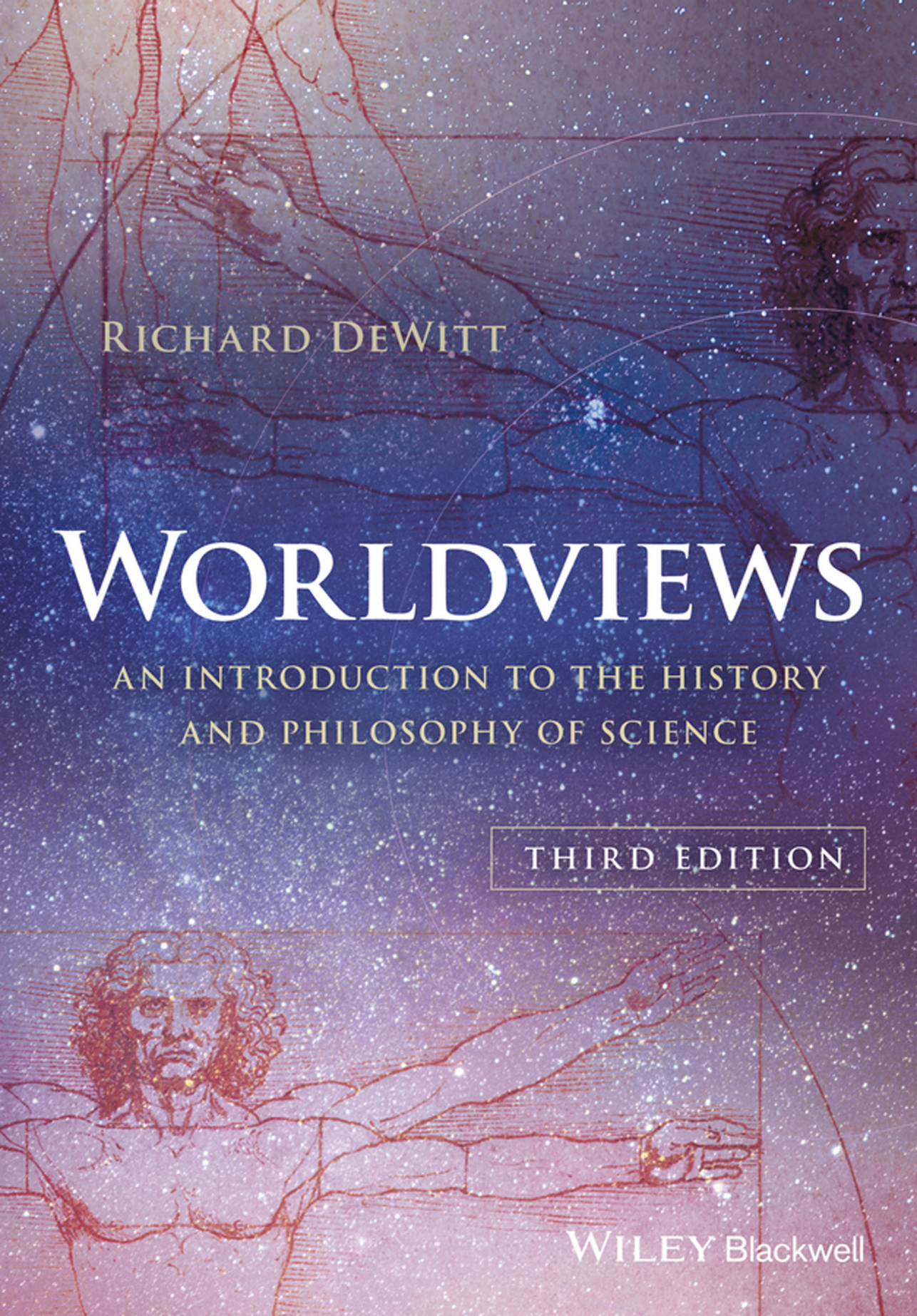
Richard DeWitt
Worldviews
An Introduction to the History and Philosophy of Science
Third Edition
Wiley Blackwell

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# Worldviews

An Introduction to the History and Philosophy of Science

Third Edition

*Richard DeWitt*

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*For Susie*

# Table of Contents

## List of Figures

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exceptionally valuable in helping me clarify certain aspects of Aristotle's physics and general philosophy of nature. Thanks also to Giles Flitney for his excellent work as copy-editor for this latest edition. Finally, I would again like to thank my original editor on this project, Jeff Dean, whose feedback was invaluable in the original organization and presentation of this manuscript.

*RD*

## Introduction

This book is intended primarily for those coming to the history and philosophy of science for the first time. If this description fits you, welcome to a fascinating territory to explore. This field involves some of the deepest, most difficult, and most fundamental questions there are. But at the same time, the "lens of science," so to speak, focuses these questions more sharply than they are often otherwise focused. I hope you enjoy this field as much as I do, and I especially hope your appetite is whetted to the point where you will want to return to explore these subjects in more depth.

This sort of introductory work provides special challenges. On the one hand, I want to be accurate with the history, the philosophy, and the interconnections between the two. On the other hand, I want to avoid the level of detail and minutiae that might swamp one approaching this subject for the first time. Those of us who do history and philosophy of science full-time – most of us are academics – tend to get caught up in the details of our disciplines, and I think we often lose sight of what such detail must look like to one new to the subject. When faced with these minutiae, newcomers often come away with the sense "Why would anyone care about *that*?"

The question is an understandable one. The details and minutiae are important, but their importance can only be understood in the context of a broader picture. So I hope, in this text, to paint one such broader picture. But although this text provides a rather broad-brushstroke picture, to the best of my knowledge what I say is accurate, though it admittedly leaves out a good deal of detail.

The connections between history, science, and philosophy are endlessly complex and fascinating. As mentioned, I hope to whet your appetite, to make you want to explore these issues in more detail, and perhaps even come to appreciate and enjoy the minutiae. Nothing would please me more than if, at the end of this book, you visit your bookstore, or fire up your web browser, and order works that will enable you to explore these topics further.

## Notes on the Third Edition

Since this new edition contains a fair amount of new material, some brief notes on these additions are in order. Various scientific traditions (Aristotelian,

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Richard DeWitt.

Newtonian, current sciences) have always been a central theme in the book, and given this, questions surrounding the possible incommensurability of such scientific traditions (roughly, the question of whether one tradition can be properly understood from the point of view of a different tradition) have always been sort of lurking in the background of previous editions. For this edition, and following the suggestions of several reviewers of earlier editions, I've added a chapter explicitly discussing issues surrounding incommensurability. This chapter comes relatively late in the book (Chapter 25), which allows the discussion to use, as examples, scientific traditions discussed earlier in the book.

In addition, I've added a chapter on the measurement problem in quantum theory. The measurement problem is widely viewed as a major (perhaps the major) issue with the standard approach to quantum theory (at least, quantum theory taken realistically). Most, perhaps all, of the discussions of the measurement problem I am familiar with are not geared toward someone who might be encountering these topics for the first time. For this chapter, I took pains to try to describe the measurement problem, especially why it is a problem, in a way that will work for someone who has not encountered such issues before.

Regarding evolutionary theory: since the publication of the second edition, I've become less than happy with the way I presented the basics of evolutionary theory in that edition. It's not that what was said was mistaken; rather, I think it was overly simplistic. For this edition, I took the previous material, tossed it in the bin, and started from scratch. So while the title of the chapter is the same, the material on the basics of evolutionary theory is entirely new, and substantially more extensive than what was in the second edition. I think it works much better. (The historical material toward the end of that chapter, on Darwin's and Wallace's routes to discovering natural selection, has been cleaned up and condensed, but is basically the same.)

I might note that I do not anticipate there being another edition beyond this one. The main reasons are (i) practical considerations mean that books of this sort can only be so long, and with this edition we are at the point where it would be difficult to add new material without exceeding these practical limits, and (ii) I do not believe in putting out new and only slightly modified editions mainly aimed at killing off sales of previous editions. As such, for this edition I've taken a good amount of time to carefully review every chapter. For some chapters only minor changes were made, for example, rewriting sentences for greater clarity. For other chapters I made much more substantial changes.

Finally, for the chapters in the final section concerning recent developments, I have added references to some interesting experiments that have been conducted since the publication of the second edition. Mainly these involve relativity (for example, the recent detection of gravitational waves predicted by Einstein's general relativity), and recent experiments in quantum theory (for example, involving further tests of Bell's theorem).

## Suggested Primary Sources to Accompany the Book

Much of the material in the book can be usefully accompanied by primary sources. A wide variety of additional primary sources could be used, and below is a list, I think of manageable length, of primary sources I would recommend. All of the sources below have the advantage of being available online, and from sources in the public domain such that copyright issues do not arise.

Descartes' *Meditations* I and II
Hume's *Enquiry*, Section IV, Part II
Aristotle's *On the Heavens*, Book II, Chapter 14
Osiander's forward to Copernicus' *On the Revolutions of the Heavenly Spheres*
Letter from Schonberg to Copernicus (as included in Copernicus' *On the Revolutions*)
Galileo's *Letter to Castelli*
Bellarmine's *Letter to Foscarini*
Galileo's *Letter to the Grand Duchess Christina*
The Inquisition's Indictment of Galileo
The Inquisition's Sentencing of Galileo
Galileo's Abjuration
Einstein's "On the Electrodynamics of Moving Bodies"
Einstein, Podolsky, and Rosen's "Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?"
Bell's "On the Einstein Podolsky Rosen Paradox"

## A Note on the Structure of the Book

In the barest of outlines, my approach in this book is (i) to introduce some fundamental issues in the history and philosophy of science; (ii) to explore the transition from the Aristotelian worldview to the Newtonian worldview; and (iii) to explore challenges to our own western worldview brought on by recent developments, most notably relativity theory, quantum theory, and evolutionary theory.

To accomplish these goals, the book is divided into three parts. Part I provides an introduction to some fundamental issues in the history and philosophy of science. Such issues include the notion of worldviews, scientific method and reasoning, truth, evidence, the contrast between empirical facts and philosophical/conceptual facts, falsifiability, and instrumentalism and realism. The relevance of and interconnections between these topics are illustrated throughout Parts II and III.

In Part II, we explore the change from the Aristotelian worldview to the Newtonian worldview, noting the role played by some of the philosophical/conceptual issues involved in this change. Of particular interest is the role played by certain philosophical/conceptual "facts" that are central to the Aristotelian

worldview. Discussion of these beliefs serves to illustrate many of the issues from Part I, and also sets the stage for the discussion, in Part III, of some of our own philosophical/conceptual "facts" that we must abandon in light of recent discoveries.

Part III provides an introduction to recent discoveries and developments, most notably relativity theory, quantum theory, and evolutionary theory. As we explore these, we will see that these new discoveries and developments require substantial changes in some of the key beliefs that almost everyone in the western world was raised with. And having emphasized, in Part II, the role played by philosophical/conceptual beliefs in the Aristotelian worldview, we now see that some of the beliefs we have long taken as obvious empirical facts turn out, in light of recent developments, to be mistaken philosophical/conceptual "facts."

At this point in time it is clear that changes in our overall view of the world will be required as recognition of these mistaken philosophical/conceptual beliefs becomes more widespread. It is difficult to say at this point just what shape these changes will take, but it is becoming increasingly likely that our grandchildren will inherit a view of the world substantially different from our own. I hope you enjoy exploring and thinking about not only the changes that have taken place in the past, but also the changes we find ourselves in the midst of.

At the end of the book, in the Chapter Notes and Suggested Reading, I provide further information on some of the topics discussed, as well as suggestions for where to find additional information on these topics. As mentioned, nothing would please me more than if, at the end of this work, you find yourself interested in further investigating these issues.

As a final note on the structure of the book, although this book is intended to be read as a whole, and its three main parts are connected in the ways described above, it is possible to read Parts I, II, and III more or less independently of each other. For example, those more interested in the scientific revolution of the 1600s and the development of Newtonian science and the Newtonian worldview, and less interested in related issues in the philosophy of science, could largely start with Chapter 9, at the beginning of Part II. I would, however, encourage such readers to take at least a quick pass through Chapters 1, 3, 4, and 8. Likewise, readers interested primarily in more recent developments in science, especially relativity theory, quantum theory, and evolutionary theory, could jump immediately to Chapter 23, at the beginning of Part III. I would encourage such readers to take at least a quick look at Chapters 3 and 8.

Once again, I hope you enjoy your exploration.

# Part I

## Fundamental Issues

In Part I, we explore some preliminary and basic issues involved in the history and philosophy of science. In particular, we will discuss the notion of worldviews, truth, evidence, empirical facts versus philosophical/conceptual facts, common types of reasoning, falsifiability, and instrumentalism and realism. These topics provide the necessary background for our exploration, in Part II, of the transition from the Aristotelian worldview to the Newtonian worldview, and also for our exploration, in Part III, of recent developments that challenge our own view of the world.

*Worldviews: An Introduction to the History and Philosophy of Science*, Third Edition.
Richard DeWitt.

# 1

# Worldviews

The main goal of this chapter is to introduce the notion of a *worldview*. As with most of the topics we will explore in this book, the notion of a worldview turns out to be substantially more complex than it at first appears. We will begin, though, with a relatively straightforward characterization of this notion. Then as the book progresses, and we come to appreciate more about the Aristotelian worldview and about our own worldview, we will come to a better appreciation of some of the complexities involved.

Although the term "worldview" has been used fairly widely for over 100 years, it is not a term that carries a standard definition. So it is worth taking a moment to clarify how I will be using the term. In the shortest of descriptions, I will use "worldview" to refer to a system of beliefs that are interconnected in something like the way the pieces of a jigsaw puzzle are interconnected. That is, a worldview is not merely a collection of separate, independent, unrelated beliefs, but is instead an intertwined, interrelated, interconnected *system* of beliefs.

Often, the best way to understand a new concept is by way of an example. With this in mind, let's begin with a look at the Aristotelian worldview.

## Aristotle's Beliefs and the Aristotelian Worldview

In the western world, what I am calling the Aristotelian worldview was the dominant system of beliefs from about 300 BCE to about 1600 CE. This worldview was based on a set of beliefs articulated most clearly and thoroughly by Aristotle (384–322 BCE). It is worth noting that the term "Aristotelian worldview" refers not so much to the collection of beliefs held specifically by Aristotle himself, but rather to a set of beliefs shared by a large segment of western culture after his death and that were, as noted, largely based on the beliefs of Aristotle.

To understand the Aristotelian worldview, it will be easier to begin with Aristotle's own beliefs. Following this, we will discuss some of the ways these beliefs evolved in the centuries after the death of Aristotle.

*Worldviews: An Introduction to the History and Philosophy of Science*, Third Edition.
Richard DeWitt.

### Aristotle's beliefs

Aristotle held a large number of beliefs that are radically different from the beliefs we hold. Here are a few examples:

a) The Earth is located at the center of the universe.
b) The Earth is stationary, that is, it neither orbits any other body such as the sun, nor spins on its axis.
c) The moon, the planets, and the sun revolve around the Earth, completing a revolution about every 24 hours.
d) In the sublunar region, that is, the region between the Earth and the moon (including the Earth itself) there are four basic elements, these being earth, water, air, and fire.
e) Objects in the superlunar region, that is, the region beyond the moon including the moon, sun, planets, and stars, are composed of a fifth basic element, ether.
f) Each of the basic elements has an essential nature, and this essential nature is the reason why the element behaves as it does.
g) The essential nature of each of the basic elements is reflected in the way that element tends to move.
h) The element earth has a natural tendency to move toward the center of the universe. (That's why rocks fall straight down, since the center of the Earth is the center of the universe.)
i) The element water also has a natural tendency to move toward the center of the universe, but its tendency is not as strong as that of the earth element. (That's why, when dirt and water are mixed, both tend to move downward, but the water will eventually end up above the dirt.)
j) The element air naturally moves toward a region that is above earth and water, but below fire. (That's why air, when blown into water, bubbles up through the water.)
k) The element fire has a natural tendency to move away from the center of the universe. (That's why fire burns upward, through air.)
l) The element ether, which composes objects such as the planets and stars, has a natural tendency toward perfectly circular movement. (That's why the planets and stars continuously move in circles about the Earth, that is, about the center of the universe.)
m) In the sublunar region, an object in motion will naturally tend to come to a halt, either because the elements composing it have reached their natural place in the universe, or far more often because something (for example, the surface of the Earth) prevents them from continuing toward their natural place.
n) An object that is stationary will remain stationary, unless there is some source of motion (either self-motion, as when an object moves toward its natural place in the universe, or an external source of motion, as when I push my pen across my desk).

The beliefs just mentioned are only a small, small handful of Aristotle's views. He also had extensive views on ethics, politics, biology, psychology, the proper