‘To Explain the World: The Discovery of Modern Science’ by Steven Weinberg

By Marcia Bartusiak February 13

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TO EXPLAIN THE WORLD

The Discovery of Modern Science

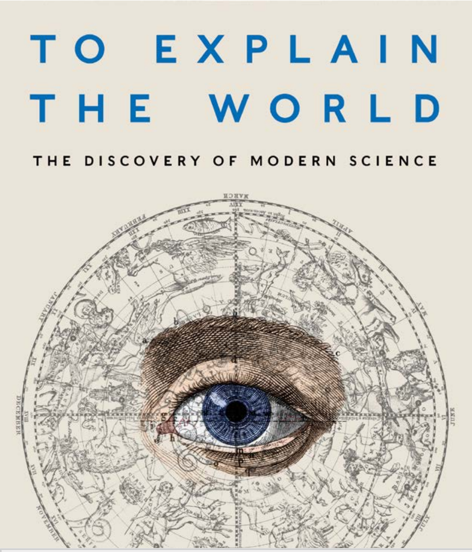
by Steven Weinberg

Harper. 416 pp. $28.99

What does it mean to think like a scientist? How do you learn to search for natural laws that predict a wide range of phenomena? Today it takes students years to grasp the essentials. For our ancestors, it took centuries.

The long march toward the modern scientific method is well-trodden territory for historians of science, but in tackling this familiar topic, Nobel laureate in physics Steven Weinberg offers a thoughtful, supplementary viewpoint. We observe how ancient philosophers, starting in Greece, “learned how to learn” through the eyes of a present-day theoretical physicist. It’s a whirlwind tour of early science that takes the reader from

Greece, to Alexandria in Egypt, and on to the universities of medieval Europe.



Some historians want to judge ancient philosophy not by how much it anticipates modern scientific thought but rather by how it treated questions about nature in its day — to which Weinberg replies, “I don’t buy it . . . this sort of judgment is indispensable if what one wants is to understand how science progressed.”

Early investigators, he contends, were more poets and speculators, with a bias against examining nature for themselves. They preferred a priori reasoning based on what they viewed as higher principles. “This was not just intellectual laziness,” Weinberg notes. They were simply convinced that “circular orbits are more perfect than elliptical orbits, that gold is more noble than lead, and that man is a higher being than his fellow simians.” To Weinberg, the advance of mathematics was a hindrance at first because it allowed natural philosophers to believe that nature's laws could be deduced solely from the mind. Yet proof from reason alone was still a move forward, because ancient philosophers, such as Aristotle in the fourth century B.C., were attempting to explain natural phenomena without reference to gods. Although Aristotle didn't conduct experiments, he did observe.

The rise of commerce, with markets connected to all parts of the known world, enhanced the progress, as knowledge could now be seen to have practical uses. Archimedes' discovery that a floating body displaces water equal to its own weight led to a way for rulers to tell if their crowns were made of pure gold.

Astronomy is known as the queen of all sciences for a reason: With the moon, sun and planets crossing the celestial sky in such regular fashion, ancient astronomers learned how to make precise measurements in tracking their paths. These skills led to the first attempts by the Hellenistic world at gauging the size of the Earth and its distance to the sun. Fortunately, during the Dark Ages, these advances by ancient Greece were preserved and extended by the medieval Islamic world, with translations later spreading the knowledge throughout Europe during the Renaissance.

With Aristotle at last unleashed upon Christendom, reigniting a curiosity about nature, most histories of science at this point proceed to the triumphant "scientific revolution" of the 16th and 17th centuries. A few modern historians, such as Steven Shapin, have challenged this concept of a revolution, writing that "there was no such thing." But Weinberg persuasively stands by tradition: "With a few bright Greek exceptions, science before the sixteenth century seems to me very different from what I experience in my own work. . . . After the seventeenth century I feel at home."

At this point Weinberg goes on to examine the work of the usual suspects, the pillars of that upheaval: Nicolaus Copernicus, Johannes Kepler, Galileo and Isaac Newton. It wasn't perfect sailing from pillar to pillar; Copernicus, with his sun-centered solar system, still kept a few of Ptolemy's epicycles around, and Kepler (along with discovering elliptical planetary orbits) dabbled in astrology on the side for extra money. But modern science was definitely erupting. "The work of Copernicus illustrates," Weinberg notes, how "a simple and beautiful theory that agrees pretty well with observation is often closer to the truth than a complicated ugly theory."

Galileo provided the observational evidence for Copernicus's scheme and carried out experiments on the motion of objects that were crucial for Newton's formulation of his laws of gravitation a generation later. At last someone arrived at a set of mathematical principles that were not based on speculation or philosophical choice. Instead, Newton's laws could accurately predict the movement of the planets, the rise and fall of the tides, the paths of comets and the fall of an apple. "It provided an irresistible model for what a physical theory should be, and could be," Weinberg writes.

This book arose from an undergraduate course Weinberg taught on the history of physics and astronomy, and so a few discussions, such as on Ptolemy's epicycles or Descartes's optics, have a textbook feel that only the physics-minded might fully appreciate. A few historians may challenge some of Weinberg's conjectures, but they are intriguing to consider nonetheless.