FIRST THINGS

A NEW ERA

A REVIEW OF *GOD'S PLANET*

by Stephen M. Barr

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God's Planet

BY OWEN GINGERICH

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According to a famous formulation of Stephen Jay Gould, science and religion constitute "non-overlapping magisteria" or "NOMA." What he meant is that they are separate domains, deal with different questions, and can never conflict if they keep within their own boundaries. Gould's term caught on (despite its misuse of the word *magisterium*), but his idea is not tenable. Some religions make claims about matters on which science has something to say. And some scientific discoveries are relevant to important philosophical questions. So theology cannot be walled off from science. But it is also the case, as Owen Gingerich shows in this set of lectures, that science itself is often influenced by wider currents of thought.

Gingerich is emeritus professor at the Harvard-Smithsonian Center for Astrophysics and a renowned astronomer and historian of science. He is an expert on Copernicus and Kepler, and especially on Copernicus's great treatise *De Revolutionibus Orbium Coelestium*, which sparked the Scientific Revolution. He therefore has an intimate knowledge of how modern science has operated both in its early centuries and lately.

God's Planet consists of three lectures Gingerich gave at Gordon College in 2013 as the Herrmann Lectures on Faith and Science. The first two deal with the theories of Copernicus and Darwin. The third ranges over several questions in modern cosmology.

In the first lecture, Gingerich considers why it took so long for heliocentrism to gain acceptance. Copernicus's book was published in 1543, and yet few astronomers advocated heliocentrism until the

1600s. Arthur Koestler suggested this was because the book went unread; but Gingerich famously tracked down all extant early copies and found that many were carefully annotated by the sixteenth-century astronomers who owned them. Most of those astronomers, however, saw Copernicus's heliocentric system as just another way of doing astronomical calculations, not as a claim about which bodies are in actual motion.

The idea then current was that astronomy is a branch of mathematics devoted to calculating where and when things appear in the sky, whereas it was the job of "philosophy" (as science was then called) to explain the nature and causes of things. It is telling that the great astronomers Tycho Brahe and Johannes Kepler held the title of "Imperial Mathematician" in Prague, whereas Galileo, when accepting a position at the Medici court, insisted his title be "Mathematician *and Philosopher* to the Grand Duke." Boundaries between the disciplines were differently drawn and highly permeable. So too with science and theology. Astronomers on all sides made scriptural and theological arguments to support their ideas. Kepler saw Trinitarian symbolism in the relation of the sun and planets. And Newton invoked divine intervention—in a scientific treatise—to explain the stability of the solar system.

Copernicus was led to his new system partly by aesthetics. He regarded a feature of the Ptolemaic system called "the equant" as ugly and artificial. And the way that system explained certain aspects of planetary motion was ad hoc. Moreover, some beautiful patterns emerged if one assumed the sun was at the center: For example, the speeds of the various planets became correlated in a simple way with their distance from the sun. As late as 1674, the English scientist Robert Hooke noted that the strongest and "better reasoned grounds" for embracing the Copernican system were its "proportion and harmony."

Some might question whether such subjective criteria as "beauty" and "harmony" belong in science, where theories can be evaluated objectively by whether they fit the data. But things are rarely that simple. The Ptolemaic system (suitably refined) *did* fit the data. Or at least it did until 1610, when Galileo discovered the phases of Venus, which revealed that the sun, Earth, and Venus were sometimes configured in ways not possible in the Ptolemaic system. But this only refuted Ptolemy's version of geocentrism. A different version had been proposed in 1588 by Tycho Brahe, and Tycho's system fit all the data, including the phases of Venus, just as well as the system of Copernicus.

In fact, better. There was one fact that posed a great difficulty for heliocentrism. If the Earth really moved around the sun, the apparent positions of stars should change slightly over the course of a year, an effect called "stellar parallax," and no parallax was seen. Copernicans had to explain this by saying the stars were extremely far away, but this ran into a formidable objection. The Jesuit astronomer Riccioli noted that stars had a width as seen in telescopes, and therefore, if as far away as Copernicanism required, must be incredibly large. Astronomers did not realize back then that the type of lenses they were using smeared the images of stars slightly, making them look bigger than they are.

By 1632, Galileo thought he had found two proofs of the Earth's motion, one of them based on his theory of the tides. It is one of the great ironies of scientific history that both of Galileo's proofs and his theory of the tides were wrong. In fact, it simply wasn't possible to resolve the dispute over heliocentrism with the data available in the 1600s. The first real observational evidence of the Earth's motion came in 1729 with the discovery of the "aberration of starlight." In 1736, the slight flattening of the Earth at the poles due to its rotation, which had been predicted by Newton, was confirmed by the arctic expedition of Maupertuis ("the man who flattened the earth"). Only in 1838 was stellar parallax finally observed. In the same year, the Catholic Church removed its censure from Copernicus's *De Revolutionibus*. (Though Gingerich doesn't mention it, the *general* censure of books defending heliocentrism had been lifted already in 1758, at the urging, it seems, of the Jesuit scientist Rudjer Boskovic.)

By 1700, scientific opinion had shifted toward heliocentrism. What caused this, and why did it take so long? In Gingerich's words, "it was the gradual abandonment of an entrenched world view," which envisioned "a tidy universe, the Earth in the center surrounded by the planetary spheres, and, beyond the stars, Dante's layers of the empyrean." There was an impressive coherence to this view, which smoothly integrated the science of the ancient Greeks, theological notions, and common sense. Things fall toward the Earth's center, so it made sense that it should be the center of the universe as well. And nothing was more obvious than the enormous contrast between the earthly realm, with its corruptible beings and unpredictable changes, and the eternal heavenly realm, with its luminous bodies moving in circles that have no beginning or end. Placing the Earth in the heavens threw everything into confusion. Gradually, however, acceptance of Copernicanism grew, "based not on proofs but on the persuasion of what was increasingly seen as a coherent system." The decisive role was played by Newton:

> Newton's [*Principia,* published] in 1687[,] described a solar system [circling] a Sun

> vastly more massive than any of the planets, yet holding them in orbit by the mysterious yet mathematically expressed gravitational power. Even the wayward comets fell into elliptical orbits rounding the Sun. Likewise, calculations showed that people would not be spun off into space by the rotation of the earth. Here was an awesome coherency, persuasion par excellence.

In the story of the gradual acceptance of Darwin's theory, as discussed in Gingerich's second lecture, one can see several parallels. Darwin was led to the idea of evolution by patterns he noticed in the distribution of species. For example, living species were often similar to extinct ones of the same region. And species in the Galapagos Islands seemed related to those on the nearby mainland. Of course, special creation could *fit* this data, but only in an ad hoc way, whereas evolution provided an elegant explanation of the patterns.

As with heliocentrism, though, the data was at first inadequate or even misleading. Certain transitional forms were not seen in the fossil record till long after Darwin. And there was a formidable scientific objection to Darwin's ideas. He could not explain why new traits wouldn't simply be diluted away as they blended with more common traits in later generations. Not until Mendel's discoveries were known could this be answered satisfactorily. Mendelian genetics did for Darwinism what Newtonian physics did for Copernicanism: make it into a consistent and coherent system.

The theological issues Copernicanism had raised were rather peripheral, though they didn't seem so in the feverish times of the Reformation and Counter-Reformation. Even Cardinal Bellarmine had admitted that astronomical matters concerned the faith only "incidentally." Darwinian evolution, however, necessarily involves theological and philosophical issues of the highest importance. One cannot discuss human origins without dealing with the question of what it is to be human, which empirical science alone cannot answer. Gingerich quotes with approval the following statement of Pope John Paul II:

> With man, we find ourselves facing a different ontological order—an ontological leap we could say. . . . The moment of passage into the spiritual realm is not something that can be observed with research in the fields of physics and chemistry

> —although we can nevertheless discern, through experimental research, a series of very valuable signs of what is specifically human life. But the experience of metaphysical knowledge, of self-consciousness and self-awareness, of moral conscience, of liberty, or of aesthetic and religious experience—these must be analyzed through philosophical reflection, while theology seeks to clarify the ultimate meaning of the Creator's designs.

As Gingerich pithily puts it, "the transition to a spiritual being . . . does not fossilize."

With the developments in modern cosmology discussed in Gingerich's third lecture, the domains of science, philosophy, and theology again overlap. Some physicists were skeptical of the Big Bang theory, Gingerich notes, because "it was too much like the Genesis account of God saying 'Let there be light!'" And other scientists were doubtful for philosophical reasons. The lesson of the Copernican controversy, for them, was that science must avoid any trace of anthropocentrism, such as the idea that we live in a special part of the universe. This was formulated as the "Copernican Principle," according to which all regions of the universe must be qualitatively alike. In its strong form it said that all cosmic *times* must be alike as well; that is, the universe has forever been and forever will be much as it is now. This notion led the astrophysicist Fred Hoyle and others to develop the so-called "Steady State Theory" of cosmology as an alternative to the Big Bang theory.

As with heliocentrism and evolution, the Big Bang theory at first faced problems with the data. The first estimates of the age of the universe based on its rate of expansion gave about a billion years, which was inconsistent with the known ages of the oldest rocks and of stars. But those first estimates turned out to be based on a mistaken calculation of the distances between galaxies. Eventually things got sorted out, and evidence for the Big Bang mounted to the point where it is regarded as conclusive. Nevertheless, the idea of an everlasting universe remains philosophically appealing to some scientists. It has inspired numerous speculative cosmological models in which the Big Bang was not the beginning of time, but only one of an infinite number of such explosions in a universe without beginning or end.

The issue of anthropocentrism looms large in two other much-debated questions that Gingerich discusses toward the end of his book: Is there intelligent life elsewhere in the universe? And are the laws of physics “fine-tuned” to make such life possible? This latter idea is often called the “Anthropic Principle.” Ironically, it was Fred Hoyle who discovered one of the most famous and impressive examples of “anthropic fine-tuning”: He showed that if a certain property of the carbon-12 nucleus were not precisely what it is, the universe would have very little carbon, an element crucial for life. This led Hoyle, once an outspoken atheist, to say, “A common sense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as with chemistry and biology,” to make life possible.

For decades, the subject of “anthropic” features of the laws of physics was virtually taboo among scientists. It had obvious religious overtones and looked like an attempt to bring discredited teleology back into science. But some anthropic features were too obvious to ignore, and the “multiverse” idea gave a respectably naturalistic way to account for them. So now many papers on these subjects, including some by top physicists, appear in reputable physics journals. Nevertheless, most physicists remain hostile both to anthropic explanations and to the multiverse idea as untestable and therefore not belonging in science.

One sees from Gingerich’s absorbing narratives the extent to which scientists are sometimes guided by philosophical ideas. Some of these are theological or (more recently) anti-theological. More often, however, they are hunches about the way the world works or convictions about what a valid scientific explanation should look like. This does not impede science; it often propels it. But the older controversies surveyed by Gingerich also show something else. Whatever roles philosophical and theological ideas played in the debates over heliocentrism, biological evolution, and the Big Bang theory, the scientific issues were eventually settled by more and better data and by considerations that were purely “scientific” in the modern sense. To that limited extent Gould was right. There is an internal logic and dynamism to the development of science that determines in the long run where it will end up, notwithstanding the philosophical leanings of scientists themselves.

Now, however, we seem to be entering a new era. Many of the most interesting and fundamental questions that science has stimulated are unlikely to be decidable by new data: Was there something before the Big Bang? Did the universe have a beginning? Do we live in a multiverse? Is the universe infinitely large? Are the laws of nature fine-tuned for life? Are there other intelligent species in the universe? How did the “transition to the spiritual” occur? Increasingly, one finds science lapping over its seawalls. Indeed, in some areas, the boundary between science and speculation has been entirely washed away. Science began with philosophical speculation twenty-five centuries ago, and it seems likely that it will end in the same place.

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