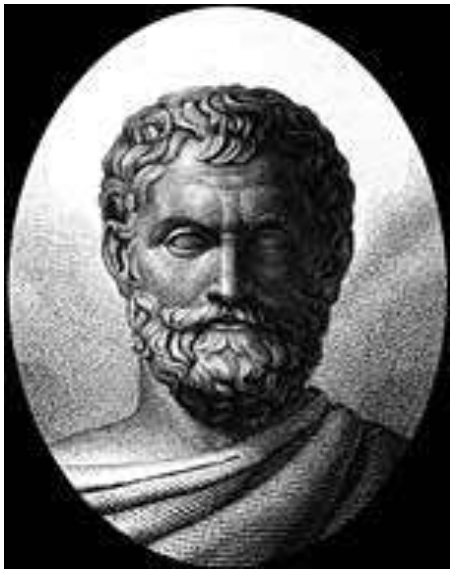
Eratosthenes of Cyrene: The Father of Geography

Eratosthenes, in full Eratosthenes of Cyrene, (born c. 276 BCE, Cyrene, Libya—died c. 194 BCE, Alexandria, Egypt), Greek scientific writer, astronomer, and poet, who made the first measurement of the size of Earth for which any details are known.

The life of Eratosthenes



Eratosthenes was the founder of scientific chronology; he endeavored to revise the dates of the chief literary and political 1events from the conquest of Troy. Eratosthenes dated The Sack of Troy to 1183 BC. In number theory, he introduced the sieve of Eratosthenes, an efficient method of identifying prime numbers. After studding in Alexandria and Athens, Eratosthenes settled in Alexandria about 255 BCE and became director of the great library there. He tried to fix the dates of literary and political events since the siege of Troy. His writings included a poem inspired by astronomy, as well as works on the theatre and on ethics

He was a figure of influence in many fields. According to an entry in the Suda (a 10th-century reference), his critics scorned him, calling him Beta (the second letter of the Greek alphabet) because he always came in second in all his endeavors. Nonetheless, his devotees nicknamed him Pentathlos after the Olympians who were well rounded competitors, for he had proven himself to be knowledgeable in every area of learning. Eratosthenes yearned to understand the complexities of the entire world. Eratosthenes was afflicted by blindness in his old age, and he is said to have committed suicide.

Earth is not flat: The experiment

At Syene (now Aswān), some 800 km (500 miles) southeast of Alexandria in Egypt, the Sun’s rays fall vertically at noon at the summer solstice. Eratosthenes noted that at Alexandria, at the same date and time, sunlight fell at an angle of about 7.2° from the vertical. (Writing before the Greeks adopted the degree, a Babylonian unit of measure, he actually said “a fiftieth of a circle.”)

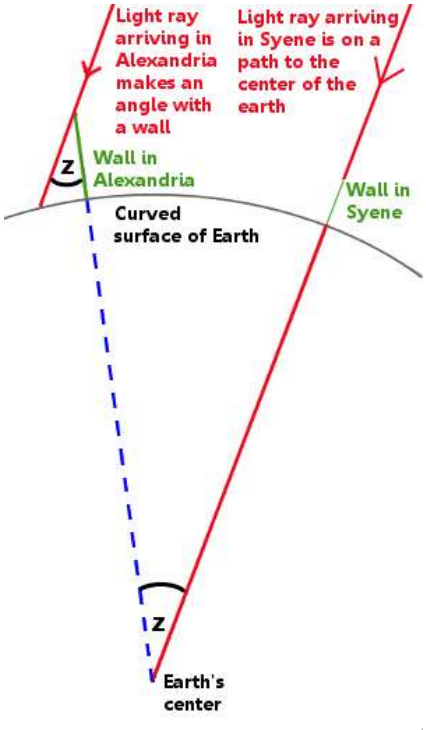
He correctly assumed the Sun's distance to be very great; its rays therefore are practically parallel when they reach Earth. Given an estimate of the distance between the two cities, he was able to calculate the circumference of Earth, obtaining 250,000 stadia. Earlier estimates of the circumference of Earth had been made (for example, Aristotle says that "some mathematicians" had obtained a value of 400,000 stadia), but no details of their methods have survived. An account of Eratosthenes' method is preserved in the Greek astronomer Cleomedes' Meteora.

The exact length of the units (stadia) he used is doubtful, and the accuracy of his result is therefore uncertain. His measurement of Earth's circumference may have varied by 0.5 to 17 percent from the value accepted by modern astronomers, but it was certainly in the right range. He also measured the degree of obliquity of the ecliptic (in effect, the tilt of Earth's axis) and wrote a treatise on the octaëteris, an eight-year lunar-solar cycle. His only surviving work is Catasterisms, a book about the constellations, which gives a description and story for each constellation, as well as a count of the number of stars contained in it, but the attribution of this work has been doubted by some scholars.

His mathematical work is known principally from the writings of the Greek geometer Pappus of Alexandria, and his geographical work from the first two books of the Geography of the Greek geographer Strabo.

The Calculation

On the diagram below, the angle z is the angle of shadow Eratosthenes found in Alexandria. He found it was one-fiftieth of a whole circle.



Using a little simple Euclidean geometry, he knew that by drawing a line downward from each wall to the center of the earth, they would form the same angle z.

This meant the distance from Syene to Alexandria was one-fiftieth of the distance all the way around planet Earth.

His maps told Eratosthenes the distance from Alexandria to Syene was 5000 stades. Eratosthenes multiplied 50 x 5000 to get an answer of 250,000 stades for Earth's

circumference. He then added a correction of 2000 stades (lacking his original work, we don't know why he did this) and concluded that:
Earth's circumference is equal to 252,000 stades. All we need to do now is convert stades to modern units.

Eratosthenes lifetime achievements

• Eratosthenes produced a reliable, logical method to discover prime numbers: The Sieve of Eratosthenes. In an updated form, this is still important in modern number theory.

• In about 240 BC Eratosthenes calculated Earth's size with good accuracy. This was a moment of triumph for the human intellect: first to recognize our planet is a sphere, then to use the powers of observation, deduction, and mathematics to calculate its size.

• Eratosthenes saw that the heavens seemed to rotate once a day around Earth. The axis of rotation formed an imaginary line from the North Pole to the South Pole through Earth's center. Eratosthenes calculated the tilt of Earth's axis relative to the plane of its equator with good accuracy.

• He produced the first map of the world featuring meridian lines and parallel lines. These were similar to our modern lines of latitude and longitude. He marked the equator and its size, considered the size of the polar zones and how far these zones were from the tropics. (Evidently, the Ancient Greeks knew a lot about our planet!)

• He invented the armillary sphere, for 1800 years the most important instrument in astronomy for determining the positions of celestial objects.

• He invented geography. We still use the word he coined for the discipline. ('Geo' was Greek for 'Earth' and 'graphy' meant 'field of study.')

• He was the first person to explain why the River Nile flooded every year – i.e. heavy, seasonal rains fall near the source of the river causing an annual flood in Egypt.

This was created by students taking part in the programme "Four Seasons in the Sky"