Models of the Solar System

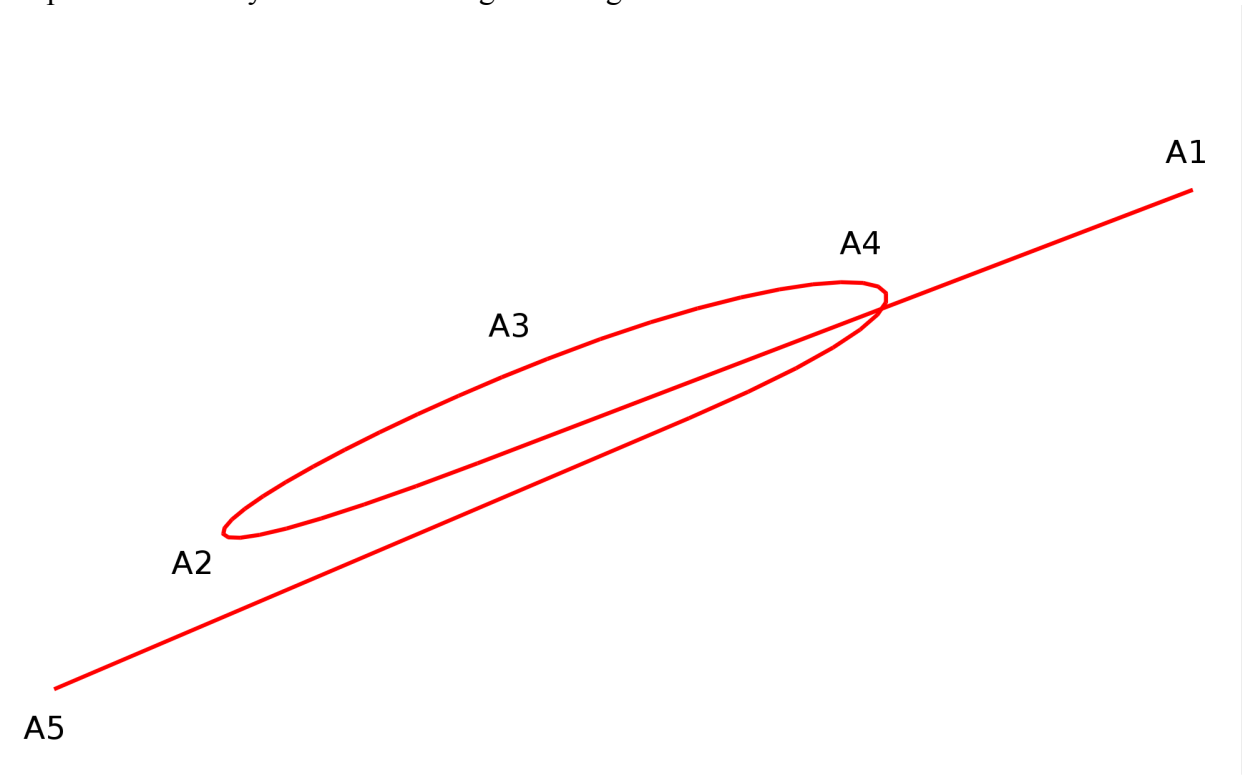
Since the days of the ancient Greeks (around 500 BC), there have primarily been two models that attempted to explain the arrangement of the universe: the **geocentric model**, and the **heliocentric model**. These models are described below.

Geocentric Model

The geocentric model (also known as the Ptolemaic system) is the theory that the Earth is the center of the universe, and that all other objects orbit around it. Though this theory existed previously, it is generally agreed to have been finalized by Ptolemy in the 2nd century AD.

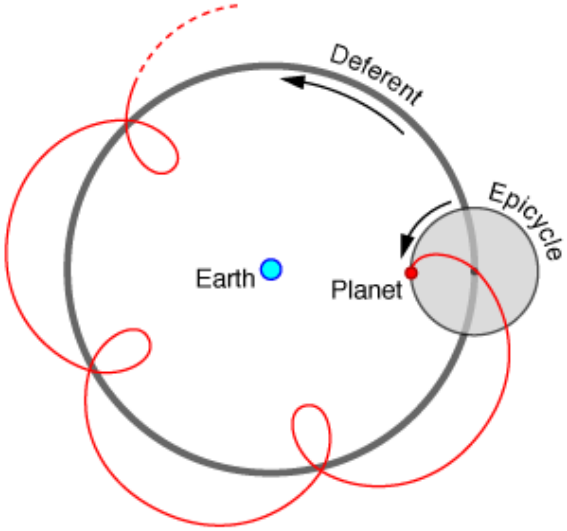
Two commonly made observations supported the idea that the Earth was the center of the universe. The first was that the stars, Sun, and planets appear to move around the Earth each day. The second was that the Earth does not seem to move from the perspective of an Earth bound observer.

One observation that the geocentric model had trouble explaining was the so-called **retrograde motion** of certain planets, like Mars. A planet is said to undergo retrograde motion when it appears to briefly reverse its direction of travel across the night sky. The diagram below shows the path followed by Mars as it undergoes retrograde motion.



In the Ptolemaic system, retrograde motion is explained by assuming that each planet is moved around the Earth by a system of two or more spheres: one called its **deferent**, the others called its **epicycles**.

The diagram to the right is a simplified illustration of how the geocentric model explains retrograde motion..



In this model, the Earth is a stationary sphere located at the center of the universe. The deferent is the large circle with the Earth at its center. The epicycles are smaller circles embedded in the deferent.

The planet moves along the epicycle at the same time as the epicycle moves along the path marked by the deferent. These combined movements result in the planet following a path that appears to reverse direction periodically (as shown by the curly path).

In the geocentric model, the order of spheres from the Earth outward is:

1. Moon
2. Mercury
3. Venus
4. Sun
5. Mars
6. Jupiter
7. Saturn
8. Celestial Sphere

The celestial sphere was the outermost sphere of the geocentric model, and contained all of the stars.

The Ptolemaic system of epicycles was extremely complicated, but it worked well for predicting the movements of the planets.

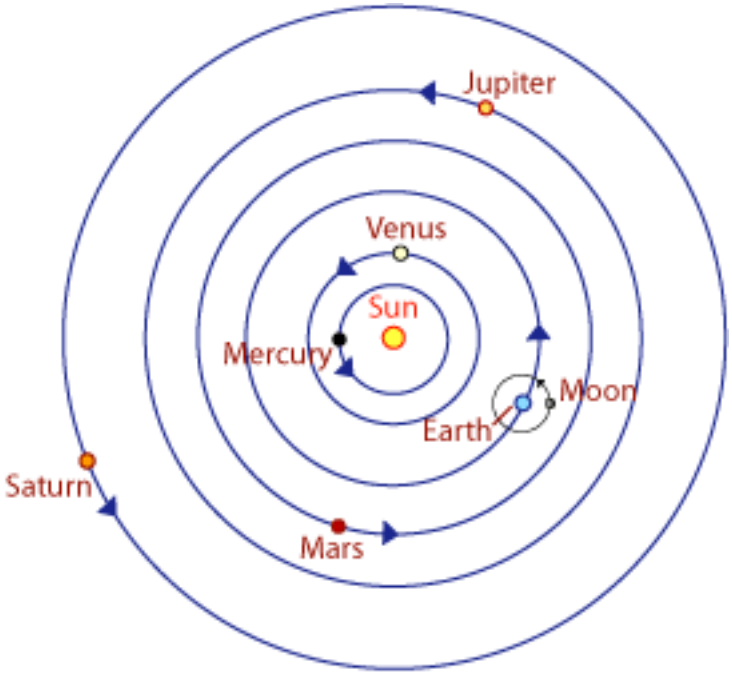
Heliocentric Model

The heliocentric model is the theory that the Earth and other planets orbit around a stationary Sun at the center of the universe. This model was suggested as early as the 3rd century BC, but did not receive general support until the 16th century AD.

In the 16th century, a mathematician and astronomer by the name of Copernicus, presented a heliocentric model that was fully capable of predicting the motion of the planets. The Copernican model became the basis for the modern heliocentric model.

In the 17th century, the Copernican model was elaborated and expanded by Kepler and supported by observations made by Galileo.

According to the heliocentric model, the Sun is a stationary sphere at the center of the universe. The planets orbit around the sun on spherical or circular paths, all of which lie on the same plane (called the solar plane).



This model explained retrograde motion by arguing that such motion was not real, but was only perceived as a result of parallax (this is the phenomenon that makes a car that you are passing seem to move backwards against the horizon).

Where the geocentric model required as many as 56 spheres in order to explain the motion of the planets, the heliocentric required only 1 sphere per planet. Thus, the heliocentric model was much simpler; a fact that led to its eventual adoption as the accepted model of the universe.

In the early 1900s, it was discovered that our solar system is only a tiny part of the Milky Way galaxy, and that our galaxy is only one of billions in the universe. Thus, the heliocentric model is really only a model of our solar system, rather than a model of the whole universe.