by presbyopic Europeans. These conclusions are based on very scant evidence. For one thing, we simply don't know nearly enough about the history of the manufacture of eyeglasses from rock-crystal in Asia, an industry that still exists today in Sri Lanka. Similarly, the speculation that the Franciscan friars Roger Bacon and John Pecham may have been inspired to write about optics by seeing the light streaming through the stained glass in the recently built cathedrals is picturesque but does not bring much to our understanding of their work.

Much of the importance of glass that the book emphasizes stems from the use of glass in the production of lenses. But the authors include almost no discussion of the history of the techniques used to grind lenses, despite their admission that "grinding glass to make artifacts is about the most precise craft skill in the world." Even though Galileo, Descartes, Newton, Fraunhofer, and a great many other scientists devoted an enormous amount of their time to the improvement of techniques for producing lenses, no consideration of these techniques appears in the book.

Although they sometimes overstate their case, Macfarlane and Martin cannot be wrong to point to the extraordinary importance of glass for science. Nonetheless, we are left very much in the dark about how past scientists, glassblowers, and lens-grinders wrestled with this difficult substance to produce reliable knowledge about the natural world.

BOOKS: PHILOSOPHY

Empiricism, Realism, and Religion

Paul Thagard

One of the most active debates in current philosophy of science is between empiricism and scientific realism. Realism is the view that science aims to produce theories that are at least approximately true, along with the claim that it often succeeds in doing so. Theories go beyond sensory observation by hypothesizing the existence of nonobservable entities such as quarks, chemical bonds, genes, and mental representations. According to scientific realists, we are justified in believing that atoms and other theoretical entities exist because the theories that hypothesize their existence are the best available explanations of experimental results and other observations.

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In contrast, empiricists such as Princeton University's Bas van Fraassen argue for a more modest view of the aims and accomplishments of science. They claim that it is too risky to believe in the existence of nonobservable entities and that we should not believe that theories are true, only that they are, at best, adequate for predicting what is observed. Atoms, quarks, and other such entities are not to be taken as parts of the world but merely as convenient means for predicting or redescribing observable phenomena such as those that result from experiments in physics.

Empiricism might seem inherently more antagonistic to religion than scientific realism. Various religions assume the existence of a host of entities that are not observed, such as gods, souls, angels, and heaven. If it is not legitimate to believe in the existence of atoms or electrons, for which there is an enormous amount of empirical evidence, surely one should not believe in the existence of gods, souls, and angels. On the other hand, the methodology of scientific realism seems to open the door for a reconciliation of science and religion. If science can justify the existence of atoms because the theories that postulate them provide the best explanation of observations, so religion might be able to justify the existence of God because this hypothesis provides the best explanation of phenomena such as the origin and design of the universe, the prevalence of religious belief, and the contents of scripture.

The Empirical Stance
by Bas C. van Fraassen
Yale University Press, New Haven, CT, 2002. 302 pp. $30, £22.50, €36. ISBN 0-300-08874-4.

Surprisingly, however, empiricism and religiosity can coexist. Pierre Duhem, the most distinguished empiricist of the early 20th century, was a devout Catholic. And in *The Empirical Stance*, van Fraassen, the most influential empiricist of recent decades, combines a penetrating discussion of empiricism in science and philosophy with a sympathetic discussion of religion. According to van Fraassen, empiricism is not a doctrine but a stance, which is a cluster of attitudes, commitments, and approaches. This stance urges scientists to perform experiments and observations in order to evaluate the empirical adequacy of hypotheses, while avoiding issues concerning their truth. Empiricism does not claim that atoms exist, but it also does not assert that they do not exist. Similarly, empiricism says nothing about the existence of God.

In contrast, scientific realism can give rise to intense skepticism about religious claims. Past science has proposed theoretical entities, such as phlogiston, vital force, and the ether, that are now considered nonexistent because the theories advocating them have been superseded by alternatives that better explain observable phenomena. For example, chemists no longer believe in phlogiston because Lavoisier's oxygen theory provides a much better explanation of combustion, respiration, and other phenomena. Similarly, religious hypotheses such as divine design are no longer the best explanation of the complexity of the world, for we now have well-supported scientific theories of cosmology, geology, evolution, genetics, and so on.

Hence the allegiance between empiricism and religion is surprisingly natural; it enables one, in Kant's phrase, to deny knowledge in order to make room for faith. Just as science lacks knowledge about the existence of oxygen or phlogiston, it has nothing to say about the existence of God. According to van Fraassen, science is not the only approach to understanding ourselves and the world we live in, but should be supplemented by what he calls "an abiding astonishment not allayed by the fruits of scientific inquiry." He explores this approach by discussing what existentialist theologians such as Martin Buber and Rudolf Bultmann have said about the distinction between secular and religious approaches to life. Van Fraassen concludes that the crucial distinction between the secular and the religious lies in a certain attitude to how we approach the world and relate to our own experience. He does not go so far as to designate this attitude the "religious stance," but he clearly sees it as a valuable supplement to the empirical stance that he thinks best fits the secular, scientific side of life.

From a realist perspective, however, religion is the wrong place to look for a supplement to what science has to tell us about the nature of our lives. Inference to the best explanation provides us adequate grounds to judge that atoms and many other kinds of theoretical entities exist and serious reasons to doubt whether theological entities are real. Science does not by itself tell us how to live meaningfully and ethically, and many people have thought that religion could fill in the philosophical gaps. But we cannot reasonably complete our lives with wishful thinking about mythical beings. Reflection on meaning and values can proceed philosophically by means of discussion of secular theories of ethics, enriched by insights from literature, history, and sciences such as psychology and anthropology. Hence van Fraassen's eloquent examination of empiricism and religion does not undermine scientific realism.