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History of Astronomy: The Renaissance

Copernicus and the Heliocentric Revolution

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Conclusion

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Introduction

In the year 1543, a dying canon in a remote Baltic cathedral town published a book that moved the Earth. Nicolaus Copernicus set the Sun at the center of the universe, demoted our world to a planet, and let the whole machinery of the heavens turn around a stationary star. The book appeared, by a coincidence its first readers found deeply meaningful, in the very year its author died, and it opened a century of astronomy so turbulent, so productive, and so dramatic that historians have ever since called it a revolution.

The astronomical Renaissance, the subject of this volume, is the period between roughly Copernicus's education and Galileo's trial, from the closing decades of the fifteenth century to the 1630s. It is a strange and wonderful stretch of history. A Church official, quietly, almost secretly, dismantles the cosmos his employers had certified. A Danish nobleman, the richest astronomer who ever lived, builds a castle observatory on an island granted by his king, catalogs the sky with brass instruments of unprecedented size and precision, and loses his nose in a duel along the way. A poor German mathematician with a gift for grinding lenses points a modified spyglass at the heavens and finds mountains on the Moon, stars beyond counting, and four little worlds circling Jupiter.

An ex-seminarian wanders Europe teaching that the stars are other suns with other earths, and burns at the stake in Rome. And a half-blind, debt-ridden, thoroughly odd imperial mathematician, working from a dead man's observations, discovers that the planets do not move in circles at all, and writes down, in three short laws, the true machinery of the solar system.

The story is usually told as a collision between science and faith, a myth of light against darkness. The truth is more interesting. The Renaissance astronomers were mostly religious men: Copernicus a canon, Kepler a devout Lutheran who wanted to read God's geometrical mind, Galileo a believing Catholic who argued that the Bible teaches how to go to heaven, not how the heavens go. The revolution succeeded not against the culture of its age but through it: through the new printing press that spread the books, the princes who paid for observatories, the humanist scholars who taught Europe to criticize texts, and the colleges and courts that employed mathematicians. When the clash with authority finally came, at the trial of 1633, it was as much about politics, personality, and papal pride as about the structure of the sky.

This book follows the whole arc. Its early chapters trace the revolution's beginnings: the state of astronomy on the eve of Copernicus, the slow gestation of his book, and what it actually argued, which is often not what the

myths say. The middle chapters examine the working life of the new astronomy: the observatory of Tycho Brahe with its instruments and nightly records, the telescope of Galileo and what it showed, the patronage and print culture that made both possible, and the calendar reform of 1582, the era's most practical astronomical achievement. The later chapters carry the story through Kepler's laws and the Rudolphine Tables to the trial, and then look at how modern historians have reassessed everything, what mysteries remain open, and what the whole upheaval meant, a question with more answers than the schoolbook version allows.

No mathematics beyond arithmetic is required, and every technical idea, the epicycle, the parallax, the ellipse, the phases of Venus, is explained in plain words where it first appears. What the reader needs is only curiosity about the century when humanity's address in the universe changed, told here through its books and instruments, its rivalries and its letters, and the actual people, vain, devout, quarrelsome, brilliant, who made the sky modern.

A note on the evidence may help, since this era is unusually well documented. The Renaissance astronomers lived in the first scientific generation that could be followed through their own print and paper: books with named publishers, letters dated to the day, instruments that still sit in museums, and even, in Copernicus's case, the working draft of the masterwork itself. What follows therefore rests on a mountain of surviving material, and where the record is legend rather than fact, the famous deathbed scene, for instance, this book says so. The names are given in their familiar forms, the dates as the sources give them, and the sky itself, which keeps all its old appointments, can still be checked against every claim the era made about it: the positions of 1572's nova, the moons of Jupiter, the phases of Venus, all still perform, four and a half centuries later, exactly as the first observers recorded.

Readers of the earlier volumes in this series will find here the seam where their story meets a new one: the medieval custody of the heavens, described in the book on the medieval centuries, ended by handing the Renaissance exactly the inheritance this volume opens with, the tables, the instruments, the schools, and the calendar problem all described in earlier chapters' terms. The Renaissance, in turn, will hand its own bequest, the Copernican order, Kepler's laws, and the telescopic sky, to the centuries that followed. This book stands at the hinge, the moment the longest custody in the history of science turned into the fastest revision, and it tells the hinge's story whole.

Chapter 1: The Discovery of The Renaissance

The astronomical Renaissance did not announce itself; it accumulated. To see how it began, one must first see what astronomy looked like in the last decades of the fifteenth century, when Copernicus was a student.

The inherited system was the Ptolemaic one, filtered through medieval transmission and taught in every university: a central, motionless Earth, with the Moon, Sun, and five planets carried around it on circles compounded of circles, inside a sphere of fixed stars. The working tools were the Alfonsine Tables, computed in the thirteenth century and worn by two hundred years of copying and use, and the standard curriculum descended from Sacrobosco's textbook and Peurbach's planetary theory, polished by the great

Regiomontanus, whose printed ephemerides of the 1470s had revived the practice of predicting the sky's positions for Europe's physicians and sailors. It was a respectable science, and by 1500 it was showing strain. The tables had drifted; the equinox had slipped nearly ten days from its calendar date; the conjunction of Jupiter and Saturn predicted for 1504 appeared days from where the almanacs put it; and critics, Regiomontanus's own heirs among them, openly called for the re-measurement of everything.

Into this ferment came Nicolaus Copernicus, born in 1473 in Torun on the Vistula, orphaned young, and raised by a clerical uncle who steered him into a church career. His education mapped the international standard: the University of Krakow, famous for astronomy, where he acquired the mathematical arts; then Bologna for canon law, where he lodged with the university's astronomer and made his first recorded observation; then Padua, where medicine was taught, and finally a doctorate in canon law at Ferrara in 1503. He returned to his uncle's diocese as a canon of the chapter at Frauenburg, the little cathedral town on the Frisches Haff where he would spend the rest of his administrative, medical, and astronomical life. The job left time for the sky.

The idea that made him famous seems to have crystallized early. Sometime around 1510, while still in his thirties, Copernicus wrote a brief manuscript, the Commentariolus, the little commentary, which he circulated by hand to a few interested scholars. It survives in a handful of copies, and in it, for the first time in Europe since antiquity, the whole planetary system was rearranged: the Sun stands still at the center; the Earth becomes a planet, third from the Sun, rotating daily on its axis and revolving annually around the Sun; the sphere of the fixed stars becomes vastly more distant; and the apparent loops and retreats of the planets, which Ptolemy had modeled with epicycles, are revealed as optical effects of our own moving vantage point.

The little tract did not argue the case fully; it asserted the design and promised details. But its very quietness is evidence: Copernicus, a canon of a Catholic diocese, knew precisely what a loud assertion would cost, and he spent the following three decades checking, computing, and postponing.

What he did in those decades was attempt to rebuild the whole of planetary astronomy on the new foundation. His surviving working manuscript, its margins crowded with decades of revision, records the labor: observations of eclipses, conjunctions, and occultations made to establish his parameters; a critique of Ptolemy's lunar theory, which he showed predicted an absurdly swollen Moon; treatises on the minting of money and a lost work on the planets; and, eventually, the six books of De revolutionibus, on the revolutions, as the title ran, which he was still correcting in his sixties. The manuscript made no public progress for years, and the story of its rescue belongs to the next stage: in 1539 a young Lutheran mathematician named Georg Joachim

Rheticus arrived at Frauenburg, read the work, and was converted.

He published a first account, the Narratio prima, which circulated widely and won sympathy for the new system, and he took on the duty of shepherding the master's book through the press in Protestant Nuremberg. The printed book appeared in 1543.

The old canon's death framed the publication. Copernicus, paralyzed after a stroke, received, by the traditional account, the finished printed volume on the last day of his life, touching it without knowing, perhaps, what had been printed in it, because the book had been given a preface its author never approved. It is with that preface, and with what the book actually said, that any honest account of the revolution must begin, and the next chapter takes it up directly.

The crisis of prediction, in those same years, gave the young scholar his agenda. The conjunction of Jupiter and Saturn, the slowest and most watched of all planetary events, was predicted for 1504, and the inherited tables disagreed with one another, and with the sky, by days; Copernicus, by one account a student in Bologna at the time, observed the event and its predecessors with his astronomer-landlord and saw at first hand how far the science of the sky had drifted from its subject. The experience, which every working astronomer of the age shared in some form, framed the century's first task: the tables had to be rebuilt, whatever the rebuilding cost, and Copernicus, who never once in his surviving letters claims novelty as his motive, presented his life's work exactly so, as a repair of the art's foundations, undertaken because the old foundations had been measured and found wanting.

One curiosity of the young canon's career belongs here, because it rounds the portrait: the same mind that moved the Earth also wrote, in the 1520s, a treatise on the reform of coinage, a memorandum for his king's Prussian estates on how debased money destroys trade, a document that modern economists cite as one of the first clear statements of the quantity view of money. The two works, heavenly and monetary, are twins: both are Copernicus insisting that a system's instability, planetary or fiscal, must be corrected at its foundations, and both show the same cast of mind, analytic, unhurried, and braver in writing than in publication, for the monetary treatise, like the cosmological one, circulated quietly and was printed only after its author's death.

Krakow deserves its own memory, because the young canon's first university was then the astronomical capital of the north. Its professors had made their name on the tables and the computus, its alumni staffed the northern courts, and its mathematical curriculum, unusually strong for the age, gave the youth from Torun the tools, the alphabets of the heavens and the discipline of the tables, that a lifetime of rebuilding the sky would require. Copernicus kept his Krakow notebooks all his life, and the oldest datable instruments of his observing career are Krakow-trained eyes; the revolution, like every other, began as a student's education.

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ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.