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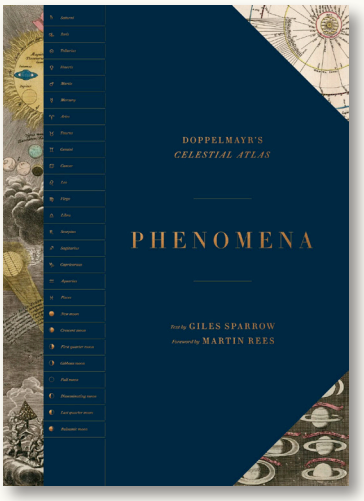

PHENOMENA: DOPPELMAYR'S CELESTIAL ATLAS

By Giles Sparrow

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256 pages, 736 illustrations, 600 color plates

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Review by: Veronica Penney, The Washington Post

We may think of progress in the science of astronomy as the product of a forward march of scientific discoveries to the present day, but *Phenomena: Doppelmayr's Celestial Atlas*, by Giles Sparrow, reminds us that history is never straightforward. *Phenomena* is an exploration and summation of Johann Gabriel Doppelmayr's 1742 *Atlas Coelestis* from the perspectives of both the eighteenth and twenty-first centuries. The *Atlas Coelestis* itself, a best seller of its day, summarized the then-current scientific understanding of planetary movements and physics, and depicted it in thirty "plates," or full-page illustrations, with captions and annotations that made the underlying theories and calculations accessible to a wide readership. Because Doppelmayr was epitomizing what was known about the field of astronomy—rather than introducing new concepts—author Giles Sparrow places Doppelmayr's work in the category of "popular science" (21).

Sparrow creates space to examine Doppelmayr's work and the evolution of astronomy in a way that is rarely offered in the long, sweeping arc of history courses—narratives that often bypass the details of scientific debates. These days, for example, the slow progress of planetary understanding that culminated in the wide acceptance of Copernicus' heliocentric model is easy to overlook. From our modern vantage point, any theories that predated the understanding that the planets orbit the Sun can appear quaint. Yet the widespread acceptance of heliocentric models of the solar system took hundreds of years and countless iterations. Sparrow explores such nuances in an engaging way and provides key context for the inclusion of some non-Copernican planetary models in Doppelmayr's *Atlas*.

Each section of *Phenomena* corresponds with one of the plates in the *Atlas Coelestis*. New technology and theories in the almost three centuries since the book's publication have advanced the field of astronomy, so the text in each section provides key context for why the theories portrayed on each plate were significant at the time. Sparrow begins each section with an overview of the diagrams on the plates and background on the theories they depict. He reproduces each atlas plate in full, at a slightly reduced size, followed by magnified sections showing the detail in the illustrations and images of other research and theories that inspired Doppelmayr's work.

Phenomena is visually stunning. It is printed on generously sized, 10½ by 14⅜ inch pages and bound in a handsome blue cover with gold foil text. Although these pages are only about two-thirds the size of Doppelmayr's, they still allow for large images of Doppelmayr's illustrations and the work that inspired his *Atlas*, all of which are filled with minute writing and intricate detail. *Phenomena* is equally well-suited for use as an historical reference or as a coffee table display to flip through for visual inspiration.

According to Sparrow, the *Atlas Coelestis* illustrations that are reproduced in *Phenomena* "provide an unrivaled insight into the Enlightenment view of the cosmos: a world that had shaken off many of the wrong-headed theories that

had persisted since classical times, but for whom many questions remained unanswered" (12). The inclusion of mythical figures, gods, and references to the Zodiac in Doppelmayr's plates evoke a time when religious beliefs influenced scientific theories, and kings and emperors relied on astronomy and divinations to make important decisions. Sparrow writes that "the *Atlas* remains a salutary reminder that revolutions in the history of science and ideas are always more gradual, more tangled and more intriguing than the 'Just So' stories that we tell ourselves with the benefit of hindsight" (21).

Phenomena illuminates that point in recounting the debate over whether the Sun or Earth is the center of the solar system. In 1543, Copernicus famously published a treatise arguing that the Earth and the other planets in the solar system orbit the Sun. "History is written by the winners," writes Sparrow, "and it is often assumed that, despite his condemnation by the Church, Galileo's discoveries and arguments settled the matter in the mind of all rational thinkers from that point onwards" (12). Yet when the *Atlas Coelestis* published a century later, the debate had not yet been resolved.

A fundamental imperfection in the original Copernican model fueled the debate. Copernicus himself was "unable to break free from the shackles of circular motion at a uniform rate" (54), a carryover of Plato and Aristotle's belief in the perfection of the heavens, which left room for only perfect circles and spheres. A model employing circular paths and constant rates of motion could not adequately predict the observed positions of planets that were actually following elliptical paths. The original Copernican model, like its competing models, relied on complicated systems of epicycles, or smaller orbits imposed upon larger orbits. "For this reason," writes Sparrow, "the initial response to Copernicus's ideas was to treat them as a useful calculating tool, but not necessarily an alternative model that overthrew long-held notions of physical reality" (54). That ongoing debate led Doppelmayer to include some of Tycho Brahe's Earth-centric models in the *Atlas*.

The illustrations in *Phenomena* are exemplary pieces of draftsmanship, but slowing down to spend time with the text yields its own delights. Sparrow's descriptions are rich, filled with anecdotes and details that explore how astronomical findings progressed over time. Sparrow explains how theoretical models—like the idea that the cosmos forms a sphere that mirrors the sphere of Earth—came to be. If constellations rise in the east and set in the west, and if stars circle the poles over the course of twenty-four hours, one explanation could be that the stars are arranged in a spherical framework that rotates around the Earth.

Sparrow's recounting opens a window into the past, tracing how researchers communicated with each other and how knowledge slowly disseminated across countries and continents. He includes reminders of why some measurements were difficult to take and how discoveries were contingent on other technological advances—notably the "longitude problem," or the challenge of determining the relative east-west location of widely separated objects. Observers along the same line of latitude will see the same stars rising and setting at different times, and a measurement of that difference enables them to determine their separation in longitude. However, for centuries, observers relied on the Sun or stars to determine time. At best, they could record celestial positions in local time, but without a synchronized time keeper or rapid communication, they could not easily compare their recorded time with observations made at another location. This obstacle remained until the invention of the pendulum clock and portable chronometer in the seventeenth century.

The chapters that explore Doppelmayr's plates on comets again demonstrate the unresolved state of astronomical knowledge at that time. Sparrow explains that comets behave differently than planets and stars: they travel in straight lines across the sky and can vary widely in appearance and motion. This led to a spirited, centuries-long debate on their nature. Were comets part of the fiery sphere that Aristotle proposed, which hung above the air and below the realm of the stars? Or were they nearby phenomena, occurring within the upper atmosphere? Sparrow's explanation helps us see why, and how, the early stargazers who saw bright streaks of light across the sky struggled to categorize them.

In the centuries since Doppelmayr examined the field, astronomers built more powerful and capable telescopes and the understanding of physics progressed. Sparrow explains how those advancements refined or outright replaced some of the theories depicted in the *Atlas Coelestis*. That nonlinear process of research and refinement is equally applicable to contemporary scientific theories. Today, for example, it is thought that nearly ninety-five percent of the universe is composed of dark energy and dark matter—forces and masses that astronomers and physicists can neither observe

nor completely explain. Could today's accepted models be, in some ways, as nascent as Earth-centric models governed by perfect, circular motion?

On the whole, *Phenomena* is an engaging read, and Sparrow's wit and humor shine through in his commentary. His anecdotes serve as moments of color, such as his story about how one lunar eclipse, accurately predicted, still elicited "much excitement" from astrologers for occurring at the same time as the French "Sun King" Louis XIV's defeat at Barcelona (119).

Phenomena includes two full pages of Maria Clara Eimmert's elegant, blue-and-white illustrations of the moon's phases, but otherwise, female astronomers and researchers are nearly absent from the book. This lacuna reflects the historical exclusion of women from science, and the systematic attribution of their work to male contemporaries. In the final chapter, Sparrow notes how Caroline Herschel's research advanced the field of astronomy in the years following the publication of Doppelmayer's *Atlas*. More than forty years after Doppelmayr's *Atlas* appeared, Herschel published her astronomical findings under her own name—making her the first woman to author a paper in the *Philosophical Transactions* of the Royal Society.

Most of the illustrations in *Phenomena* are of a good size and are well printed. For example, the reproduction of Doppelmayr's second plate shows the Sun with its planets orbiting on (what we now know to be incorrect) circular paths. The model is bordered by illustrations of zodiac constellations and individual labels for stars, and is large enough to be easy to read. However, images of the other detailed maps and charts that contributed to Doppelmayr's *Atlas* —such as Althanasius Kircher's *Typus Corpus Lunaris* map of the moon's surface—are printed in small sizes that make the text and details difficult to see.

Sparrow's descriptions of some of the three-dimensional models and tools of the celestial trade in use during Doppelmayr's time can be challenging to envision, despite the illustrations he provides. Admittedly, these models and tools are complex, unfamiliar to most readers, and challenging to describe in text, but these sections could benefit from more thorough descriptions and additional diagrams showing the instruments at different angles.

Phenomena's historical illustrations have a warmth and humanity that is rare in modern-day scientific communication and data visualizations. Centuries ago, any graphic, no matter how "scientific," had to be turned over to skilled illustrators to even appear in print. The clarity and beauty of the plates in Doppelmayr's *Atlas* are a product of that trade. As Sparrow observes, astronomy in particular lends itself to illustration and art: "The very nature of our place in the cosmos limits our ability to see it clearly," he writes. Even now, astronomers "turn to the talent of artists to bridge the gap and transform equations, digits, and data into visions of other stars and other worlds" (245).

In this age of big data and computer-generated graphics, modern scientists—and even cartographers—could benefit from a return to more artistic and creative forms of visualization. As Sparrow says, "the enticement of visual splendour can be a powerful tool for conveying scientific arguments" (245). *Phenomena*: *Doppelmayr's Celestial Atlas* demonstrates that using "visual splendour" in conveying scientific arguments can be both effective and inspiring, but the question for twenty-first century cartographers is how it can be appropriately used today.