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GEOGRAPHIC

HISTORY

**MYSTERY OF
DELPHI**

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THE ORACLE**

**STONE AGE
CITY LIFE**

**CLOSE QUARTERS
IN ÇATALHÖYÜK**

**COSMIC
CONTROVERSY**

**THE REVOLUTIONARY
IDEAS OF COPERNICUS**

**FIGHTING
WORDS**

**YELLOW JOURNALISM
AND THE SPANISH-
AMERICAN WAR**

PLUS:

**Mesmerized!
The Man Who Discovered
Animal Magnetism**

MARCH/APRIL 2019

H Briggs

Ex libris ex dono celebrissimi
m. s. Henr. Cellieraud;
Fletcher 1634

NICOLAUS COPERNICUS

The Reluctant Revolutionary

As new ideas about science and religion were dividing Europe, a Polish clergyman quietly pieced together a unifying theory that reorganized the heavens.

ERNEST KOWALCZYK

ITEM, DE LIBRIS REVOLUTIONVM NICOLAI
Copernici Narratio prima, per M. Georgium Ioachim-
mum Rheticum ad D. Ioan. Schone-
rum scripta.



Cum Gratia & Priuilegio Cæs. Maiest.
BASILEAE, EX OFFICINA
HENRICPETRINA.



HIS LIFE'S WORK

Copernicus is shown at work in a 20th-century painting by Jean-Léon Huens, commissioned by the National Geographic Society. On the left is the frontispiece of the 1566 second edition of Copernicus's life work, *Six Books Concerning the Revolutions of the Heavenly Orbs*, printed in Basel.

PORTRAIT: NATIONAL GEOGRAPHIC CREATIVE/ALAMY/ACI

FRONTISPICE: CULTURE CLUB/GETTY IMAGES

The Sacred and the Stars

1473

Nicolaus Copernicus is born in Torun, Poland. After his father's death, his uncle, Lucas Watzenrode, a senior cleric, cares for Nicolaus.

1491

Copernicus begins his education in Krakow. Later, he will study law and medicine at Italian universities while also learning astronomy.

1503

Copernicus returns to his homeland and works for his uncle, who has become the Bishop of Warmia, a region near the Baltic Sea.

1512

His uncle dies. Soon after, handwritten copies of Copernicus's *Commentariolus*, are circulated to a select group of scholars.

1533

German humanist J. A. Widmannstetter lectures on the Copernican theory at the Vatican during an audience with Pope Clement VII.

1540

G. J. Rheticus, a follower of the elderly Copernicus, persuades him to publish a one-volume summary of his working theories.

1543

One year after Copernicus agrees to publish his theories in full, *De revolutionibus* rolls off the press. Shortly after, Copernicus dies on May 24.

A 1566 EDITION OF ONE VOLUME IN COPERNICUS'S SIX-TOME WORK, *CONCERNING THE REVOLUTIONS OF THE HEAVENLY ORBS (DE REVOLUTIONIBUS)*.

BRIDGEMAN/ACI



GOD AND COMMERCE

The son of a merchant, Nicolaus Copernicus was born in Torun (above) in 1473. Looming over the Vistula River, the Gothic cathedral reflects the city's medieval wealth.

KRIVINIS/GETTY IMAGES

Rumors were circulating in the 1530s that Nicolaus Copernicus, a cathedral cleric in a small Polish city, had written a revolutionary theory on the cosmos. To the frustration of many, however, the secretive clergyman was refusing to publish it.

Curiosity came from many quarters. One letter, written in 1536, begged for more information. It praised Copernicus's "new theory of the Universe according to which the Earth moves and the Sun occupies the basic, and hence, central, position." Its author was Cardinal Nikolaus von Schönberg, a prince of the Catholic Church.

By placing the sun at the center, Copernicus's idea overturned the ideas devised by the second-century astronomer Ptolemy. In Ptolemy's theory the sun and planets orbited the Earth, which was regarded as the orthodox model across the Christian world. Through decades of work, Copernicus had slowly and carefully found a new way of organizing the heavens, but his reticence kept these new ideas isolated from the public, who could only speculate about them.





POPE GREGORY XIII
PRESIDES OVER DISCUSSIONS
FOR A NEW CALENDAR. 16TH-
CENTURY PAINTING
ORONOV/ALBUM

FAITH IN ASTRONOMY

A CENTURY BEFORE Galileo's persecution, the church's attitude toward astronomy was more open. The Julian calendar, then in use, had become so inexact that it fell out of time with the seasons. Copernicus submitted a statement to a 1512-16 council convened to address the problem, in which he called for more accurate observations. A new "Gregorian" calendar with leap years was introduced under Pope Gregory XIII in 1582 and is still in use today.

A man of both science and faith, Copernicus lived during a time of great change in Europe. A new flowering of humanist thought was spreading throughout the continent, as scholars and artists looked back to the classical era and brought its influence to bear on art, architecture, literature, politics, and science. After Martin Luther published his Ninety-Five Theses in 1517, a religious revolution began that would roil the Catholic Church and form new denominations. Throughout all this tumult, Copernicus held fast at the center, methodically crafting his own astronomical revolution.

A Renaissance Man

Copernicus was born Mikolaj Kopernik in 1473, in Torun, Poland. (Following the custom among scholars in the Renaissance, he later latinized his name.) A major port on the Vistula River, Torun was part of a loose grouping of rich, northern trading cities known as the Hanseatic League. Copernicus's father was a merchant, and historians speculate

SYSTEM UPDATE

Ptolemy, whose venerated Earth-centered system was challenged by Copernicus, is depicted in this 1476 painting by Pedro Berruguete.

BRIDGEMAN/ACI



that he and his family dealt in copper, an association which gave rise to the family name. When Copernicus was 10 years old, his father died, and he went to live with his mother's brother, Lucas Watzenrode. Later appointed the Bishop of Warmia in northern Poland, Watzenrode became an important patron to his nephew.

Copernicus began his university studies in 1491 at the Academy of Krakow (today the Jagiellonian University), which was then attracting some of Europe's finest minds in mathematics and astronomy. Cosmopolitan Krakow, full of merchants and intellectuals, was an exciting place to receive an education. Reports of startling discoveries of new lands across the Atlantic by a Genoese sailor, Christopher Columbus, and the new humanist teachings of the Renaissance, were arriving in Poland from southern Europe. Krakow was the adoptive home of the flamboyant Italian scholar Filippo Buonaccorsi, secretary to the Polish king and tutor to his children.

After several years, Copernicus was drawn to Italy, the epicenter of humanist



LIFE OF THE MIND

An engraving (below) of Filippo Buonaccorsi in the Dominican Monastery of Krakow, shows the Italian humanist in his study. Buonaccorsi helped foster the Renaissance spirit of Krakow that molded Copernicus.

MARY EVANS/AGE FOTOSTOCK

learning at the time. Whatever diffidence he later showed in his scientific theories, Copernicus did not lack funds or time to pursue a solid student career there. In 1497 his uncle appointed him a canon at the cathedral of Frombork in his own diocese, even though Copernicus had begun his Italian studies a year before. The position gave him ample financial security. Well over a decade would pass before the absentee canon took up his duties on the chilly shores of the Baltic; in the interim, Copernicus dedicated himself to university life, first at Bologna, then at Padua, finally emerging as a doctor from the small university of Ferrara in 1503.

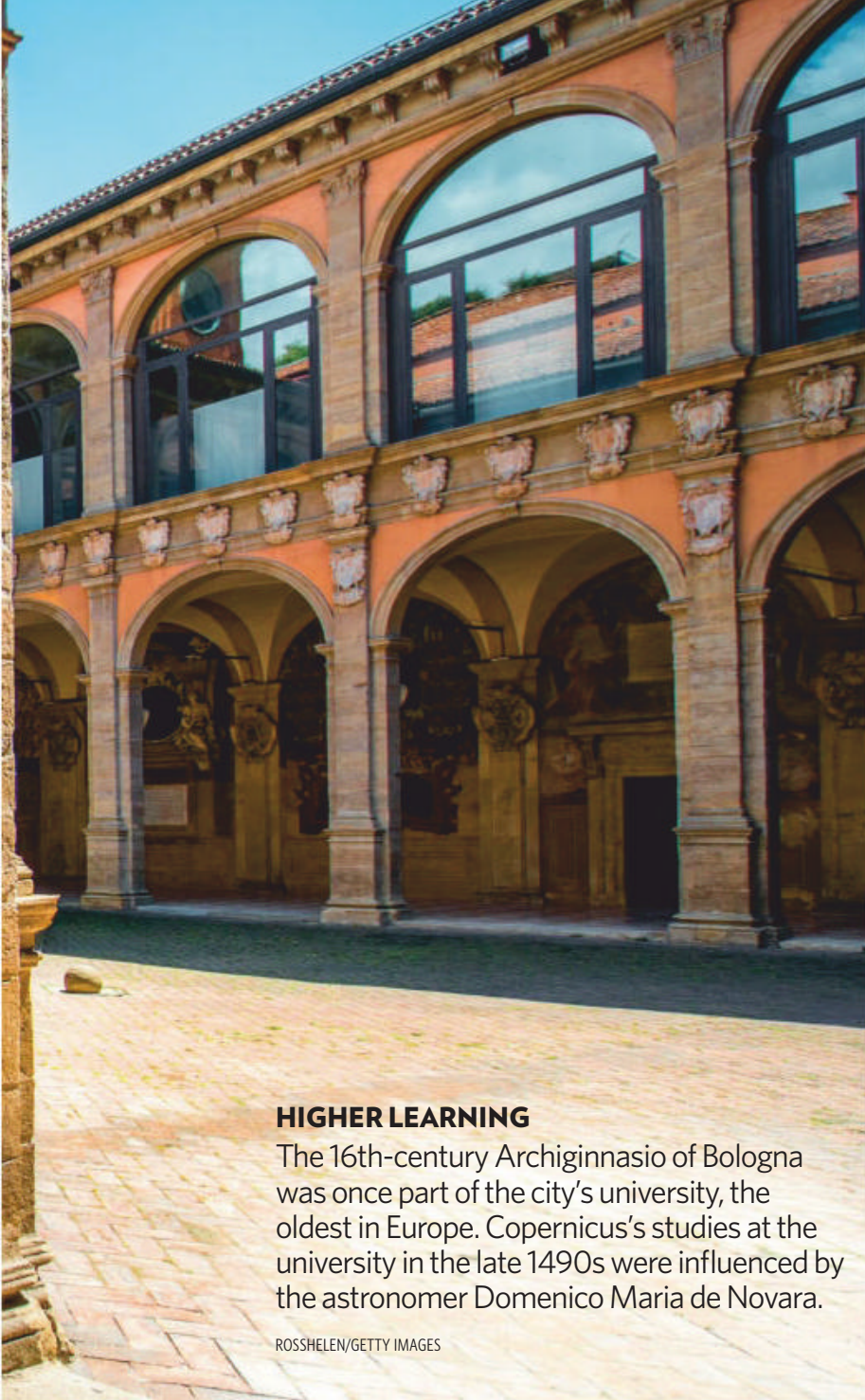
Higher education in this period was much more far-ranging than the specialism of a modern university. His studies included the intricacies of civil and church law, deemed essential for a high-ranking career in the clergy. In addition, Copernicus immersed himself in medicine and mathematics. This pairing was regarded as natural, epitomized in the 16th-century humanist scholar Jakob Milich, who served as both a professor of

mathematics and anatomy. In his later career Copernicus would also be known as much as a physician as a mathematician.

Another discipline that intrigued Copernicus was the study of the stars, which encompassed both astronomy and astrology. Today astronomy is regarded as a science, based on observation, while astrology—the idea that heavenly bodies affect the health and fortunes of people—is not. In Copernicus's time, however, scholars made no clear-cut distinction between the two. Bologna University's astronomer, for example, Domenico Maria de Novara, was tasked with providing astrological predictions for the city's rulers and nobility.

Novara proved to be an important influence on the young Polish stargazer. For a while, Copernicus lodged with him, and the two scholars made observations together. The invention of the telescope would not take place for over a century, so the two men relied on naked-eye observation, using their knowledge of Greek to consult treatises translated from Arabic, or the ancient classical works, such as the writings





HIGHER LEARNING

The 16th-century Archiginnasio of Bologna was once part of the city's university, the oldest in Europe. Copernicus's studies at the university in the late 1490s were influenced by the astronomer Domenico Maria de Novara.

ROSSHELEN/GETTY IMAGES



COPERNICUS OBSERVING THE HEAVENS FROM HIS TOWER AT FROMBORK, 1873 OIL PAINTING BY JAN MATEJKO

BRIDGEMAN/ACI

CLEAR SKIES

A TRADITION holds that Copernicus made astronomical observations from a tower in the cathedral complex at Frombork. He found his adoptive home far from ideal for this purpose, and in *De revolutionibus* expresses his conservative view that things were better in classical times, especially in the land of Ptolemy: "The ancients had the advantage of a clearer sky; the Nile does not exhale such misty vapors as those we get from the Vistula."

of Ptolemy. Some of Ptolemy's assertions were already being questioned by Novara. He introduced Copernicus to the work of Johann Müller, known by his humanistic sobriquet Regiomontanus, another skeptic of the Ptolemaic model.

On March 9, 1497, together with Novara, Copernicus made his first known astronomical observation: At 11 p.m. both watched as the moon briefly eclipsed a distant star, Aldebaran, an event that cast doubt on Ptolemy's theory of the distance of the moon from the Earth. The idea that the Sun was fixed in the center of the cosmos was starting to take hold in Copernicus's mind.

A Theory Evolves

In 1503 Copernicus returned north to his uncle's diocese in Poland. He spent several years working alongside his uncle as both his secretary and personal physician. He took part in minor acts of diplomacy on trips around Poland and also published a translation into Latin of a work by a seventh-century Byzantine historian. After his uncle's death in 1512, he devoted more time to

the duties of a church canon, which were largely administrative: collecting rents, managing finances, securing military resources, and overseeing the local businesses (bakeries, breweries, and mills) of the diocese.

During this time Copernicus also continued his astronomical work. He earned a solid reputation as a leading mind of the time. In 1514 Copernicus was invited to contribute to a council to reform the calendar, so as to enable the church to fix feast days with more accuracy. Later, as an administrator at the Bishop's Castle in the Warmian city of Olsztyn, he produced an astronomical table, or heliograph, still visible on one of the walls of the castle cloister, for observing the movements of the sun.

Sometime before 1514, Copernicus wrote a small treatise, the *Commentariolus* ("little commentary" in Latin). He circulated a few handwritten copies among a learned elite. This small work, described by scholars as "a manuscript of six leaves," first presented Copernicus's notion that the Earth and other planets move while the sun stands still. Using his observations and



▲ *Armillary sphere*

A classic, Earth-centered, brass model made in 1549. The rings show the sun's annual path, equinoxes, solstices, and the zodiac. Pinacoteca Ambrosiana, Milan

BRIDGEMAN/ACI

MAPPING THE STARS

THE FIRST TELESCOPES were developed in the early 1600s. Copernicus was limited to three instruments that the mathematician Ptolemy had described in the second century A.D. Two of these, the triquetrum (upper right) and the quadrant (lower right), were used to measure the height and position of the sun and other heavenly bodies. The third, the armillary sphere (left), shows the apparent movement of the heavens around the Earth. After the Copernican theory gained ground, armillary spheres were made to reflect the sun-centered model.



▲ *Triquetrum*

With its slanted arms, this instrument could measure how high an astronomical object was in the sky. The image shows a replica of the instrument used by Copernicus.

ALAMY/ACI

▼ *Quadrant*

This instrument was used to measure the position of heavenly bodies according to the degrees marked in a semicircle. 1784. Brera Astronomical Observatory, Milan

BRIDGEMAN/ACI

ratione salva manente, nemo enim convenientiore allegabit
 q̄ ut magnitudinē orbium multitudine t̄pis mutatur, ordo sphae-
 rarum sequitur in hunc modū: a sumo capientes micrum.

prima et
 si

1 Stellarū fixarū sphaera immobilis

2 Saturnus xxx anno revoluitur

3 Iovis xij annorū revoluitio

4 Martis bima revoluitio

5 Telluris cū Luna an. re.

6 Veneris nonimēssis
 7 Mercurii xxx dies

SOL

suprema omnium est stellarum

fixarum sphaera separata

et omnia continens

ideoq; immobilis

utempe un-

iversi locus

ad quē

motus

us

et

P

o

A DIAGRAM (DETAIL) FROM COPERNICUS'S WORK *DE REVOLUTIONIBUS*
 FORUM/ALBUM





"THE MONEYCHANGER AND HIS WIFE." 1539 OIL PAINTING BY MARINUS VAN REYMERSWAELE. PRADO MUSEUM, MADRID ALBUM

ECONOMIST AND ASTRONOMER

As Copernicus wrestled with his scientific ideas, his duties as a church administrator led him to develop an important theory of economics. In the 1520s, war between the Teutonic knightly order and Poland affected Frombork and Warmia. Political instability had led to gold and silver being reduced in the coinage, which in turn led to dramatic inflation. In 1528 Copernicus published an influential treatise warning on how debasing coins would lead to the disappearance of high-value, "good" coins from circulation, with baleful economic effects. The phenomenon was also described by the English banker Thomas Gresham, and the Gresham-Copernicus law (as it is now known) is often summarized as "Bad money drives out good."

other research, Copernicus calculated the time each planet took to go around the sun: Mercury (88 days), Venus (225 days), Earth (one year), Mars (1.9 years), Jupiter (12 years), and Saturn (30 years). This pamphlet was the first milestone in Copernicus's journey to redefine the universe.

Gaining Ground

The *Commentariolus*'s early findings raised questions and exposed problems with the data. To avoid errors in his calculations and assumptions, Copernicus spent decades of his life finding the strongest evidence to support his epoch-shaking idea. The *Commentariolus* was only circulated among a few scholars and caused very little commotion.

In the meantime, Copernicus was busy with his duties with the church, whose very foundations were shaken by Martin Luther's dramatic challenge to papal authority in 1517. Throughout the 1520s he helped steer his diocese through the ensuing conflict, taking part in diplomatic missions and even proposing reforms to the monetary system.

Many years later, the *Commentariolus* came to the attention of German humanist Johann Albrecht Widmannstetter. In 1533 he gave a lecture in the Vatican gardens before Pope Clement VII and explained Copernicus's still unpublished theory. The church's interest in his work was genuine, and at this time did not see a sun-centered universe as threatening to orthodoxy.

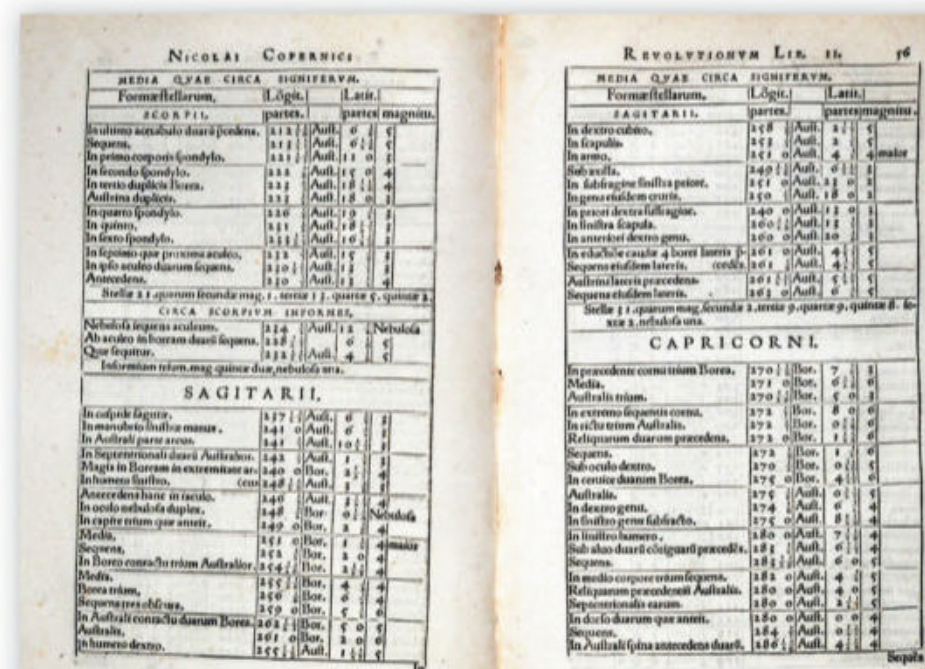
A young Austrian mathematics professor, Georg Joachim Rheticus, was instrumental in helping Copernicus push heliocentrism out to the wider world. In 1539 Rheticus moved to Frombork to work alongside the astronomer for two years and became Copernicus's devoted disciple.

After much persuasion, Rheticus finally managed to convince Copernicus to let him publish an account of

CHARTING THE HEAVENS

Book II (below) of Copernicus's work *Six Books Concerning the Revolutions of the Heavenly Orbs (De revolutionibus)* features astronomical data tables he constructed over his lifetime.

SOCIETY PICTURE LIBRARY/GETTY IMAGES

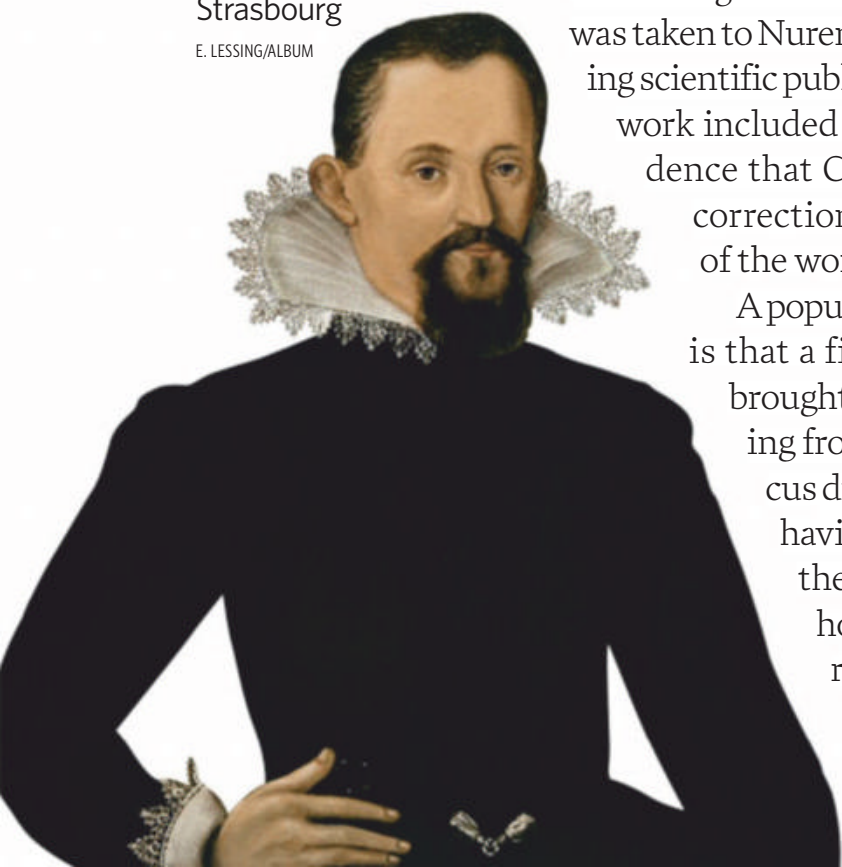




WAITING IN THE WINGS

Johannes Kepler (below) built on Copernicus's work to prove that bodies move in elliptical orbits. 1627 painting, Musée de l'Oeuvre Notre-Dame, Strasbourg

E. LESSING/ALBUM



his theory in 1540. The treatise, called *The First Account of the Book on the Revolutions* by Nicolaus Copernicus, piqued the interest of astronomers all over Europe. They would not have to wait long for a full accounting of Copernicus's astronomical work.

Two years later, the manuscript of *De revolutionibus orbium coelestium libri VI* (*Six Books Concerning the Revolutions of the Heavenly Orbs*), was taken to Nuremberg to be printed by a leading scientific publisher. The lavishly illustrated work included 142 woodcuts. There is evidence that Copernicus made numerous corrections and edits to the first part of the work.

A popular story (perhaps apocryphal) is that a first edition of the book was brought to his deathbed as he lay dying from a stroke in 1543. Copernicus drew his last breath on May 24, having completed his work. Now the rest of the world would see how this humble cleric would reorganize the heavens.

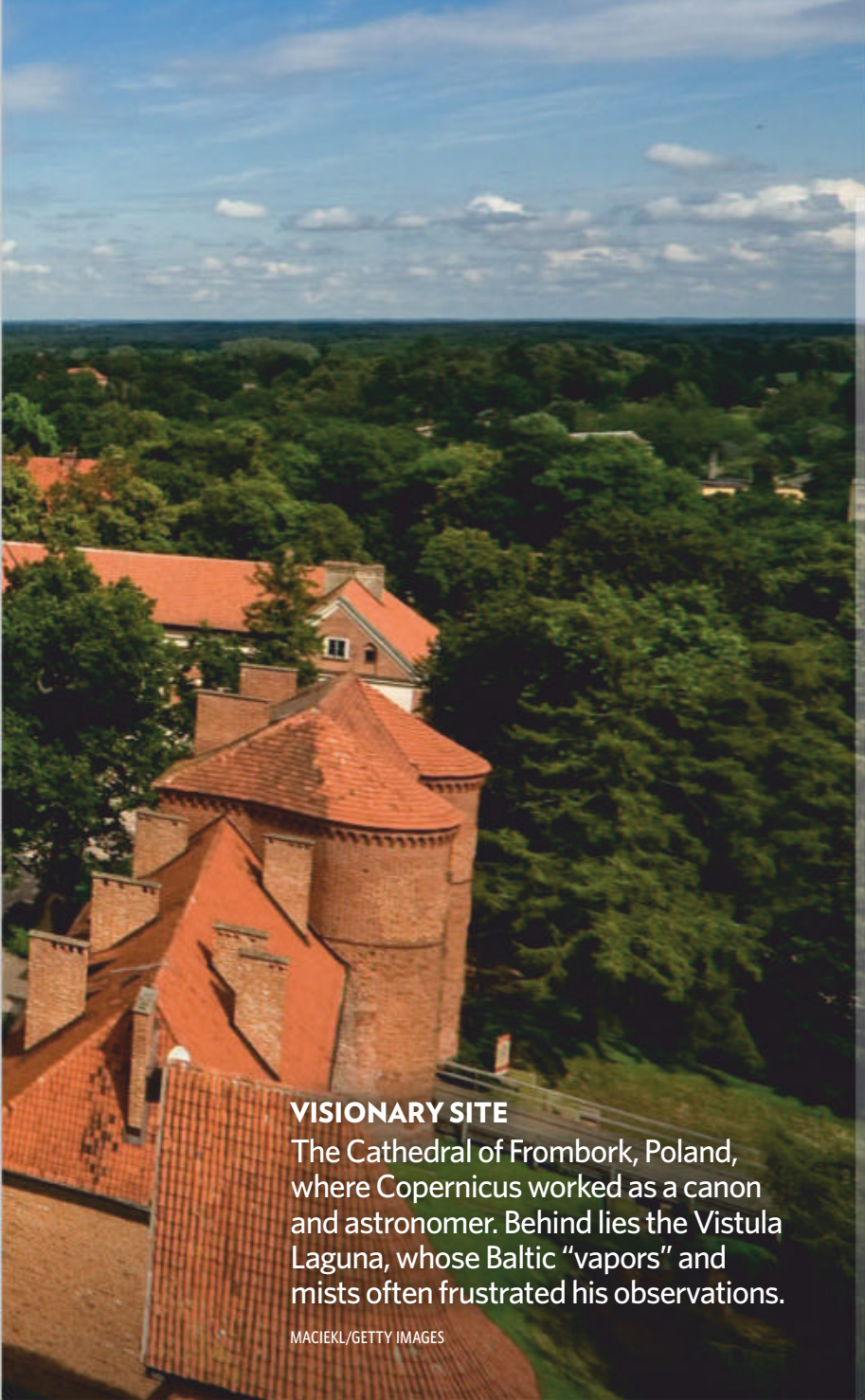
Moving Heaven and Earth

De revolutionibus expands the fundamental ideas put forth in *Commentariolus*. It declares that the Earth orbits the sun in the course of a year, turns around its own axis in the course of a day, and annually tilts on its axis. His sequencing of the planets from the sun—placing the Earth third in line—was to become the accepted order. In his introduction, addressed to Pope Paul III, he explains why he took so long to publish his work:

[T]he scorn which I had reason to fear on account of the novelty and unconventionality of my opinion almost induced me to abandon completely the work which I had undertaken.

His friends were able to convince him otherwise:

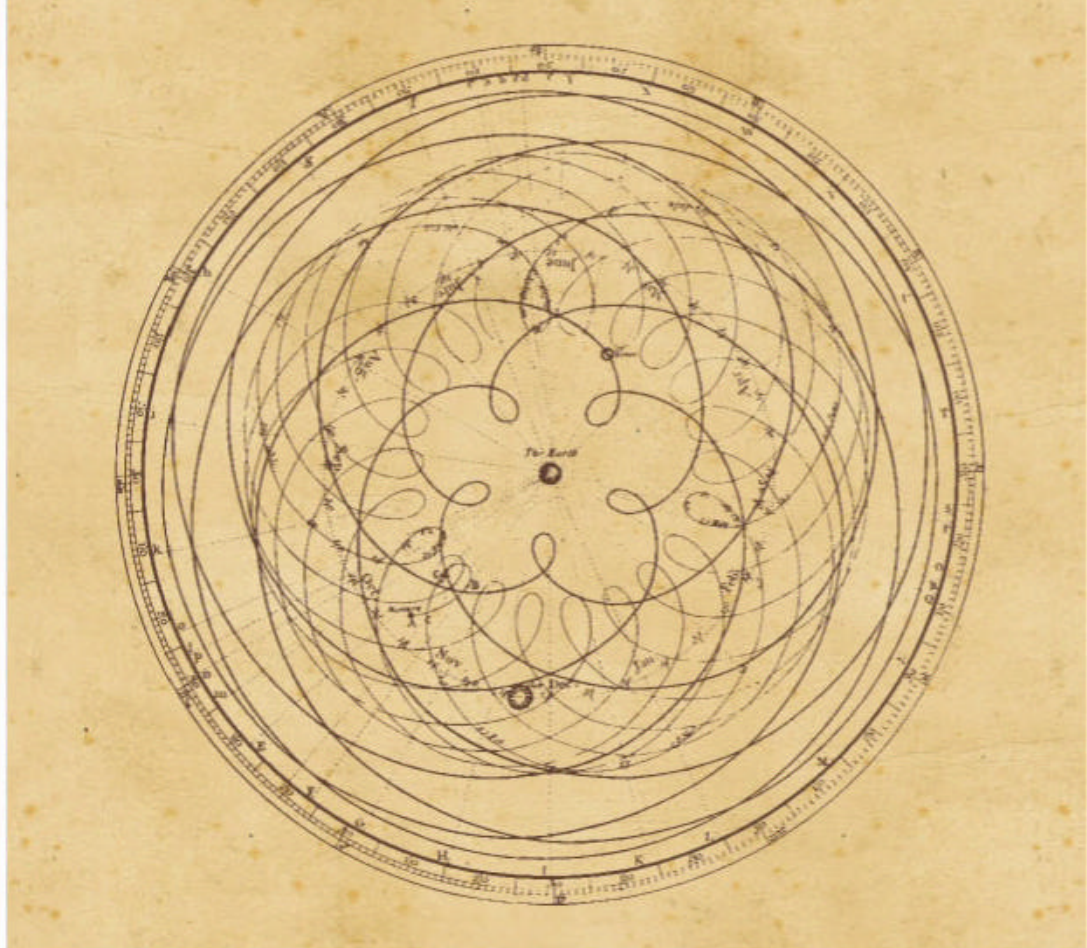
As crazy as my doctrine of the earth's motion now appeared to most people, the argument ran, so much the more admiration and thanks would it gain after they saw the publication of my writings dispel the fog of absurdity by most luminous proofs.



VISIONARY SITE

The Cathedral of Frombork, Poland, where Copernicus worked as a canon and astronomer. Behind lies the Vistula Laguna, whose Baltic “vapors” and mists often frustrated his observations.

MACIEKL/GETTY IMAGES



ROYAL ASTRONOMICAL SOCIETY/SPL/AGE FOTOSTOCK

WHEELS WITHIN WHEELS

COPERNICUS could not let go of an idea enshrined in 350 B.C. by Aristotle in *On the Heavens*: “The circle is a perfect thing.” Only by mounting certain planets on turning wheels known as epicycles could 15th-century astronomers make circular orbits fit with actual planetary behavior. Drawn in 1756 by Scottish astronomer James Ferguson, a diagram (above) of the patterns produced by epicycles reveals how complex their motions would be.

In other ways, however, Copernicus did not break new ground. Solar centrality was not a new idea, as he acknowledged: “I first found in Cicero that Hicetas [a Greek philosopher from the fourth century B.C.] supposed the earth to move.”

Copernicus also got some things wrong. He held on to the idea that orbits were perfectly circular, which was later disproved by Johannes Kepler, who demonstrated that orbits are elliptical. In order to reconcile circular orbits with actual planetary behavior, Copernicus continued the tradition, developed by Ptolemy, of arguing that planets spin on wheels, known as epicycles.

Upon its publication, the Catholic Church was not hostile to *De revolutionibus*. Copernicus had made no attempt to challenge papal authority in his writings, and his dedication goes to great lengths to establish his respect for the pope. By the 1560s several universities, including the University of Salamanca in Spain, a deeply orthodox Catholic institution, had *De revolutionibus* on the curriculum.

This tolerant attitude would shift by the early 1600s, when Galileo Galilei was using the newly

invented telescope to scan the skies. Even as he was becoming increasingly convinced that Copernicus was correct, Galileo was warned by the church in 1616 not to “hold or defend” the Copernican theory. The same year, Copernicus’s *De revolutionibus* was placed on the church’s Index of Forbidden Books.

Science continued moving forward even as Galileo was being silenced. Kepler was working on his laws of planetary motion, and in time, the Copernican model would become universally accepted. Some historians even date the beginnings of the scientific revolution to 1543 and the publication of *De revolutionibus*. As the 21st-century American science writer Dava Sobel put it: “Thanks to Copernicus, the Sun doesn’t set. The Earth turns.” ■

ERNEST KOWALCZYK IS A SENIOR MEMBER OF THE POLISH CULTURAL INSTITUTE IN MADRID.

Learn more

BOOK

A More Perfect Heaven: How Copernicus Revolutionized the Cosmos

Dava Sobel, Bloomsbury USA, 2011.

CENTERED ON THE SUN

Published in 1543, Copernicus's life's work preserves a key tenet of medieval cosmology: The universe is formed of spheres, each one nested within another. Starting with this underlying assumption, Copernicus constructed his theories based not only on mathematics but also on philosophy. Even heliocentricity was influenced by the belief that a central fire animated the whole universe, which was formulated by a follower of the sixth-century B.C. philosopher Pythagoras. The primacy of the sun and its centrality to classical thought is eloquently invoked by Copernicus. In Book I of his great work, he wrote: "Then in the middle of all stands the Sun. For who, in our most beautiful temple, could set this light in a better place than that from which it can illuminate the whole? Not unfittingly do some call it the light of the world, others the soul. Tremigistus calls it the visible God; Sophocles' Electra, the All-seer. And in fact does the sun, seated on his royal throne, guide his family of planets as they circle round him."

SITTING AT THE CENTER, THE SUN ILLUMINATES EIGHT CELESTIAL SPHERES IN COPERNICUS'S MODEL OF THE UNIVERSE.





COPERNICANVM
Systema
TIVS CREATI
THESI
CANA IN
EXHIBITVM.

ORBITA MARS
ORBITA IUPITER
ORBITA SATURNUS
ORBITA VENUS
ORBITA MERCURIUS
ORBITA TERRAE
ORBITA LUNAE
SOL
MARS
IUPITER
SATURNUS
VENUS
MERCURIUS
TERRA
LUNA

THE COPERNICAN MODEL
DEPICTED IN HARMONIA
MACROCOSMICA, A STAR ATLAS
BY ANDREAS CELLARIUS, 1660