CHAMPIONS OF SCIENCE

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This book is dedicated
to
Lenon and Marie Dawson.

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THE DAWN OF MODERN SCIENCE

Suppose a teacher of the 1500s asked a scientific question. Students did not solve it by experiments. Instead, they hurried to find the answer in ancient Greek books. If the answer they found disagreed with what they observed, then the error was with their eyes and not in the ancient books.

Changing this attitude and establishing modern science took exceptional skill and personal courage. Overcoming the powerful authority of the long-dead Greeks was an enormous challenge. One of those who took up the challenge was Copernicus.

The great astronomer Nicolaus Copernicus was born in 1473 in Poland. He was the son of a wealthy family. He was able to attend the best schools to prepare him for any profession he chose. Would he be a scientist? At the University of Krakow in Poland, he took courses in mathematics, philosophy, and astronomy. Would he be a scholar? He traveled to Italy to study literature at Bologna. Would he be a doctor? He studied medicine at Padua, Italy. What about becoming a lawyer? He studied law at the University of Ferrara, Italy.

Copernicus could have been a doctor, lawyer, or held a high government post. Instead, he served as a bishop's private physician. He faithfully devoted most of his time to church work.

Nicolaus Copernicus

In his spare time, Copernicus studied astronomy. One practical reason to study astronomy was to produce an accurate calendar. A calendar was important to merchants, churchgoers, and country people. Most calendars listed more than days, weeks, and months. The extended calendars were known as almanacs, from an Arab word meaning a calendar of the heavens.

Almanacs contained information such as times of sunrise, sunset, full moon, and holidays. In addition, they usually contained remembrances of historical events, riddles, pithy sayings, simple home remedies for sickness or injuries, and other tips for a better life. A well-written almanac would be used every day, the year around.

Farmers used almanacs to plan when to plant and harvest crops. Governments and church leaders relied on calendars and almanacs to mark off holidays and special events. Some communities planned a harvest festival on the first full moon in October.

How does a person who makes a calendar or almanac know when the events will occur? The Bible says that God made the sun, moon, and stars. In Genesis 1:14 the Bible reads: "And God

said, 'Let there be lights in the expanse of the sky to separate the day from the night, and let them serve as signs to mark seasons and days and years.' "

Astronomers calculated orbits of planets to predict their positions and forecast celestial events such as eclipses. A skilled astronomer could calculate the position of sun, moon, and planets for a date far in the future. Almanacs and calendars were built from this information.

Astronomers today use computers to calculate celestial events. Five hundred years ago, Copernicus had to make these difficult calculations with pen and paper. The calculations were not easy and were prone to error. One problem was the complicated way that Greek astronomers viewed the planetary system.

Aristotle, an important Greek scholar, wrote about astronomy. Few people dared to question his ideas. What Aristotle said settled the matter. He put a motionless earth at the very center of the universe. Everything in the sky revolved around our planet. He believed the circle to be the perfect figure. Aristotle reasoned that heavenly bodies were perfect, so their paths must be perfectly circular. The sun, moon, and each of the five visible planets were carried around in circular orbits.

Copernicus, like astronomers after Aristotle, noticed a puzzling change in the paths of the planets Mars, Jupiter, and Saturn. Every once in a while these planets slowed in their forward orbit. They stopped, made a backward loop and then went forward again.

Greek astronomers struggled to preserve Aristotle's plan for the heavens. One Greek astronomer, Ptolemy, succeeded in explaining the backward loops of Mars, Jupiter, and Saturn. He used a combination of smaller circles looping around larger circles. In all, his complex system employed 70 circles.

Copernicus could not believe that tracking the sun, moon, and five planets would take 70 circles.

To simplify matters, Copernicus made two assumptions: the earth rotates on its axis every 24 hours, and the sun is at the center of the planetary system.

The sun-centered model of the solar system explained the backward loops of Mars, Jupiter, and Saturn. Those planets orbited further from the sun than the earth. As the earth overtook them, they fell behind. They seemed to travel in reverse. Mars orbited the sun in two years but the earth sped around in only one year. When earth passed Mars, it seemed to fall backwards.

Copernicus explained it with an example. Imagine a speedy horse passing a slower cart. Both are going in the same direction. The horse overtakes the cart and passes it. To the rider on the horse, the cart appears to fall behind.

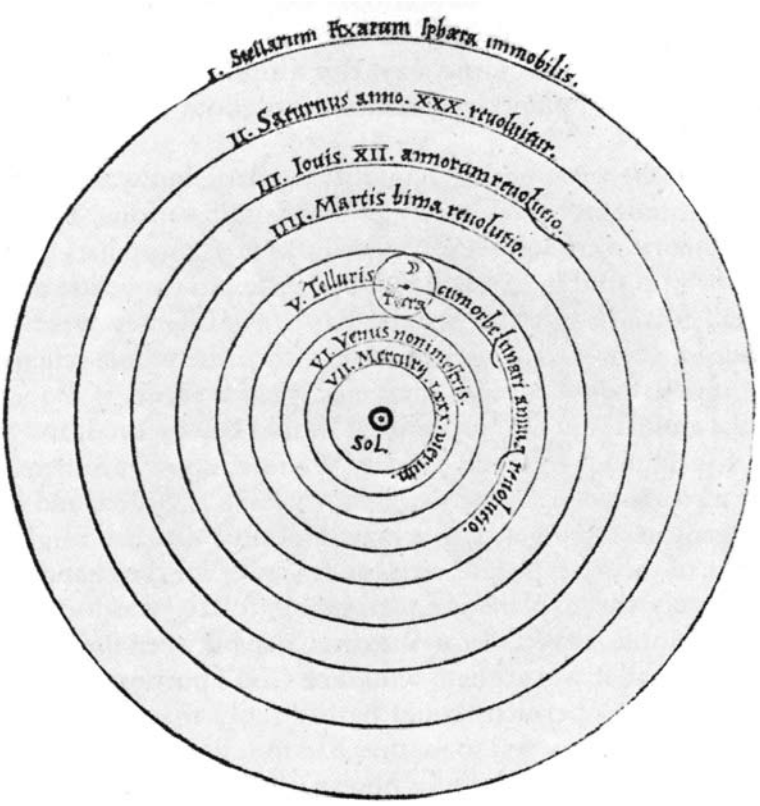
Copernicus worked out his system in full mathematical detail. He summarized his ideas in a short, handwritten manuscript. He sent it around to his friends and fellow scientists. He still used circles to describe planetary motions. Also, he didn't entirely eliminate all the extra, small circles that Ptolemy used. However, Copernicus' ideas did make easier the prediction of celestial events.

At first, Copernicus recommended his system only because it was quicker and more accurate. Then he noticed that his sun-centered planetary system could explain observations that baffled the Greeks. For instance, Mars changed in brightness. During a period of about two years, it faded from a bright red object to a much dimmer light. Why?

The earth-centered planetary system of Greek science offered no explanation. According to Aristotle, Mars circled the earth. It should have been equally bright the year around.

Copernicus' system gave a reason. Mars and Earth both traveled around the sun. They orbited at different speeds. Sometimes their orbits brought them closer together. Mars looked brighter. At other times, their orbits drew them farther apart. From the greater distance, Mars looked dimmer.

Copernicus spent many years gathering evidence for his sun-centered theory. He observed the planets carefully and made detailed calculations. He improved the original handwritten manuscript. He called the new book *On the Revolution of the Celestial Sphere*.



A diagram of Copernicus' sun-centered system of the universe, from his book in 1543.

Friends encouraged Copernicus to publish the book but he hesitated. People believed that everything had a natural place. Flame rose to the sky because that was its natural place. Rocks fell to earth because that was their natural place. Kings sat on their thrones because that was their natural place.

Rulers did not encourage new ideas. Suppose astronomers removed the earth from its natural place as the center of the universe. People might think a king didn't belong on his throne at the center of the kingdom. New ideas led to unrest. Those in power punished authors of books that caused problems.

Finally, Copernicus took the dangerous step. He sent his manuscript to a printer. On May 24, 1543, he lay in bed desperately ill. The first copy of the book arrived. A friend put the book in his hands. Copernicus died that same day.

In his book, Copernicus gave evidence that the sun and not the earth was at the center of the planetary system. He correctly stated that the earth is a globe that spins on its axis. The earth and all the planets revolve around the sun. The moon alone orbits the earth.

The honor of writing the first modern book on science belongs to Copernicus. The publication of *On the Revolution* began a revolution not only in astronomy but also in all science.