



From the Annals of the World History

Copernicus

-- 19 February 1473 - 24 May 1543



Nicolaus Copernicus was the first astronomer to formulate a comprehensive heliocentric cosmology, which displaced the Earth from the center of the universe. Copernicus' epochal book, *De revolutionibus orbium coelestium* (On the Revolutions of the Celestial Spheres), published just before his death in 1543, is often regarded as the starting point of modern astronomy and the defining epiphany that began the scientific revolution. His heliocentric model, with the Sun at the center of the universe, demonstrated that the observed motions of celestial objects can be explained without putting Earth at rest in the center of the universe. His work stimulated further scientific investigations, becoming a landmark in the history of science that is often referred to as the Copernican Revolution. Among the great polymaths of the Renaissance, Copernicus was a mathematician, astronomer, physician, quadrilingual polyglot, classical scholar, translator, artist, Catholic cleric, jurist, governor, military leader, diplomat and economist. Among his many responsibilities, astronomy figured as little more than an avocation - yet it was in that field that he made his mark upon the world.

Life

Nicolaus Copernicus was born on 19 February 1473 in the city of Torun (Thorn) in Prusy Królewskie (Royal Prussia), a *provincia* (Region) of the Kingdom of Poland. His father was a merchant from Kraków and his mother was the daughter of a wealthy Torun merchant. Nicolaus was the youngest of four children. His brother Andreas became an Augustinian canon at Frombork (Frauenburg). His sister Barbara, named after her mother, became a Benedictine nun. His sister Katharina married Barthel Gertner, a businessman and city councillor. Copernicus never married nor had children. Copernicus spoke Latin, Polish, and German with equal fluency. He also spoke Greek and Italian. The vast majority of Copernicus' surviving works are in Latin, which in his lifetime was the universal language of academia. Latin was also the official language of the Roman Catholic Church and of Poland's royal court, and thus all of Copernicus' correspondence with the Church and with Polish leaders was in Latin.

Education

Copernicus' uncle seems first to have sent him to the St. John's School at Torun where he himself had been a master. Later the boy attended the Cathedral School at Wloclawek, up the Vistula River from Torun, which prepared pupils for entrance to the Kraków Academy, in Poland's capital. In 1491 Copernicus enrolled in the Kraków Academy (now Jagiellonian University). It was there that he probably first encountered astronomy with Professor Albert Brudzewski. Astronomy soon fascinated him, and he began collecting a large library on the subject. Copernicus' library would later be carried off as war booty by the Swedes during the Deluge; it is now at the Uppsala University Library.

After four years in Kraków, followed by a brief stay back home in Torun, Copernicus went to study law and medicine at the universities of Bologna and Padua. Copernicus' uncle, Lucas Watzenrode the Younger, financed his education. Copernicus, however, while studying canon and civil law at Bologna, met the famous astronomer, Domenico Maria Novara da Ferrara. Copernicus attended Novara's lectures and became his disciple and assistant. Copernicus published his first astronomical observations, made with Novara in 1497, in *De revolutionibus*.

In 1497 Watzenrode was ordained Bishop of Warmia, and Copernicus was named a canon at Frombork Cathedral. But Copernicus remained in Italy, where he attended the Jubilee of 1500. He also went to Rome, where he observed a lunar eclipse and gave lectures in astronomy and mathematics. Copernicus returned to Frombork in 1501. As soon as he arrived, he obtained permission to complete his studies in Padua, where he studied medicine with Guarico and Girolamo Fracastoro, and at Ferrara, where he received a doctorate in canon law on 31 May 1503. One of the subjects that Copernicus must have studied was astrology, since it was considered an important part of a medical education. However, unlike most other prominent Renaissance astronomers, he appears never to have practiced or expressed any interest in astrology.

Work

On 10 January 1503, before obtaining his doctorate in canon law at Ferrara, Copernicus had received a sinecure at the Collegiate Church of the Holy Cross in Wroclaw (Breslau), Silesia, Bohemia. He would hold this for many years before resigning it for health reasons shortly before his death. In 1503, having completed all his studies in Italy, Copernicus returned to Warmia, where he would live out the remaining 40 years of his life. The Prince-Bishopric of Warmia enjoyed substantial autonomy, with its own diet, army, monetary unit (the same as in the other parts of Royal Prussia) and treasury.

From 1503 to 1510, or perhaps till his uncle's death (29 March 1512), Copernicus was his personal secretary and physician and resided in the Bishop's castle at Lidzbark Warminski (Heilsberg). It is there that he began work on his heliocentric theory. In his official capacity, he took part in nearly all his uncle's political, ecclesiastic and administrative-economic duties. It was probably on the latter occasion, in Kraków, that Copernicus submitted for printing at Jan Haller's press his translation, from Greek to Latin, of a collection, by the 7th-century Byzantine historian Theophylact Simocatta, of 85 brief poems called Epistles, or letters,

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supposed to have passed between various characters in a Greek story.



Copernicus' tower at Frombork, where he lived and worked

They are of three kinds—"moral," offering advice on how people should live; "pastoral," giving little pictures of shepherd life; and "amorous," comprising love poems. They are arranged to follow one another in a regular rotation of subjects. Copernicus had translated the Greek verses into Latin prose, and he now published his version as *Theophilacti scolastici Simocati epistolae morales, rurales et amatoriae interpretatione latina*, which he dedicated to his uncle in gratitude for all the benefits he had received from him. With his translation, Copernicus proclaimed himself on the side of the humanists in the struggle over the question whether Greek literature should be revived.

Some time before 1514 at the latest, Copernicus wrote an initial outline of his heliocentric theory known only from later transcripts, by the title *Nicolai Copernici de hypothesibus motuum coelestium a se constitutis commentariolus*—commonly referred to as the *Commentariolus*. It was a succinct theoretical description of the world's heliocentric mechanism, without mathematical apparatus, and differed in some important details of geometric construction from *De revolutionibus*; but it was already based on the same assumptions regarding Earth's triple motions. The *Commentariolus*, which Copernicus consciously saw as merely a first sketch for his planned book, was not intended for printed distribution. He made only a very few manuscript copies available to his closest acquaintances, including, it seems, several Kraków astronomers with whom he collaborated in 1515-30 in observing eclipses. Tycho Brahe would include a fragment from the *Commentariolus* in his own treatise, *Astronomiae instauratae progymnasmatia*, published in Prague in 1602, based on a manuscript that he had received from the Bohemian physician and astronomer Tadeáš Hájek, a friend of Rheticus. The *Commentariolus* would appear complete in print for the first time only in 1878.

In 1510 or 1512 Copernicus moved to Frombork, a town to the northwest at the Vistula Lagoon on the Baltic Sea coast. Copernicus conducted astronomical observations in 1513-16 presumably from his external curia; and in 1522-43, from an unidentified "small tower" (*turricula*), using primitive instruments modeled on ancient ones—the quadrant, triquetrum, armillary sphere. At Frombork Copernicus conducted over half of his more than 60 registered astronomical observations.

In 1526 Copernicus wrote a study on the value of money, *Monetae cudendae ratio*. In it he formulated an early iteration of the theory, now called Gresham's Law, that "bad" (debased) coinage drives "good" (undebased) coinage out of circulation—70 years before Thomas Gresham. He also formulated a version of quantity theory of money. Copernicus' recommendations on monetary reform were widely read by leaders of both Prussia and Poland in their attempts to stabilize currency.

In 1533, Johann Widmanstetter, secretary to Pope Clement VII, explained Copernicus' heliocentric system to the Pope and two cardinals. The Pope was so pleased that he gave Widmanstetter a valuable gift. In 1535 Bernard Wapowski wrote a letter to a gentleman in Vienna, urging him to publish an enclosed almanac, which he claimed had been written by Copernicus. This is the first and only mention of a Copernicus almanac in the historical records. The "almanac" was likely Copernicus' tables of planetary positions. Wapowski's letter mentions Copernicus' theory about the motions of the earth. Nothing came of Wapowski's request, because he died a couple of weeks later.

Some time before 1514 Copernicus made available to friends his "*Commentariolus*" ("Little Commentary"), a forty-page manuscript describing his ideas about the heliocentric hypothesis. It contained seven basic assumptions. Thereafter he continued gathering data for a more detailed work. About 1532 Copernicus had basically completed his work on the manuscript of *De revolutionibus orbium coelestium*; but despite urging by his closest friends, he resisted openly publishing his views, not wishing—as he confessed—to risk the scorn "to which he would expose himself on account of the novelty and incomprehensibility of his theses."

Copernicus was still working on *De revolutionibus orbium coelestium* (even if not convinced that he wanted to publish it) when in 1539 Georg Joachim Rheticus, a Wittenberg mathematician, arrived in Frombork. Philipp Melanchthon, a close theological ally of Martin Luther, had arranged for Rheticus to visit several astronomers and study with them.

Rheticus became Copernicus' pupil, staying with him for two years and writing a book, *Narratio prima* (First Account), outlining the essence of Copernicus' theory. In 1542 Rheticus published a treatise on trigonometry by Copernicus (later included in the second book of *De revolutionibus*). Under strong pressure from Rheticus, and having seen the favorable first general reception of his work, Copernicus finally agreed to give *De revolutionibus* to his close friend, Tiedemann Giese, bishop of Chelmno (Kulm), to be delivered to Rheticus for printing by Johannes Petreius at Nuremberg (Nürnberg). While Rheticus initially supervised the printing, he had to leave Nuremberg before it was completed, and he handed over the task of supervising the rest of the printing to a Lutheran theologian, Andreas Osiander. Osiander added an unauthorised and unsigned preface, defending the work against those who might be offended by the novel hypotheses. He explained that astronomers may find different causes for observed motions, and choose whatever is easier to grasp. As long as a hypothesis allows reliable computation, it does not have to match what a philosopher might seek as the truth.

Death

Copernicus died in Frauenburg (Frombork) on 24 May 1543. Legend has it that the first printed copy of *De*

revolutionibus was placed in his hands on the very day that he died, allowing him to take farewell of his life's work. He is reputed to have awoken from a stroke-induced coma, looked at his book, and then died peacefully.

Copernican System

Philolaus (c. 480-385 BCE), a Greek philosopher of the Pythagorean school, described an astronomical system in which the Earth, Moon, Sun, planets, and stars all revolved about a central fire. Heraclides Ponticus (387-312 BCE) proposed that the Earth rotates on its axis. According to Archimedes, Aristarchus of Samos (310-230 BCE) wrote of heliocentric hypotheses in a book that does not survive. Plutarch wrote that Aristarchus was accused of impiety for "putting the Earth in motion". The prevailing theory in Europe during Copernicus' lifetime was the one that the Greek astronomer Ptolemy published in his *Almagest* circa 150 CE. Ptolemy's system drew on previous Greek theories in which the Earth was the stationary center of the universe. Stars were embedded in a large outer sphere which rotated rapidly, approximately daily, while each of the planets, the Sun, and the Moon were embedded in their own, smaller spheres. Ptolemy's system employed devices, including epicycles, deferents and equants, to account for observations that the paths of these bodies differed from simple, circular orbits centered on the Earth.



Copernicus Heliocentric solar system

Copernicus' major theory was published in *De revolutionibus orbium coelestium* (On the Revolutions of the Celestial Spheres), in the year of his death, 1543, though he had formulated the theory several decades earlier. Copernicus' "**Commentariolus**" summarized his heliocentric theory. It listed the "assumptions" upon which the theory was based as follows:

1. There is no one center of all the celestial circles or spheres.
2. The center of the earth is not the center of the universe, but only of gravity and of the lunar sphere.
3. All the spheres revolve about the sun as their mid-point, and therefore the sun is the center of the universe.
4. The ratio of the earth's distance from the sun to the height of the firmament (outermost celestial sphere containing the stars) is so much smaller than the ratio of the earth's radius to its distance from the sun that the distance from the earth to the sun is imperceptible in comparison with the height of the firmament.
5. Whatever motion appears in the firmament arises not from any motion of the firmament, but from the earth's motion. The earth together with its circumjacent elements performs a complete rotation on its fixed poles in a daily motion, while the firmament and highest heaven abide unchanged.
6. What appear to us as motions of the sun arise not from its motion but from the motion of the earth and our sphere, with which we revolve about the sun like any other planet. The earth has, then, more than one motion.
7. The apparent retrograde and direct motion of the planets arises not from their motion but from the earth's. The motion of the earth alone, therefore, suffices to explain so many apparent inequalities in the heavens.

De revolutionibus itself was divided into six parts, called "books":

- General vision of the heliocentric theory, and a summarized exposition of his idea of the World
- Mainly theoretical, presents the principles of spherical astronomy and a list of stars (as a basis for the arguments developed in the subsequent books)
- Mainly dedicated to the apparent motions of the Sun and to related phenomena
- Description of the Moon and its orbital motions
- Concrete exposition of the new system
- Concrete exposition of the new system

Georg Joachim Rheticus could have been Copernicus' successor, but did not rise to the occasion. Erasmus Reinhold could have been his successor, but died prematurely. The first of the great successors was Tycho Brahe, followed by his erstwhile co-worker, Johannes Kepler.



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