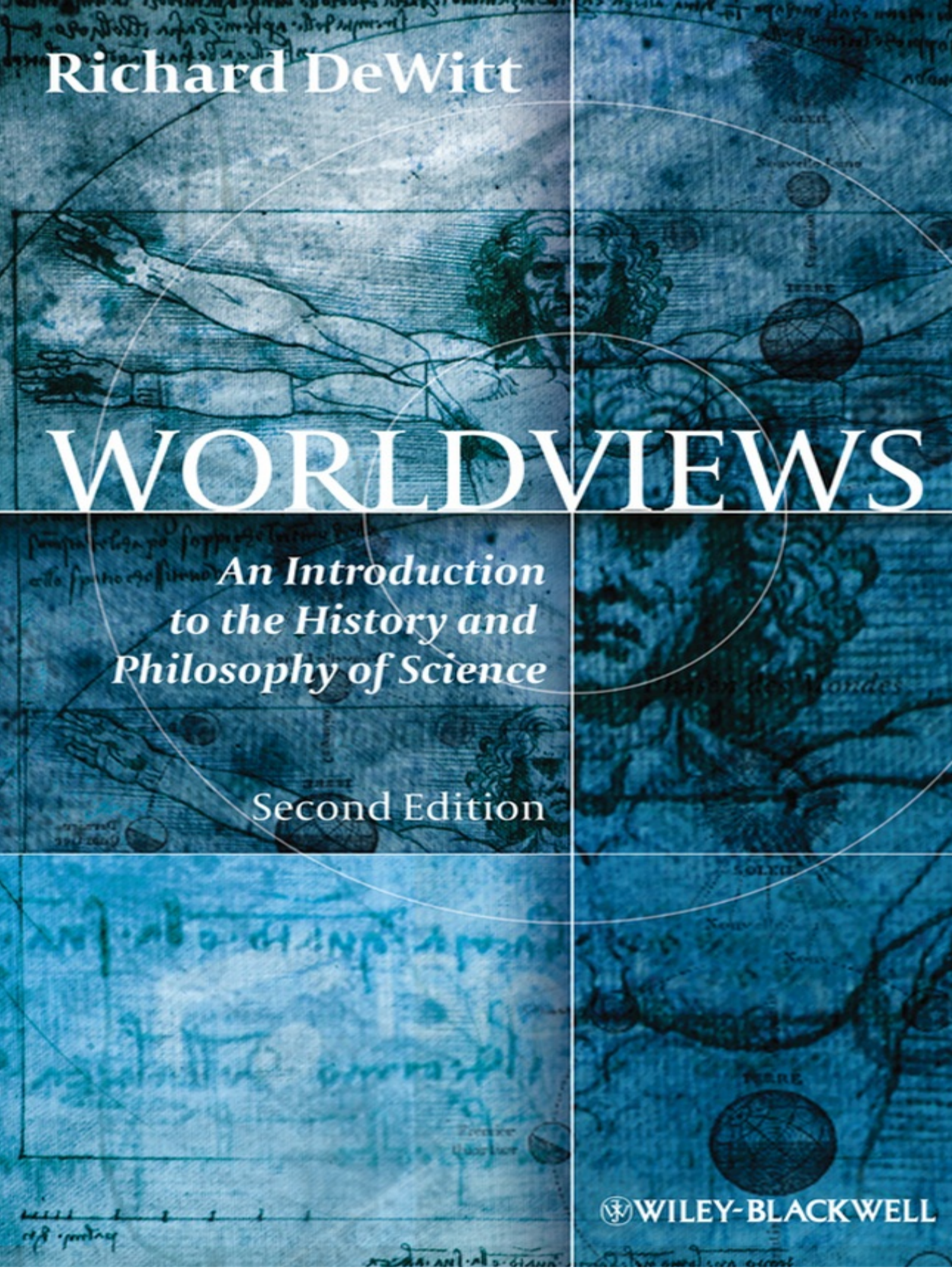
Richard DeWitt
WORLDVIEWS
An Introduction to the History and Philosophy of Science
Second Edition
WILEY-BLACKWELL

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Praise for Worldviews

"Quite simply, this is one of the most accessible – and teachable – introductions to the history an 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 helpfull complemented by some of the best diagrams I've seen. DeWitt thus makes complex ideas an developments cogent and straightforward, especially for undergraduates and those approaching th 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 traditions and their overthrow – geared to engage undergraduates. It is historically informed an philosophically sensible. Best of all, it abounds in examples skillfully drawn from the physic sciences and made accessible to the non-specialist. The philosophy of science students encount through *Worldviews* will strike them as the philosophy of *real* science – the science of Newto Einstein, Copernicus, and Aristotle – and not some denatured surrogate for science concocted b philosophers so that it might succumb to the tools of their trade." *Laura Ruetsche, University Pittsburgh*

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

Worldviews
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WILEY-BLACKWELL
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For Susie

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R

Introduction

This book is intended primarily for those coming to the history and philosophy of science for the fir time. If this description fits you, welcome to a fascinating territory to explore. This field involv some of the most deep, difficult, and fundamental questions there are. But at the same time, the "le of science," so to speak, focuses these questions more sharply than they are often otherwise focused hope you enjoy this field as much as I do, and I especially hope your appetite is whetted to the poi 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 accura with the history, the philosophy, and the interconnections between the two. On the other hand, I wa to avoid the level of detail and minutiae that might swamp someone approaching this subject for t first time. Those of us who do history and philosophy of science full-time – most of us are academi – tend to get caught up in the details of our disciplines, and I think we often lose sight of what su detail must look like to those new to the subject. When faced with the minutiae, newcomers oft 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 importan can be understood only in the context of a broader picture. So I hope, in this text, to paint one su broader picture. But although this text provides a rather broad-brushstroke picture, to the best of m 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. A mentioned, I hope to whet your appetite, to make you want to explore these issues in more detail, a perhaps even come to appreciate and enjoy the minutiae. Nothing would please me more than if, at t end of this book, you visit your bookstore, or fire up your web browser, and order works that wi 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 a philosophy of science; (b) to explore the transition from the Aristotelian worldview to the Newtonia worldview; and (c) to explore challenges to our own western worldview brought on by rece 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 some fundamental issues in the history and philosophy of science. Such issues include the notion worldviews, scientific method and reasoning, truth, evidence, the contrast between empirical facts a philosophical/conceptual facts, falsifiability, and instrumentalism and realism. The relevance of a 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 worldvie noting the role played by some of the philosophical/conceptual issues involved in this change. particular interest is the role played by certain philosophical/conceptual "facts" that are central to t Aristotelian worldview. Discussion of these beliefs serves to illustrate many of the issues from Part and also sets the stage for the discussion, in Part III, of some of our own philosophical/conceptu "facts" that we must abandon in light of recent discoveries.

Part III provides an introduction to recent discoveries and developments, most notably relativi theory, quantum theory, and evolutionary theory. As we explore these, we will see that these ne discoveries and developments require substantial changes in some of the key beliefs that almo everyone in the western world was raised with. And having emphasized, in Part II, the role played b philosophical/conceptual beliefs in the Aristotelian worldview, we now see that some of the beliefs w have long taken as obvious empirical facts turn out, in light of recent developments, to be mistak 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 difficult to say at this point just what shape these changes will take, but it is becoming increasing likely that our grandchildren will inherit a view of the world substantially different from our own. hope you enjoy exploring and thinking about not only the changes that have taken place in the pas 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 informatio on some of the topics discussed, as well as suggestions for where to find additional information o these topics. As mentioned, nothing would please me more than if, at the end of this work, you fin 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, an its three main parts are connected in the ways described above, it is possible to read Parts I, II, and I more or less independently of each other. For example, those more interested in the scientif revolution of the 1600s and the development of Newtonian science and the Newtonian worldview, an less interested in related issues in the philosophy of science, could largely start with Chapter 9, at th beginning of Part II. I would, however, encourage such readers to take at least a quick pass throug Chapters 1, 3, 4, and 8. Likewise, readers interested primarily in more recent developments in scienc especially relativity theory, quantum theory, and evolutionary theory, could jump immediately t Chapter 23, at the beginning of Part III. I would encourage such readers to take at least a quick look 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
science. In particular, we will discuss the notion of worldviews, truth, evidence, empirical facts versu
philosophical/conceptual facts, common types of reasoning, falsifiability, and instrumentalism an
realism. These topics provide the necessary background for our exploration, in Part II, of the transitio
from the Aristotelian worldview to the Newtonian worldview, and also for our exploration, in Part II
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 w 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 notio Then as the book progresses, and we come to appreciate more about the Aristotelian worldview an about our own worldview, we will come to a better appreciation of some of the complexities involve

Although the term "worldview" has been used fairly widely for over 100 years, it is not a term th carries a standard definition. So it is worth taking a moment to clarify how I will be using the term. the shortest of descriptions, I will use "worldview" to refer to a system of beliefs that a interconnected in something like the way the pieces of a jigsaw puzzle are interconnected. That is, worldview is not merely a collection of separate, independent, unrelated beliefs, but is instead a 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 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 belie from about 300 BC to about AD 1600. This worldview was based on a set of beliefs articulated mo clearly and thoroughly by Aristotle (384–322 BC). It is worth noting that the term "Aristoteli worldview" refers not so much to the collection of beliefs held specifically by Aristotle himself, b rather to a set of beliefs shared by a large segment of western culture after his death and that were, noted, largely based on his beliefs.

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

Aristotle's Beliefs

Aristotle held a large number of beliefs that are radically different from the beliefs we hold. Here a 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 i axis.

(c) The moon, the planets, and the sun revolve around the Earth, completing a revolution abo every 24 hours.

(d) In the sublunar region, that is, the region between the Earth and the moon (including the Ear 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, su
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 wh
the element behaves as it does.

(g) The essential nature of each of the basic elements is reflected in the way that element tends
move.

(h) The element earth has a natural tendency to move toward the center of the universe. (That
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 i
tendency is not as strong as that of the earth element. (That's why, when dirt and water are mixe
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 fir
(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
why fire burns upward, through air.)

(l) The element ether, which composes objects such as the planets and stars, has a natural tendenc
toward perfectly circular movement. (That's why the planets and stars continuously move
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 becau
the elements composing it have reached their natural place in the universe, or far more oft
because something (for example, the surface of the Earth) prevents them from continuing towa
their natural place.

(n) An object that is stationary will remain stationary, unless there is some source of motio
(either self-motion, as when an object moves toward its natural place in the universe, or a
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 o
ethics, politics, biology, psychology, the proper method for conducting scientific investigations, an
so on. Like most of us, Aristotle held thousands of beliefs, most of which were quite different fro
ours.

Importantly, Aristotle's beliefs were anything but a random collection of beliefs. When I say tha
the beliefs were not random, part of what I mean is that he had good reason to believe most of ther
and the beliefs were far from naive. Every single one of the beliefs listed above turned out to b
wrong, but given the data available at the time, every one of them was quite justified. To take just on
example, the best scientific data of Aristotle's time strongly indicated that the Earth was at the cent
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, interlockin
system of beliefs. To illustrate the ways in which Aristotle's beliefs were interrelated and interlockin
consider a wrong way and a right way of picturing them.

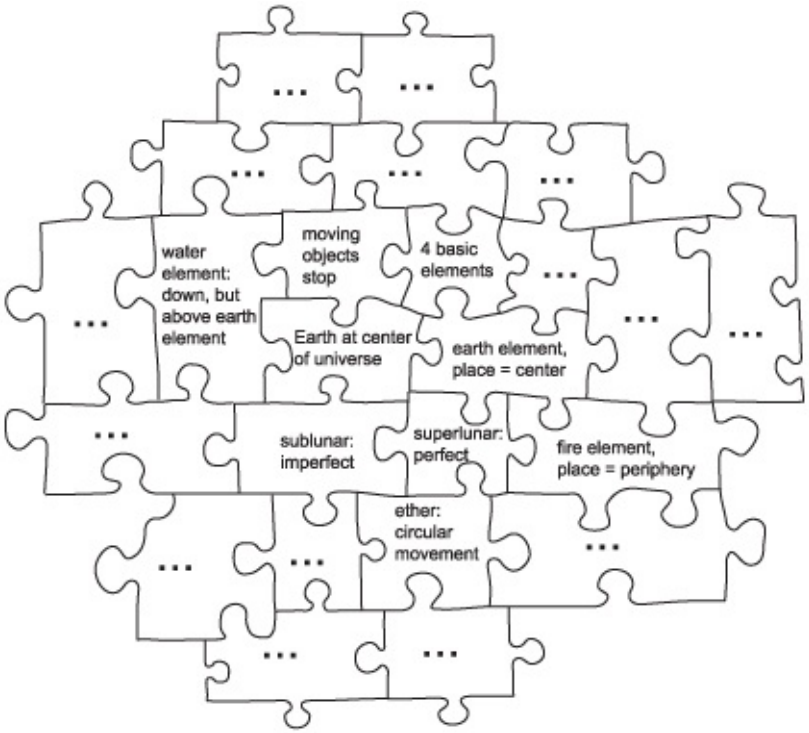
First, the wrong picture, which I will illustrate by an analogy with grocery lists. When most of u
make grocery lists, we end up with a haphazard collection of items related only by the fact that w
can, we hope, find them when we get to the grocery store. We could organize our grocery lists – wit
the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

When you think of Aristotle's beliefs, do not think of them as like a grocery list of unrelated item
That is, do not picture the collection of beliefs as like the somewhat haphazard list in Figure 1.
Instead, here is a better picture. Think of the collection of beliefs as like a jigsaw puzzle. Each pie
of the puzzle is a particular belief, with the pieces fitting together in a coherent, consiste
interrelated, interlocking fashion, as the pieces of a jigsaw puzzle fit together. That is, pictu
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 a
interconnected. Each piece of a puzzle fits with the piece next to it, and that piece fits with the piec
next to it, and so on. All the pieces are interconnected and interrelated, and the overall result is
system in which the individual pieces fit together into an interlocking, interconnected, coherent, a