Let's look back on some of the most notable personalities and principles that have shaped the field of astronomy into what it is today.

Early Astronomy.

The roots of modern astronomy or **early astronomy** can be traced back to Ancient Greece during the **"Golden Age" of astronomy** (600 B.C. – 150 A.D.). During this time, the early Greeks developed geometry and trigonometry and utilized these in order to discern and describe observable celestial bodies.

The early Greeks believed that the Earth was the center of the universe and that all the other heavenly bodies orbited around it. This was known as the **geocentric model** (from the Greek word *geo* meaning "Earth") of the universe.

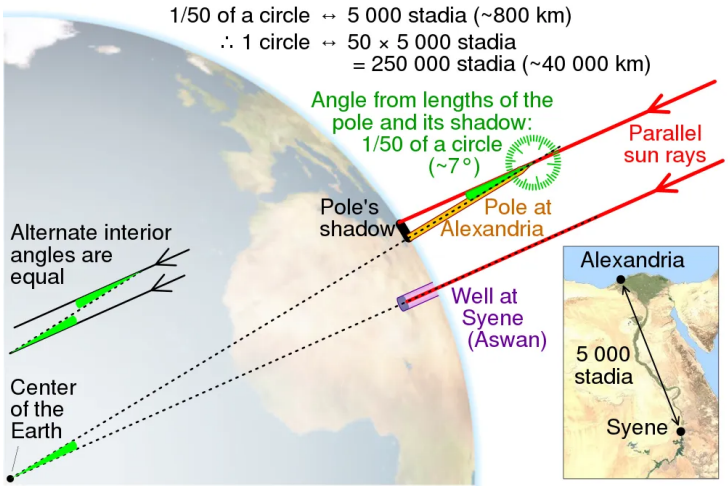
And although great minds like **Aristarchus** (312-230 BC) also offered the possibility of a **heliocentric model** (from the Greek word *helios* meaning "Sun") of the universe which suggested that the Earth and other planets revolved around the Sun, the idea would not gain traction until the 15th century.

Despite this incorrect belief, early Greeks still managed to contribute many important discoveries in the name of astronomy.

Here are some of the most notable contributors to early astronomy:

As early as 5th century BC, Greek philosophers such as **Parmenides** believed in a spherical Earth, but this belief was purely based on philosophical assumptions.

However, **Aristotle** (384-322 BC) would give scientific credibility to this idea by observing the shape of the Earth's shadow that is cast upon the moon during eclipses. Since the shadow cast on the moon has a round shape, the Earth would have to be spherical, not flat or disk-like, to produce such a shape.



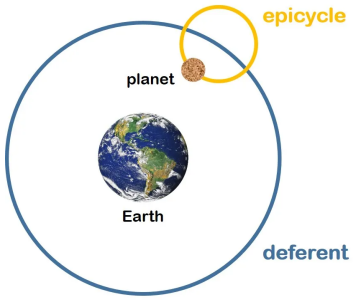
How Eratosthenes calculated the circumference of the Earth. Credit: David Jeffrey/UNLV

Eratosthenes (276 – 194 BC) is credited for successfully establishing the circumference of the Earth by observing the angles of the Sun's rays during noon in two Egyptian cities. By discovering that the angles of the rays differed by several degrees, he calculated that the circumference of the Earth is around 39,400 km, close to the actual modern-day value of 40,075 km.

Perhaps one of the greatest early Greek astronomers is **Hipparchus** (190 – 120 BC), known for his significant contributions to the field of astronomy: the development of trigonometry, accurately estimating the distance between the Moon and Earth, near accurate estimation of the length of a year, and a star catalog of nearly 850 stars classified according to their brightness (adapted into the Hertzsprung-Russell diagram).

Claudius Ptolemy (100 – 170 AD) developed the **Ptolemaic system**, a geocentric model of the universe accounting for the apparent motion of the planets as it revolves around a stationary Earth. Despite using an incorrect model, he was still able to predict the positions of the planets using a combination of large circles (**deferents**) and small circles (**epicycles**) to represent the planets' orbits.

Even with the decline of the Roman Empire, the Ptolemaic system became the prevalent model of the universe for several years.



Ptolemaic System

Artist's depiction on planetary motion according to the Ptolemaic System

The Emergence of Modern Astronomy.

The center of astronomical study would shift to Baghdad, Iraq after the fall of the Roman Empire during the 4th century.

Arabic astronomers translated the works of Greek astronomers and expanded them through their own works. Centuries would pass before astronomy was reintroduced to Europe through interaction and trade with the Arabic community. It is during this period where scientific thought started to break away from religion and philosophy.

Here are some of the most notable astronomers and scientists that contributed to the development of modern astronomy:

Nicolaus Copernicus (1473 – 1543) was a Polish astronomer who advocated for a heliocentric model of the universe, later called the **Copernican system**, after discovering Aristarchus' works. Even though his model was more correct than Ptolemy's, Copernicus could not account for planetary motion. His idea that the Earth was not the center of the universe was considered heretical at the time and thus, met with a lot of criticism.

Johannes Kepler (1571 – 1630) was a German astronomer who served as an assistant to **Tycho Brahe** (1546 – 1601), a Danish astronomer. With an observatory at their disposal, Brahe and Kepler observed and measured the locations of different celestial bodies. Tycho did this in order to refute the Copernican system. Despite serving under Brahe, Kepler remained steadfast in his belief in the Copernican model. After Tycho's death, Kepler used the data they gathered in order to formulate the basic laws of planetary motion:

The Three Basic Laws of Planetary Motion.

1. All the planets move around the Sun in an elliptical orbit, not circular as previously believed. This is also known as the **Law of Ellipses**.
2. If you trace an imaginary line from a point in the orbit to the Sun as a planet revolves, the line sweeps over equal areas in equal intervals of time. This is also known as the **Law of Equal Areas** and explains the variation in the speed at which planets orbit around the Sun. The **perihelion** refers to a point where the planet's orbit is closest to the Sun while the **aphelion** refers to when it is farthest.

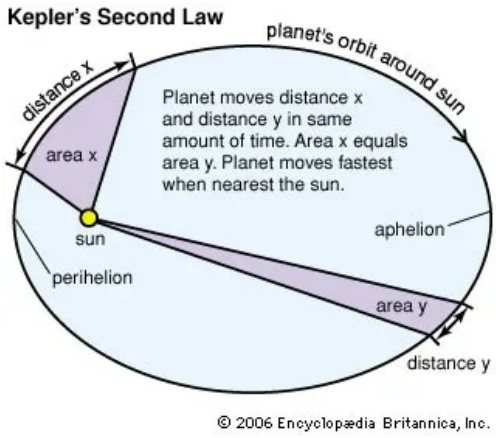


Diagram illustrating Kepler's Law of Equal Areas. Credit: Encyclopedia Britannica

3. The square of a planet's orbital period is proportional to the cube of a planet's mean distance to the sun. This is also known as the **Law of Harmonies**.

Despite understanding how planets move, Kepler could not establish *why* they moved that way and what keeps planets in their orbits instead of floating away into space.

Galileo Galilei (1564 – 1642) was an Italian astronomer, contemporary of Kepler, and also a supporter of the Copernican model. He built several telescopes which aided him in making more detailed observations of heavenly bodies. He observed the surface of the Moon which was previously believed to have been smooth as glass, but now proven to contain craters, mountains, and plains like the Earth. He discovered that Jupiter had four moons that revolved around it, further dispelling the notion that the Earth was the center of motion in the universe. He also discovered the existence of **sunspots**, relatively darker and cooler areas on the surface of the Sun. Unfortunately, prolonged observation of the Sun damaged his eyesight and eventually completely blinded him.

Sir Isaac Newton (1642 – 1727) was a prominent English scientist that made significant contributions to the fields of math, physics, and astronomy. One of his most notable contributions was the answer to the question of what kept planets in orbit– the **Law of Universal Gravitation**. According to the law, everybody in the universe attracts every other body with a force that is proportional to the mass of the bodies and inversely proportional to the square of the distance between the bodies.

Law of Universal Gravitation

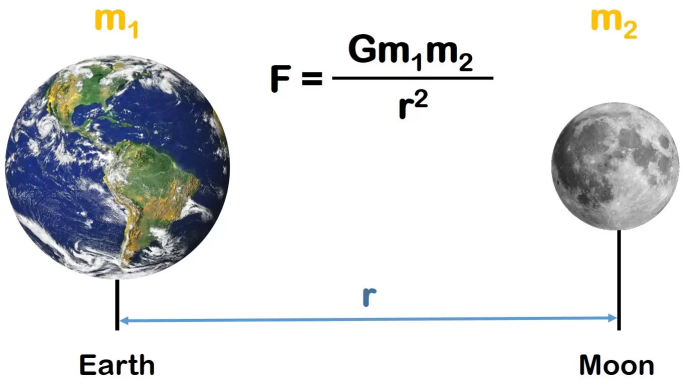


Diagram illustrating the Law of Universal Gravitation

According to the equation, the larger the mass of an object, the bigger the gravitational force it exerts. **This would explain how the Moon affects the tides on Earth** and supports the idea that the massive Sun is the center of our system.

The force of gravity and the tendency of a planet to move in a straight line contribute to the orbit of a planet around the Sun. **Without the pull of gravity, the planets would move forward in a straight line out into space. Without the tendency of the planet to move in a straight line, the planets would fall into the Sun because of its immense gravitational pull.**