two slits in it so that light can pass through either or both slits onto, for example, a photographic plate that

acts as a recording device. On the one hand, light appears to be a corpusclea photonsince, when it passes through a *single* slit, the photographic plate records a pattern of "hits"