

Biographical Encyclopedia of Astronomers

© 2007 Springer

Copernicus [Coppernig, Copernik], Nicolaus [Nicholas]

Born Toruń, Poland, 19 February 1473

Died Frombork, Poland, 24 May 1543

Nicolaus Copernicus was the astronomer and cosmologist who "stopped the sun and set the earth in motion." His *De revolutionibus orbium coelestium* (On the Revolutions of the Heavenly Spheres, Nuremberg, 1543) for the first time fully explained and supported a heliocentric system.

Copernicus' father, also named Nicholas, was a German-speaking merchant in the Hanseatic town of Toruń, which by treaty in 1466 had become Polish territory. In the 16th century, Poland was a major political force in Eastern Europe, while the German area was a patchwork of duchies and principalities. By the 19th century the roles were reversed, and for a considerable period Poland scarcely existed as an independent country; much of the emerging scholarship on Copernicus was done by German authors. With the re-establishment of Poland after World War I, a bitter intellectual battle over Copernicus' ethnic origins took place, becoming especially shrill in the Nazi period. The spelling of the Copernicus family name became a political shibboleth, with the Germans advocating Coppernig or Koppernigk and the Poles Copernik. In the oldest autograph manuscript signed by Copernicus, he spelled his name Copernik, but throughout his life he appeared indifferent to orthographica and sometimes spelled it Coppernicus. Nicolaus is the Latin form of his first name, used in his scholarly work.

When Nicholas was 10, his father died, and his maternal uncle Lucas Watzenrode, who was making great progress in ecclesiastical studies, politics, became his guardian, sending him to Cracow University (1491–1495) and later to graduate study in Bologna, Italy (1496–1501). In 1495, soon after uncle Lucas became Bishop of Warmia, the northernmost diocese in Poland, he arranged for Nicolaus to become one of the 16 canons, or managers, of the Cathedral Chapter. Copernicus spent his life as a celibate churchman but was never ordained as a priest. With permission from the canons, he returned to Italy to the University of Padua (1501–1503), where he studied medicine. However, after three years, before completing a medical degree, Copernicus briefly went to the University of Ferrara, where he completed his examinations for the degree of Doctor of Canon Law. Biographical data from these earliest years of his life are extremely sparse. For example, his birthday is known only because it appears in an early collection of horoscopes, and the fact that he studied civil law as well as canon (church) law in Bologna is attested solely by two words on a legal document where he served as a witness.

Similarly, information about Copernicus's early interest in astronomy is fragmentary. His library included two 15th-century astronomy books with characteristic Cracow bindings, presumably acquired while he was an undergraduate student. In Bologna he boarded with the professor of astronomy, Domenico da Novara, and made at least one observation there reported in his *De revolutionibus*. Four decades later, Copernicus told his only disciple that around 1500 he had lectured on mathematics in Rome to a crowd of students and experts, but apart from a single sentence nothing more is known of the occasion.

On his return to Poland, Copernicus served as his uncle's personal secretary and physician, working in the Bishop's Palace in Lidzbark (Heilsberg) from 1503 to 1510. With his growing interest in astronomy, Copernicus chose not to seek advancement in church positions, although

his fellow canons placed him He was in charge of cathedral affairs several times. From 1510 his basic residence was in Frombork (Frauenburg), where Copernicus held quarters in a tower in the wall of the cathedral complex, although from 1516 to 1519 he served in Olsztyn (Allenstein) as administrator of the Cathedral Chapter's land holdings in that area.

Precisely when and where Copernicus formulated his heliocentric cosmology is unknown, but evidence points toward the period 1510–1512. A library inventory from 1514 for a Cracow scholar includes a manuscript pamphlet advocating a Sun-centered system, and when such a tract authored by Copernicus was rediscovered in 1878 in Vienna and another copy in 1884 in Stockholm, historians realized that they had recovered an early form of Copernicus' work. The anonymous and untitled document, given the name *Commentariolus* (or Little Commentary), reveals neither the path to his discovery nor the motivations for his heliocentrism, although it expresses strong dissatisfaction with the Ptolemaic equant, which Copernicus believed violated the principle of constructing astronomical explanations from uniform circular motion. Of course, the radical heliocentric arrangement and the mobility of the Earth are quite independent of this ancient principle

When the full Latin text of the *Almagest* was finally printed in 1515, Copernicus must have realized how comprehensive any treatise hoping to compete with Ptolemy's would have to be, and he must have understood as well that he would require critical observations over a fair number of years to confirm or reestablish the parameters of the planetary orbits. Consequently, for the next 15 years, Copernicus devoted his time to making the occasional required observations. In *De revolutionibus*, he used 27 of his own observations and 45 gleaned from the *Almagest*. Copernicus presumably made many more observations, although only a dozen more are documented prior to 1530. Obviously, he made no attempt to observe on a daily or weekly basis, but only at critical times when the geometrical configurations of the planets lent themselves to the determination of the parameters. Copernicus was not a particularly accurate observer, and one of his Mars observations erred by more than 2°. His earliest observation reported in *De revolutionibus* is the occultation of Aldebaran that he observed on 9 March 1497, and the latest is one of slow-moving Saturn, made in 1527. The geometric configuration for Venus was unfavorable in the 16th century, so Copernicus reported only one modern observation of that planet, and none of his own for the planet Mercury.

Throughout the 1520s and 1530s, Copernicus attended to a great variety of Cathedral Chapter business, which included organizing defenses against the encroachments (1520–1525) of the Teutonic knights who occupied the Prussian territory to the east, and framing documents relating to currency reform, where he anticipated Thomas Gresham in formulating the law that bad currency drives out the good

Copernicus continued to labor on his astronomical treatise, which he had already promised in his *Commentariolus*, but he showed persistent reluctance concerning publication despite pressure from his fellow canons (who scarcely understood the technical aspects of his work), including his best friend, Tiedemann Giese. This situation began to change in 1539 when an enthusiastic young mathematician from the Lutheran University of Wittenberg, Rheticus, came for a visit that eventually extended more than two years. Copernicus allowed Rheticus to publish a "first report" on the heliocentric system (*Narratio prima*, Gdansk, 1540), and the favorable reception of that brief account finally encouraged Copernicus to release his manuscript for publication, even though many details still lacked the final polish he desired. In 1541, Rheticus returned to Wittenberg with a copy of the manuscript, and the following spring it went to Nuremberg, where there was a printer, Johannes Petreius, with an international distribution network that could sustain such an undertaking. As the printing progressed, Copernicus received the sheets, carefully marking the errors for inclusion on an errata leaf. The

printing of *De revolutionibus* was completed in April 1543, and according to a letter from Giese, Copernicus, who had meanwhile suffered a stroke, received the final pages on the very day he died

Copernicus presented his new heliocentric cosmology in the first 4% of the treatise, giving his counterarguments to the ancient opinion concerning the immobility of the Earth, and stressing his two most compelling pieces of evidence in favor of the Sun-centered arrangement of the planets. First, the heliocentric system provided a natural explanation for the so-called retrograde motion of the planets, and, second, the unification of the orbits automatically placed the fastest planet, Mercury, closest to the Sun, and lethargic Saturn the farthest, with the Earth's annual period falling nicely between those of Venus and Mars. As he wrote in the soaring cosmological Chapter 10 of Book I, "We find in this arrangement a marvelous common measure of the universe and a sure harmonious connection between the motions and sizes of the orbs, which can be found in no other way." The common measure was the Earth-Sun distance, which provided a measuring stick for the entire system, whose spacings were now linked together. The harmonious connection would find a mathematical expression in Johannes Kepler's third or harmonic law, which in turn gave the clue that the gravitational force from the Sun diminished by the inverse square of the distance.

Finally, Copernicus offered a solid kinematic basis for the phenomenon of precession of the equinoxes, which he described as the conical motion of the Earth's axis.

The remaining 96% of *De revolutionibus* comprised trigonometric rules and tables, a lengthy star catalog adapted from Ptolemy, a detailed determination of planetary parameters from both ancient and modern observations, and tables from which predictions could be made. Considerable attention was given to the use of small epicycles to substitute for Ptolemy's equant mechanism, in general using a single epicycle and eccentric orbital circle for each planet, as opposed to the double epicycle and concentric orbital circle proposed in his earlier *Commentariolus*. His mechanisms scored a major success with respect to the Moon; In Ptolemy's formulation, the Moon's distance varied by more than a factor of two, contrary to observations, and the Copernican scheme considerably ameliorated (but did not entirely eliminate) this problem. Because he relied so heavily on Ptolemy's observations, the accuracy of his system, which was essentially a geometrical transformation of the geocentric arrangement, was not substantially higher than the earlier tables.

When *De revolutionibus* was being printed, Petreius' proofreader, Andreas Osiander, added an anonymous introduction saying that the new cosmology was merely hypothetical, neither necessarily true nor even probable. When Giese saw it, he made a great exception, saying it was contrary to Copernicus' beliefs, and he complained to the Nuremberg city council, but to no avail. While Osiander has been much criticized for his actions, they did have the desired effect of shielding the book from religious critics. In several presentation copies, Rheticus crossed out Osiander's introduction with a red crayon, as well as the words "orbium coelestium" in the title. While it is difficult to see why "heavenly spheres" was objectionable, Copernicus apparently preferred the shorter title, and today most scholars refer to the book simply as *De revolutionibus* (or *The Revolutions*).

Astronomers of the 16th century almost unanimously withheld judgment of the heliocentric proposal in the absence of any physics compatible with a moving Earth and any physical demonstrations or proofs of the Earth's motion; Kepler and Galileo Galilei were two conspicuous exceptions. On the other hand, the idea of replacing the equant with an epicycle, ultimately a scientific dead end, was received with widespread enthusiasm, and Copernicus was reckless in the modern Ptolemy. Eventually, of course, it was the heliocentric arrangement

that paved the way for the concept of universal gravitation and Newtonian physics. Subsequently, he was praised as the Father of the Scientific Revolution.

Owen Gingerich

Alternate name

Kopernigk, Nicolaus [Nicholas]

Selected References

Copernicus, Nicolaus (1952). *On the Revolutions of the Heavenly Spheres*, trans-

Translated by Charles Glen Wallis. In *Ptolemy, Copernicus, Kepler*. Vol. 16 of *Great Books of the Western World*. Chicago: Encyclopaedia Britannica. (See Vol. 15 in the 1955 edition.)

— (1978). *On the Revolutions*, edited by Jerzy Dobrzycki with translation and commentary by Edward Rosen. Baltimore: Johns Hopkins University Press.

Gingerich, Owen (1993). *The Eye of Heaven: Ptolemy, Copernicus, Kepler*. New York: Springer.

— (2002). *An Annotated Census of Copernicus' De Revolutionibus* (Nuremberg, 1543 and Basel, 1566). Leiden: Brill.

Rosen, Edward (1971). *Three Copernican Treatises*. 3rd ed. New York: Octagon Books. (Includes a biography of Copernicus.)

Sverdlow, N. M. and O. Neugebauer (1984). *Mathematical Astronomy in Copernicus's De Revolutionibus*. 2 pp. New York: Springer-Verlag