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## 2. Copernicus

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## 2. Copernicus

### Abstract

Nicolaus Copernicus (1473-1543), of German and possibly Polish extraction, spent three years at the University of Cracow and then ten years at Italian universities. In Italy he was introduced to the Pythagorean ideas, which left a permanent mark on his mind, and became interested in astronomical theories. He returned home to the position of canon of Frauenburg cathedral where he stayed until his death. [*excerpt*]

### Keywords

Contemporary Civilization, Nicolaus Copernicus, Pythagorean, Universe, heliocentric, Scientist

### Disciplines

Astrophysics and Astronomy | History | History of Science, Technology, and Medicine

### Comments

This is a part of [Section VIII: The Development of Modern Science](#). The [Contemporary Civilization](#) page lists all additional sections of *Ideas and Institutions of Western Man*, as well as the [Table of Contents](#) for both volumes.

### More About Contemporary Civilization:

From 1947 through 1969, all first-year Gettysburg College students took a two-semester course called Contemporary Civilization. The course was developed at President Henry W.A. Hanson's request with the goal of "introducing the student to the backgrounds of contemporary social problems through the major concepts, ideals, hopes and motivations of western culture since the Middle Ages."

Gettysburg College professors from the history, philosophy, and religion departments developed a textbook for the course. The first edition, published in 1955, was called *An Introduction to Contemporary Civilization and Its Problems*. A second edition, retitled *Ideas and Institutions of Western Man*, was published in 1958 and 1960. It is this second edition that we include here. The copy we digitized is from the Gary T. Hawbaker '66 Collection and the marginalia are his.

### Authors

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*side removed the influence of the church - feeling of man's insignificance  
emphasis on God instead of man. Copernicus Science developed in both religions  
several groups & several answers.*

Nicolaus Copernicus (1473-1543), of German and possibly Polish extraction, spent three years at the University of Cracow and then ten years at Italian universities. In Italy he was introduced to the Pythagorean ideas, which left a permanent mark on his mind, and became interested in astronomical theories. He returned home to the position of canon of Frauenburg cathedral where he stayed until his death.

Copernicus found neither the Aristotelian nor the Ptolemaic theories very satisfactory. To him Aristotelian theory was based on sound physical principles but was not very precise, since no good calculations could be made from it. He granted that the Ptolemaic theory was excellent for describing planetary motions and served as the basis for all astronomical tables, but it violated many of the accepted physical principles. For example, in some cases Ptolemy had used only a uniform angular motion about a point not the center of the circular path instead of true uniform circular motion as prescribed by Aristotle. Both theories were cumbersome. Copernicus said of Ptolemy's theory that it "seemed neither sufficiently absolute nor sufficiently pleasing to the mind."

Copernicus constructed a heliocentric (sun-centered) picture in which the earth along with the other planets whirled around the sun in circular paths. He completed untold calculations that made his results quantitatively as reliable as those derived from the Ptolemaic scheme. He recognized completely the difficulty his work would have getting acceptance from the Church, and for thirty years was reluctant to publish it. Finally he was persuaded by friends, and it is said that the first printing of his book, On the Revolutions of the Heavenly Spheres, was completed on the day he died in 1543.

*Transitional figure - one foot in the old world and one in the new. Broke just on the view of simplicity, and that they had violated the Aristotelian system.*



A question arose immediately about the intent of Copernicus in formulating his new theory. Did he propose that the heliocentric scheme was just a device to simplify calculations, or did he believe that his scheme was really true? If the former were the case, then there could be no argument, since no doctrine had been violated. If the latter were the case, then the Church could be expected to condemn the work.

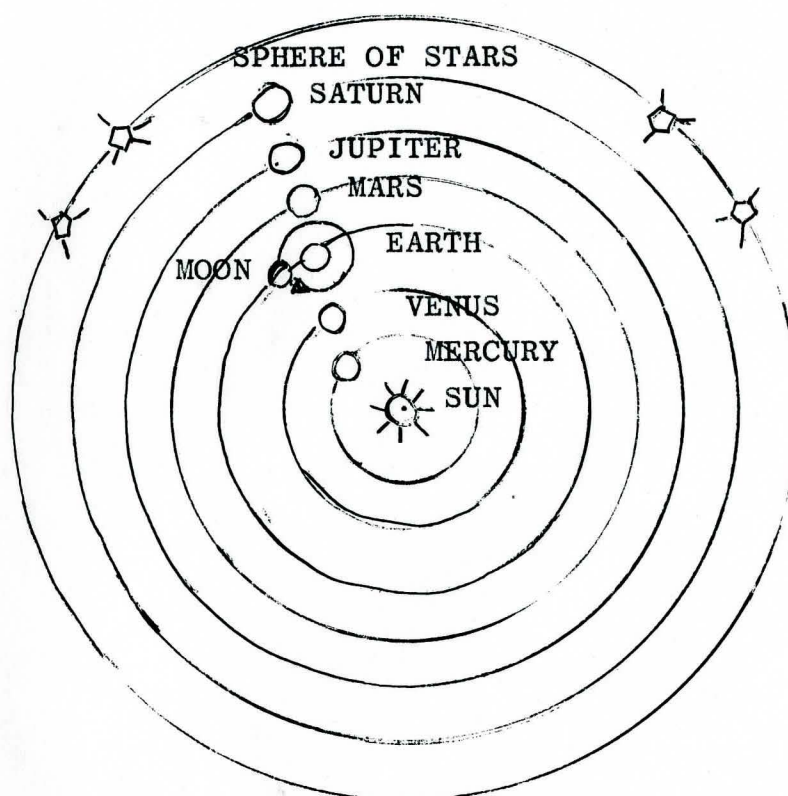
Copernicus was sick while his manuscript was being printed, and its supervision was left to a Lutheran clergyman, Andreas Osiander (1498-1552). Osiander had asked his friend Copernicus to include in the preface the statement that the heliocentric picture was to be considered as a simplifying device and not as the literal truth. Osiander was fearful that the idea of the earth's motion would not find a sympathetic ear among Lutheran thinkers. Copernicus refused to comply with the request. But hoping to save his friend from embarrassment and possibly from more serious difficulty, Osiander added a second, unsigned preface to the original manuscript stating his own position. This small deception was recognized by several of Copernicus' friends, but not before it appeared in print. Copernicus, it seems, believed that the simplest and most "pleasing" mathematical picture was the true picture. His view on this point was without question colored by his acquaintance with classical notions, principally Pythagorean.

The universe as pictured by Copernicus is shown in Figure IV (a). The sun is at rest, and the planets, including the earth, travel in circular paths with the sun at their common center. The moon is a satellite of the earth, and it moves in a circular path about the earth. A single circuit by the earth in its path takes one stellar year. In addition to the earth's motion in its circular path, it spins about its north-south axis once each day. The spinning of the earth from west to east makes it appear that the sun and stars move from east to west.

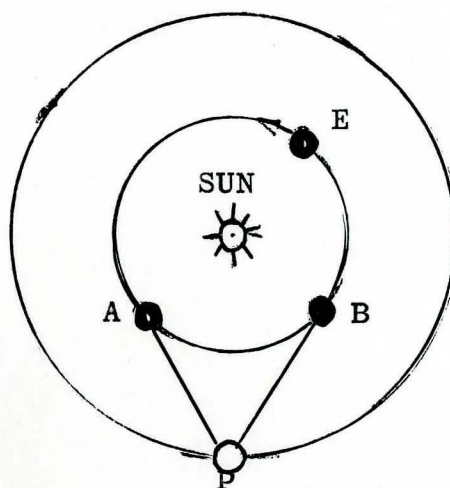
It is a bit more difficult to see how the \*Copernican system accounts for the retrograde motion of the planets. Referring to Figure IV (b), let P be the position of some planet, and for the moment assume that it is standing still. Now as the earth (E) completes one cycle in its orbit, the planet at the point P appears to rock back and forth against the fixed stars as seen by an observer on the earth. The most extreme positions occur when the earth is at the points A and B. Now imagine that the planet P moves slowly in its orbit. Then as seen from the earth, the rocking motion of the planet is superimposed on its simple circular motion. Then at times the planet appears to slow down, stop, and move in the opposite direction, which accounts for its apparent retrograde motion.

Copernicus was able to do much more with his theory than had been done with any previous theory. For example he made a more accurate measurement of the length of a year. He completed astronomical tables allowing the positions of the sun, moon, and planets to be predicted easily for any time. Their





(a) COPERNICUS' VIEW OF THE POSITIONS OF THE SUN, MOON, STARS, AND PLANETS -- THE EARTH BEING A PLANET



(b) EXPLANATION OF THE RETROGRADE MOTION OF A PLANET

FIG. IV. COPERNICUS' THEORY

practical value was no small help in speeding the eventual acceptance of the heliocentric theory. But in spite of the improvement, Copernicus had to resort to the epicycles of Ptolemy for small corrections in the positions of the planets. Some of the tinkering that he did was to bring his theory into agreement with observations which he accepted uncritically and which were later shown to be inaccurate.

We should note here that in spite of the daring Copernicus showed in his work, he still concurred with Aristotle's first principle that circular motion was the natural motion for heavenly bodies. He expressed the faith that the Creator would not have made things except "in the best possible way." He devoted a considerable part of his book to proving that the heliocentric system was as much in accord with Aristotelian physics as were the geocentric systems. He was thus in a quandary; he had to use Aristotelian principles to prove that Aristotle was wrong in concluding the earth to be at rest.

When Copernicus overcame his fears and decided to publish his book, he showed great inspiration by dedicating it to Pope Paul III (1534-1549), who he hoped would afford him protection against whatever persecution might result. In the preface of On the Revolutions of the Heavenly Spheres, he explained to the pope the reasons for presenting his startling new theory. This preface, which Copernicus did write, follows. We note how he included names of important churchmen who had encouraged him in his work and how he referred to those ancients who had proclaimed that the earth moved, realizing that the Church held the ancients in high regard. In this particular instance, it is possible that Copernicus was playing the game of his likely detractors by appealing to authority before any argument even got under way.

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Osiander proved to be a good prophet. The Protestant leaders opposed Copernicus' work from the beginning, and tried to forbid the teaching of the heliocentric theory. Since they desired to return to the Bible as the source of truth, they could not accept a theory that was so obviously in contradiction with the Scriptures ("Sun, stand thou still..." Joshua 10: 12). Luther condemned Copernicus as a fool and as a heretic. The Reformation proved no immediate direct help to science in

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\* Nicolaus Copernicus, On the Revolutions of the Heavenly Spheres, trans. Charles Glenn Wallis, (Volume XVI, Great Books of the Western World) (Chicago: Encyclopaedia Britannica, Inc., 1952), pp. 506-509. Used with permission.



its struggle to free itself from authoritarian control. The heliocentric theory found better fortune with the Roman Catholics, who tolerated it until 1616 when the Revolutions was placed on the Index of Prohibited Books. Strangely enough, the years of grace were likely the result of Osiander's slight case of fraud.

Christian theology had tied itself so closely to Aristotle's philosophy that it could not accept the heliocentric view without exposing much of the rest of its dogma to what it believed to be dangerous misinterpretation. Copernicus, who was a conservative churchman and who wanted a return to the pure first principles of Aristotle, became a menace to the very institutions he wanted most to defend.

Copernicus was not alive to answer the theological criticisms directed at his work, but he had anticipated most of the physical arguments that were to be raised and dealt with them in his book. One of the most telling criticisms goes as follows. If the earth moves in the great circular path described, why do the stars not appear to rock back and forth as we go through one cycle? Why can we always look in the same place in the sky for the same star no matter where we are in our orbit? Copernicus answered along the following lines. The stars no doubt do go through this apparent motion, called parallax, but they are so distant from us that the effect cannot be noticed, the apparent shift being very small for a very distant object. Copernicus turned out to be correct, but the stellar parallax was not noticed until 1838, by which time astronomical instruments had been improved enormously. His reply requires that the distance to the stars be far greater than anyone ever imagined in the sixteenth century, and only a few were convinced.

Many wondered why, if the earth moved, the air and other things on the earth's surface were not left behind. Copernicus replied that since these things were still of an earthly nature they rotated in sympathy with everything else of a like nature. *Aristotelian type of argument*  
*earthly and they seek their natural level.*

When asked why the earth did not fly apart as a result of centrifugal force due to the spinning motion, Copernicus replied that if circular motion was a natural motion no evil effects could come of it. He asked why the sky did not fall apart since it was much larger and hence had to rotate much faster in a geocentric system. Again he did not convince many, for most, like Aristotle, did not believe that the heavenly bodies had weight at all. They believed that the heavenly bodies were made of stuff different from that which made up the earth.

Another interesting reason existed for the resistance to Copernicus. His was an age that believed in astrology. Astrology had even become part of the university curriculum. If the earth were removed from the center of the universe, astrological interpretation of heavenly influences on man's action would



lose its cogency. In any case, man, being a self-centered creature, did not like to be removed from the center of the stage. Copernicus had one early defender in the person of Giordano Bruno (c. 1548-1600). Bruno spent his early life as a Dominican, but he was forced to leave his order and Italy because of his unusual religious beliefs and his lack of due respect for his fellow Dominicans. He was soon driven from Geneva by the Calvinists. He traveled over most of Europe, visiting the major universities and cities. Everywhere he went he expounded his philosophy and his prophetic astronomical beliefs. He thought that there were other suns and planetary systems like our own. He taught that the universe was not bounded by any finite limit but extended infinitely in all directions. He was an ardent Copernican, but he went far beyond what Copernicus would have cared to believe. For instance, he said that the sun rotated about its axis and that the earth was flattened at its poles. He pictured comets as simply another kind of planet, and he anticipated that our solar system might have more planets than were known at the time.

Bruno might have escaped retribution for his unorthodox religious views, but his ideas about the universe apparently could not be forgiven at the very time the Roman Catholic Church was waking to the dangers inherent in the Copernican theory. When he returned to Italy, Bruno was called before the Inquisition. He refused to recant and was burned at the stake in 1600.

We mention Bruno here not simply because he believed that the earth moved about the sun. It was important that he attacked the geocentric system from outside Aristotelian physics. In contrast to Copernicus, he attacked the entire Aristotelian philosophy at every opportunity. As we shall see, the scientific revolution was not to take place until Aristotelian physics was rejected. Bruno, although lacking any scientific evidence, was one of the first to attack it.