Standards: S6E1.a, S6E1.b, S6E1.d, S6CS5.a, S6CS5.b, S6CS7.b, S6CS8.c, S6CS9.d

Earth in the Universe

Key Words • theory • geocentric theory • heliocentric theory • galaxy • cluster • big bang theory

Getting the Idea

Here on Earth, the sun seems to rise in the eastern sky every morning and set in the west every night. Groups of stars appear to move across the night sky in the same way. But the sun and stars only appear to move in an arc across the sky because of our position here on Earth. In fact, Earth's rotation causes this apparent motion. When talking about the universe, it is important to remember that position, motion, and size are relative to your frame of reference.

Scientific Theories

When you look at the motions of space objects such as the sun, moon, and stars, you are making observations. People have been making observations of relatively close space objects for thousands of years. One of the goals of science is to explain observations. A **theory** is a scientific explanation of related observations.

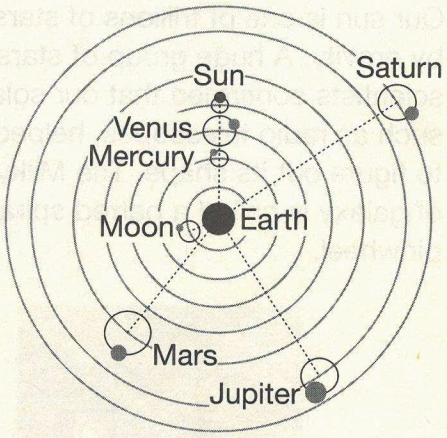
Theories about the solar system are based on observations made by astronomers. To be accepted, a theory has to explain all observations and data. Scientists are always gathering new information. Sometimes, a new discovery might not support a theory. When that happens, scientists learn as much as they can about the new discovery. As a result, they may change, or even replace, the theory. In this lesson, you will see how theories of the solar system have changed over time with new information.

Two Theories of the Solar System

Early stargazers made observations of the sky using only their unaided eyes. They did not have telescopes to get a closer look at the sun, the moon, and other planets in space. They saw the sun and moon rise in the east and set in the west, which led them to believe that these and all other space objects revolved around Earth. In short, they thought that Earth was the center of the universe.

About 2000 years ago, an astronomer named Ptolemy developed a theory of the solar system. Because he placed Earth in the center of the solar system, this theory is called the **geocentric theory**. (*Geo-* means "Earth.") Ptolemy showed the moon and the sun in circular orbits around Earth. He also included the planets that were known at the time. He thought that the planets moved in little circles as they moved around Earth. The diagram to the right is a model of the geocentric theory.

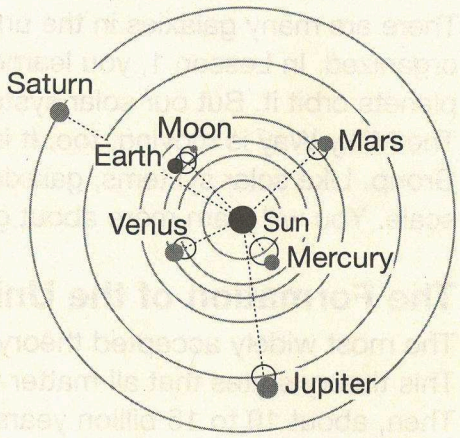
Geocentric Theory



You may be surprised to see a diagram called a model, but a model can represent real things in a number of ways. A model can be a diagram, a three-dimensional model, or even a mathematical equation. Scientists often use models to show objects that are very large (such as the solar system) or very small.

People accepted Ptolemy's theory for more than 1000 years. In the early 1500s, a Polish scientist named Copernicus proposed a new theory. He said that the sun, not Earth, is the center of the solar system. This theory is called the **heliocentric theory**. (*Helio-* refers to the sun.) The diagram to the right is a model of this theory. All the planets, asteroids, and comets in our solar system revolve around the sun. You should recognize this model as similar to the one you studied in Lesson 1.

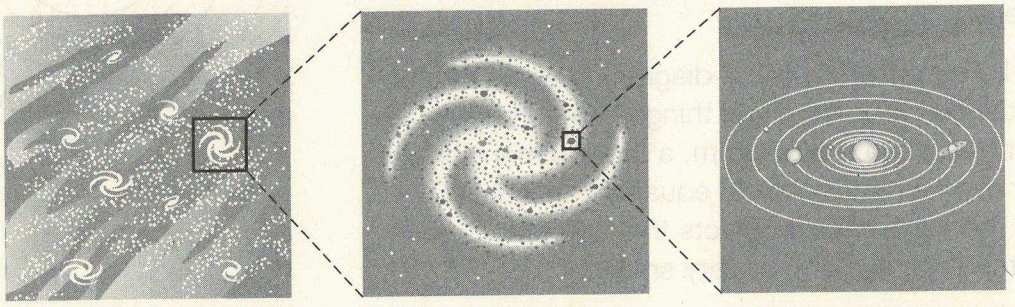
Heliocentric Theory



The heliocentric theory was not accepted at first. It took another hundred years of study and information gathering before it began to catch on. The work of several astronomers added support for the heliocentric theory. An Italian astronomer named Galileo used a telescope to observe the faraway moons of Jupiter revolving around the planet. This suggested that Earth and the other planets might revolve around the much more massive sun. The German astronomer Johannes Kepler provided more proof of the heliocentric theory. He used mathematics to show that the planets move in oval-shaped orbits around the sun.

Earth's Place in the Universe

Our sun is one of trillions of stars in the universe. Stars are found in groups held together by gravity. A huge group of stars is called a **galaxy**. In the first half of the twentieth century, scientists confirmed that our solar system is part of the Milky Way galaxy. New technology, such as radio telescopes, helped scientists learn more about our galaxy. They were able to figure out its shape. The Milky Way is shaped like a relatively flat pinwheel. This type of galaxy is called a barred spiral galaxy. Our solar system is in one of the arms of the pinwheel.



Universe Galaxy Solar system

There are many galaxies in the universe. The diagram above shows how the universe is organized. In Lesson 1, you learned that the sun stays in the center of our solar system as planets orbit it. But our solar system is actually moving around the center of the Milky Way. The Milky Way is moving, too. It is part of a **cluster**, a group of galaxies, called the Local Group. Like solar systems, galaxies and clusters are held together by gravity, but on a larger scale. You will learn more about gravity in the next lesson.

The Formation of the Universe

The most widely accepted theory of the formation of the universe is the **big bang theory**. This theory states that all matter was once together in a very hot, tiny, dense particle. Then, about 10 to 15 billion years ago, it was blown apart by an explosion called the big bang. The matter rapidly expanded and cooled. It is still expanding.

The big bang theory is relatively new. It was developed in the 1900s. Evidence to support the theory comes from observations that galaxies are moving farther and farther apart. The American astronomer Edwin Hubble helped prove this by measuring the movement of galaxies. The data he collected revealed that the farther away a galaxy is, the faster it is moving outward.

Discussion Question

What evidence supports the big bang theory of the formation of the universe?

Earth in the Universe

1. How does the heliocentric theory describe the motion of objects in space?

   A. The Milky Way moves in an orbit around the sun.

   B. Objects in space are moving farther and farther apart.

   C. Earth and the planets move in orbits around the sun.

   D. The sun and the planets move in orbits around Earth.

2. Which scientist supported the geocentric theory?

   A. Copernicus

   B. Galileo

   C. Hubble

   D. Ptolemy

3. The big bang theory explains

   A. how the universe formed.

   B. the shape of Earth's orbit.

   C. why stars are found in galaxies.

   D. why planets stay in their orbits.