THE TRUTH ABOUT TRUST • MICHAEL SHERMER ON HOPE, MEDICINE, AND DEATH

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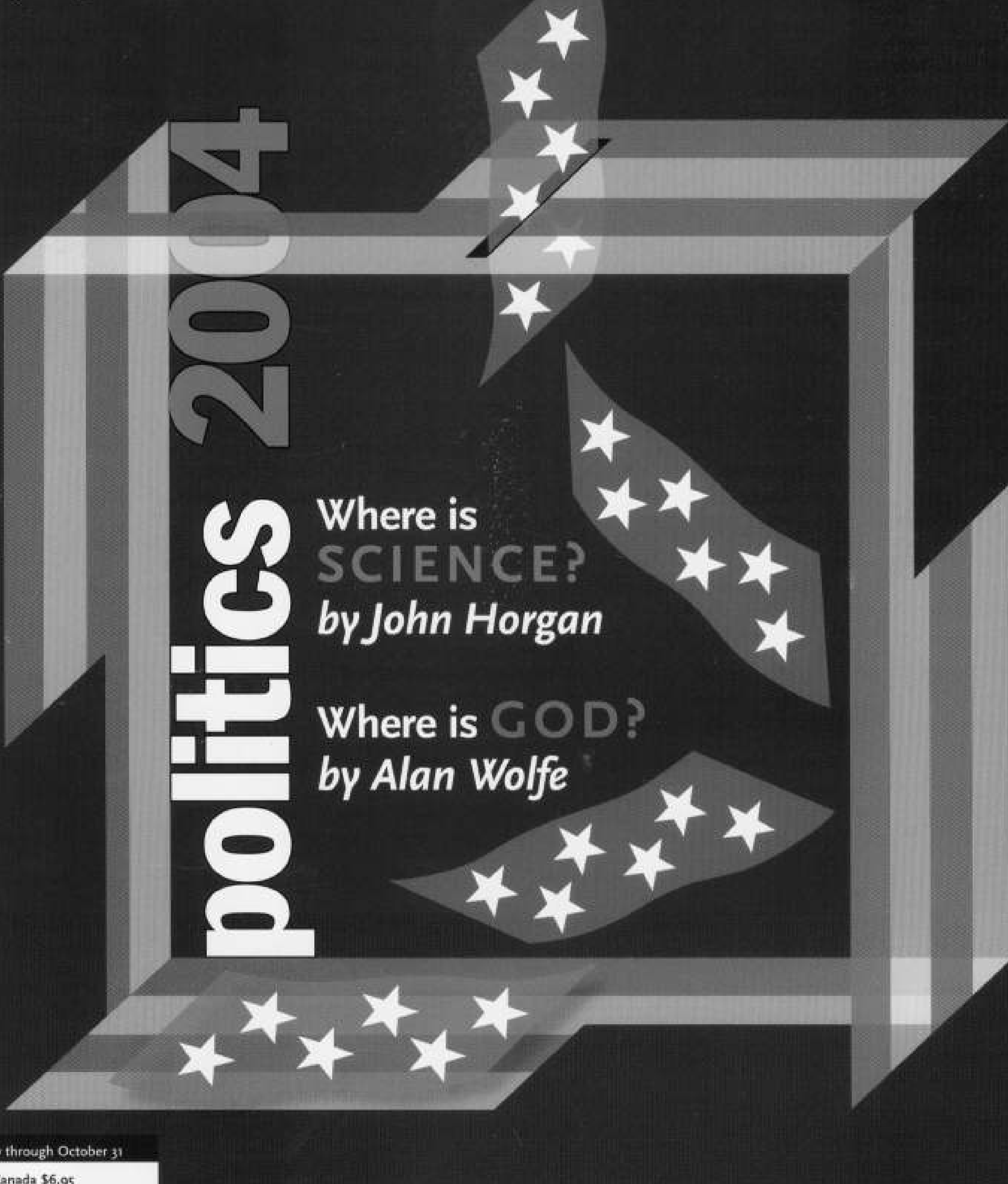

politics 2004

Where is SCIENCE?
by John Horgan

Where is GOD?
by Alan Wolfe

Doctors Are Taking Health Care Off the Grid

With his latest work, astronomer and science historian Owen Gingerich answers a claim made forty-five years ago in the book *The Sleepwalkers* and figures out how we finally came to believe in a universe centered on the sun.

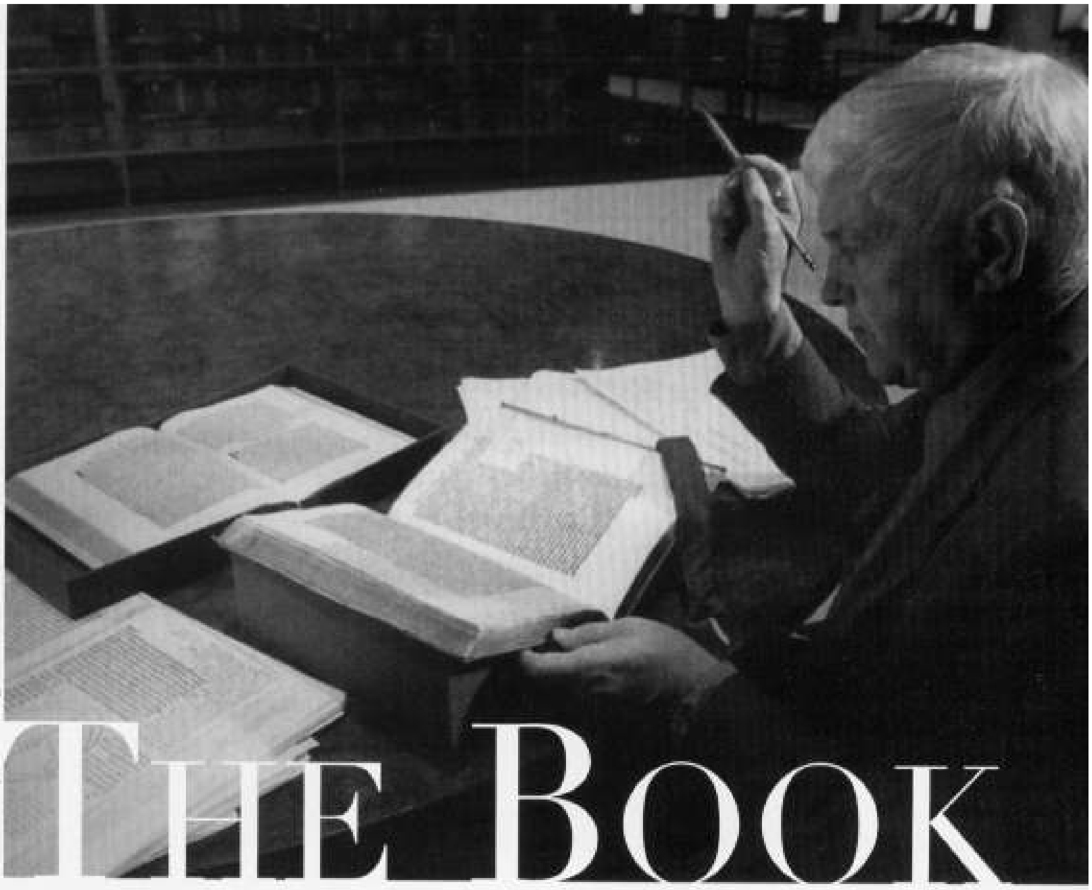

Photo Courtesy Of Eric Long, Smithsonian Institution

THE BOOK *That Moved the World*

NICHOLAS COPERNICUS' sixteenth-century treatise, *De Revolutionibus Orbium Coelestium* ("On The Revolutions of the Heavenly Spheres") is best known today for its introduction, which proposes that the Earth travels around the sun. At the time the work was published, though, neither academics nor theologians were poised to fully understand its revolutionary import, and little was said of this new, heliocentric (or sun-centered) cosmology. More than four centuries after Copernicus' death, writer Arthur Koestler claimed in his 1959 book *The Sleepwalkers* that nobody read *De Revolutionibus* when it first circulated. This claim spurred Harvard-Smithsonian astrophysicist and science historian Owen Gingerich on a three-decade quest, during which he would travel hundreds of thousands of miles and across several continents, all to personally examine the marginal notes made by the book's earliest readers.

The Book Nobody Read is Gingerich's proudly tongue-in-cheek reply to Koestler. People had read Copernicus, Gingerich found—although not in the way that we in the twenty-first century might expect. Gingerich intertwines his scholarly and personal adventures with the subtly persistent suggestion that the most vital cosmological change in Western history came not from one academic discipline, but from the nether regions between philosophy, mathematics, and astronomy. The reality of a sun-centered universe indeed required a whole new framework of thinking—a paradigm shift that paved the way for scientists like Galileo, Kepler, and Newton. Marianna Krejci-Papa sat down with Gingerich at his Harvard office to talk about this revolutionary period within the history of science, which forever altered our concepts of the universe and our place in it.

Science & Spirit: For more than thirty years, you examined marginal notes in 600 copies of *De Revolutionibus*. Did you learn anything that would impact how a layperson perceives Copernicus?

Owen Gingerich: Many people are baffled about the Copernican revolution. For example, why did it take so long for people to see this heliocentric system as a physical description of the universe? Why didn't people wake up the next morning after it was published and say, "This is it, now at last we know how the solar system is made"? Were people bound by superstition? Did religious authority prevent them from accepting the truth? I found that even intelligent and educated astronomers were reading the book but ignoring the heliocentric cosmology. Arthur Koestler, in his 1959 history of astronomy, was wrong. People were reading Copernicus—but not the way Koestler expected them to.

S&S: A proofreader, Andreas Osiander, inserted a letter to the reader into the printed work without Copernicus' knowledge or permission. In this letter, Osiander calls the treatise a mathematical exercise. Did he convince its first readers?

OG: If that letter hadn't been placed there by Osiander, the faculty at Wittenberg [the foremost German university at the time] would have invented that same interpretation anyway. It just made the treatise safe. The idea of a moving Earth totally flew in the face of common sense and of Scripture. In Psalm 103 or 104, depending on which Bible you're using, it says the Lord God "laid the foundations of the Earth that it not be moved forever." Similarly, Joshua, in the battle of Gideon, commanded the sun, not the Earth, to stand still. The cosmology of a moving Earth went against the entire framework of understanding at that time. The back end of the book, the ninety-five percent that dealt with technical mathematical issues of how to achieve uniform motion in all of the planetary circles [the idea that each planet traveled at the same rate, and in perfect circles], seemed a neat aesthetic idea, and was not threatening to anyone's belief system. This part of the book was very popular among astronomers. They were reading *De Revolutionibus* for that reason, rather than for the heliocentric cosmology.

S&S: So this explains why Erasmus Reinhold, the major German math professor of the day, annotated the technical section heavily while passing over the heliocentric part with little commentary?
OG: Exactly.

S&S: Today, every school child knows the Earth travels around the sun. Yet in the sixteenth century, even intellectuals couldn't recognize Copernicus' heliocentric system as a radical new description of the physical universe.
OG: There was a longstanding academic dichotomy: The philosophy professor would teach Aristotle's metaphysics and the mathematics teacher would teach math. The real makeup of the world was in a different academic discipline from either of those. Astronomy books such as Copernicus' were already anomalous in mixing mathematics and geometry with a level of metaphysics—the moving Earth.

S&S: So the study of the actual motion of a celestial body like the Earth was broken up into three different medieval disciplines, and those disciplines each contained a key to understanding Copernicus' work. Could you call *De Revolutionibus* an interdisciplinary work?
OG: I would call it a multidisciplinary work. Physics was in the philosophy department and mathematics was for the astronomers and mathematicians—they didn't really distinguish between astronomers and mathematicians, as astronomy was a branch of geometry.

S&S: Since the tools for understanding heliocentrism were divided up into different disciplines, could we take this one step further and say modern science was born from the intersection of medieval disciplines?
OG: You've got it. The whole intellectual landscape had to undergo a deep kind of disciplinary change. Inspiring this change is part of the achievement of Copernicus.

S&S: Before people could react to Copernicus' treatise, the boxes into which they put knowledge had to change. This explains why it took so long for the treatise to be banned by the Church. It was not put on the Index of Forbidden Books until 1616, and that was more related to Galileo than to Copernicus, wasn't it?
OG: Osiander's letter to the reader served its purpose in preventing ecclesiastical criticism because it framed the book as a fictional calculating device. Galileo and Kepler convinced theorists that the Copernican system was a real blueprint of the cosmos. Galileo made it intellectual to think in heliocentric terms by his dialogue on the two great world systems. Even though Galileo's dialogues didn't contain much new science, they consolidated arguments in a brilliant way and presented them in the Italian vernacular, reaching a wider audience than they would have in Latin, the language of scholars. The pope had to give permission to publish this book. The pope was blindsided—he must have been expecting a dry, technical geometrical treatise, and instead he got a popular polemic that marshaled the arguments for the reality of a moving Earth.

> Why didn't people **wake up** the next morning after it was published and say, "This is it, **now at last** we know how the solar system is made"?

S&S: Galileo took Copernicus literally, popularizing his treatise?
OG: For the technically inclined, the work of Kepler was more convincing than that of Galileo. But Galileo was much more successful as a popular writer than Kepler. Kepler's technical work searched for a physics that would make a moving Earth reasonable.

S&S: If you count Galileo, you could say there have been popularizers of science from the beginning. Did the new technology of the printing press affect the way science or a science community developed?
OG: The printing press revolutionized the intellectual scene in the sixteenth century. It made Martin Luther's Reformation possible because the printing press widely disseminated his sermons and ideas. Similarly, it aided Copernicus. His treatise was published before his ideas became controversial, so the printed editions were like time bombs.

S&S: Once multiple copies were out there, it became difficult to suppress his ideas.
OG: One wonders how the revolution in thinking could have taken place if the treatise hadn't existed in so many copies, if it rather had gathered mold as a manuscript on the library shelf

of a cathedral in northern Poland. The flip side is that the printing press made it possible for Copernicus to gather together in one place the materials he needed as he was writing his treatise. The availability of printed books allowed him to push ahead the way he did.

S&S: In one chapter of your book, you talk about various ways of estimating the size of the print run of the first edition of *De Revolutionibus*. What's at stake in whether the first edition was 400 or 700 copies?
OG: Knowing the number of the first print run allows one to determine how many books survived. By a variety of different methods, I came up with a number between 400 and 500 for the first print run. This means that Copernicus' *De Revolutionibus* had a very high survival rate. This book was therefore appreciated as an important and valuable item early on—it was not thrown away or left where rodents and leaky roofs could damage it.

S&S: Our modern word "science" comes from the Latin *scientia*, which means "knowledge." So in tracing the history of science, we're also tracing the history of how Western culture acquired knowledge.
OG: Studying the history of science puts epistemological questions into perspective: How do we get knowledge? How do we construct a view of the world? What is the validity of our views? I was always interested in how science works and what its claims to truth are. You get depth on these questions by looking at them historically.

S&S: Is that what turned you from an astronomer into a historian of science?
OG: I sometimes say, facetiously, that I'm the victim of anniversaries. The 400th anniversary of the birth of Johannes Kepler in 1971 and the 500th anniversary of Nicholas Copernicus in 1973 marked the end of my writing technical papers. While doing science is valuable, studying its history helps put the big picture together.

S&S: Today, when graduate programs are training scientists in diverse fields, not much of the history of the discipline is included. Is that true, and is it a problem?
OG: It's typically true. Increasingly, though, students are interested in knowing more about the history of the discipline. I use the history of science as a framework for teaching how science works, and for enticing students to look more broadly into the nature of science. Occasionally, one of my students doing an astrophysics degree will also take a master's in the history of science.

S&S: When did the history of science first emerge as its own field?
OG: Johannes Kepler wrote on this topic in the early 1600s. But as a professional discipline, the history of science developed a guild structure only in the 1950s and '60s. Today, the history of science positions at universities are largely populated by people who got their degrees in the history of science, but that wasn't a

possibility much before 1950. Professors then were largely scientists who had a deep interest in history, and switched over.

S&S: The last decade has seen a sudden explosion of interest in "quirky" science stories like *Longitude* and *The Seashell on the Mountaintop*. Each of these books elucidates some aspect of technological or conceptual development. Do you think this fills some particular need that readers of our era have?
OG: There is a long history of this kind of science writing. Sir Arthur Eddington was a science popularizer in the 1930s—stars and atoms was the topic. You will find many titles like this in the 1920s and '30s. Even more interestingly, you get books with a religious dimension as well, like *God and the New Physics* by Paul Davies [published in 1984], for example, and a whole line of them since then. Certainly Eddington, who was a Quaker, had a spiritual dimension in the books he was writing, so these books are nothing terribly new. There just seems to be a more substantial market for them in the past ten years.

S&S: You have asserted that the search for wisdom can take place within both scientific and religious frameworks. Are you a believer in intelligent design?
OG: I don't buy into the intelligent design movement as tantamount to a proof for the existence of God. But if you accept the existence of a designer as a way of making a coherent understanding of the universe, then many physical and biological details help to enforce this view. The universe offers incredible congeniality for the formation of intelligent life. You don't have to change many things and life becomes impossible. I find that awesome. I find the intricacy of the biological world very impressive. Personally, I find coherence in understanding the universe in terms of an intelligent designer. One can look at the scientific picture and say, OK, we're beginning to find out the mechanisms and avenues by which God has created the established order. One of my next projects will be to write a book on evolution designed for a thoughtful but reasonably conservative religious audience.

S&S: You've worn many hats in your long career: astronomer, historian, and now popular writer. Which of these hats suits you best?
OG: The Smithsonian's motto is "the increase and diffusion of knowledge." I have tried to balance both in my career. I have had awards for the increase of knowledge and I am pleased now to be recognized for the diffusion of knowledge as well.

To read an excerpt of The Book Nobody Read, *visit our Web site at www.science-spirit.org.*