

Richard DeWitt

WORLDVIEWS

*An Introduction
to the History and
Philosophy of Science*

Second Edition

 WILEY-BLACKWELL

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Praise for Worldviews

“Quite simply, this is one of the most accessible – and teachable – introductions to the history and philosophy of science I’ve seen in over two decades of teaching. DeWitt’s exposition and discussion manifestly honed by extensive classroom teaching experience – are exceptionally clear, and helpful, complemented by some of the best diagrams I’ve seen. DeWitt thus makes complex ideas and developments cogent and straightforward, especially for undergraduates and those approaching the history and philosophy of science for the first time.” *Charles Ess, Drury University*

“Richard DeWitt’s *Worldviews* is a splendid introductory text. It is organized around themes and traditions and their overthrow – geared to engage undergraduates. It is historically informed and philosophically sensible. Best of all, it abounds in examples skillfully drawn from the physical sciences and made accessible to the non-specialist. The philosophy of science students encounter through *Worldviews* will strike them as the philosophy of *real* science – the science of Newton, Einstein, Copernicus, and Aristotle – and not some denatured surrogate for science concocted by philosophers so that it might succumb to the tools of their trade.” *Laura Ruetsche, University of Pittsburgh*

“This is a brilliantly clear introduction (and indeed reframing) of the history and philosophy of science in terms of world-views and their elements ... In addition, the book is incredibly well informed from both a scientific and philosophical angle. Highly recommended.” *Scientific and Medical Network*

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Philosophy of Science

Second Edition

Richard DeWitt

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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 most deep, difficult, and fundamental questions there are. But at the same time, the “level 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 someone 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 those new to the subject. When faced with the 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 be understood only 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.

A Note on the Structure of the Book

In the barest of outlines, my approach is (a) to introduce some fundamental issues in the history and philosophy of science; (b) to explore the transition from the Aristotelian worldview to the Newtonian worldview; and (c) 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. 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.

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.

Chapter One

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 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 a single, 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 us 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 BC to about AD 1600. This worldview was based on a set of beliefs articulated most clearly and thoroughly by Aristotle (384–322 BC). 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 his beliefs.

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.

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 together, 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).

These beliefs are only a small, small handful of Aristotle's views. He also had extensive views on ethics, politics, biology, psychology, the proper method for conducting scientific investigations, and so on. Like most of us, Aristotle held thousands of beliefs, most of which were quite different from ours.

Importantly, Aristotle's beliefs were anything but a random collection of beliefs. When I say that the beliefs were not random, part of what I mean is that he had good reason to believe most of them, and the beliefs were far from naive. Every single one of the beliefs listed above turned out to be wrong, but given the data available at the time, every one of them was quite justified. To take just one example, the best scientific data of Aristotle's time strongly indicated that the Earth was at the center of the universe. The belief turned out to be wrong, but naive it was not.

By saying the beliefs were not random, I also mean that they form an interrelated, interlocking *system* of beliefs. To illustrate the ways in which Aristotle's beliefs were interrelated and interlocking, consider a wrong way and a right way of picturing them.

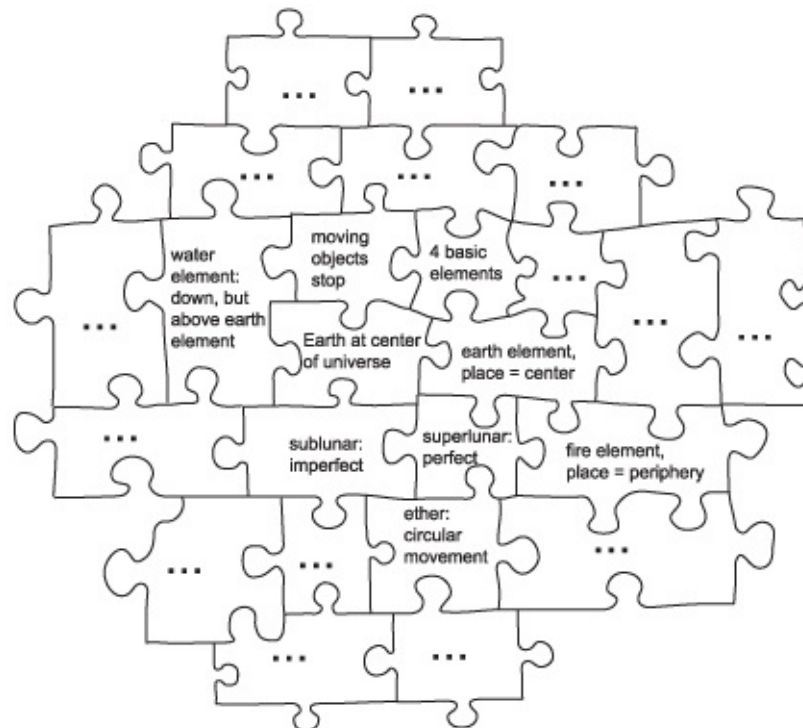
First, the wrong picture, which I will illustrate by an analogy with grocery lists. When most of us make grocery lists, we end up with a haphazard collection of items related only by the fact that we can, we hope, find them when we get to the grocery store. We could organize our grocery lists – with the dairy items in one part of the list, the bakery items in another part, and so on – but most of us simply do not bother. And the result is a haphazard list with no particular relation between the items on it.

When you think of Aristotle's beliefs, do not think of them as like a grocery list of unrelated items. That is, do not picture the collection of beliefs as like the somewhat haphazard list in Figure 1.1. Instead, here is a better picture. Think of the collection of beliefs as like a jigsaw puzzle. Each piece of the puzzle is a particular belief, with the pieces fitting together in a coherent, consistent, interrelated, interlocking fashion, as the pieces of a jigsaw puzzle fit together. That is, picture Aristotle's system of beliefs more as it appears in Figure 1.2.

Figure 1.1 A "grocery list" of Aristotle's beliefs

- | | |
|-----|--------------------------------------------------------------------------------------------------------|
| (a) | The Earth is at the center of the universe. |
| (b) | The Earth is stationary. |
| (c) | The moon, planets, and sun revolve around the Earth about every 24 hours. |
| (d) | Objects in the sublunar region are composed of the four basic elements: earth, water, air and fire. |
| (e) | Objects in the superlunar region are composed of the basic element ether. |
| (f) | Each element behaves as it does because of its essential nature. |
| (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 in a straight line toward the center of the universe. |
| (i) | ... |
| (j) | ... |
| : | ... |
| : | ... |

Figure 1.2 Aristotle's "jigsaw puzzle" of beliefs



The jigsaw puzzle metaphor illustrates the key features of the way I am using the notion of worldview. First, pieces of a jigsaw puzzle are not independent and isolated; rather, puzzle pieces are interconnected. Each piece of a puzzle fits with the piece next to it, and that piece fits with the piece next to it, and so on. All the pieces are interconnected and interrelated, and the overall result is a system in which the individual pieces fit together into an interlocking, interconnected, coherent, and

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