

What Other Objects are in the Solar System?

Lesson Objectives

- Locate and describe the asteroid belt.
- Explain where comets come from and what causes their tails.
- Discuss the differences between meteors, meteoroids, and meteorites.

Introduction

Debris. Space junk. After the Sun and planets formed, there was some material left over. These small chunks didn't get close enough to a large body to be pulled in by its gravity. They now inhabit the solar system as asteroids and comets.

Section 1: Asteroids

Asteroids are very small, irregularly shaped, rocky bodies. Asteroids orbit the Sun, but they are more like giant rocks than planets. Since they are small, they do not have enough gravity to become round. They are too small to have an atmosphere. Except for a few of the largest asteroids, they are too small to have internal heat, so they are not geologically active. These asteroids can only change due to a collision. A collision may cause the asteroid to break up. It may create craters and melt some of the rocky material on the asteroid's surface. An asteroid may strike a planet if it comes near enough to be pulled in by its gravity. The Figure below shows a typical asteroid.



Asteroid Ida with its tiny moon Dactyl.

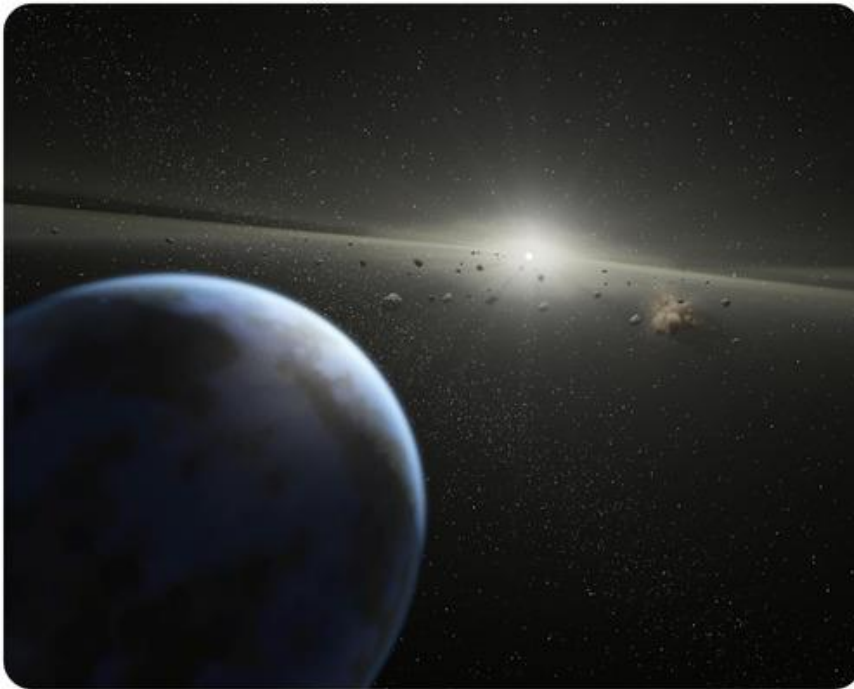
The Asteroid Belt

Terms to know

- asteroid
- asteroid belt
- comet
- Kuiper belt
- meteor
- meteoroid
- meteor shower

Hundreds of thousands of asteroids have been found in our solar system. They are now being discovered at a rate of tens of thousands of new asteroids per year! The majority are located in between the orbits of Mars and Jupiter. This region is called the asteroid belt, as shown in the Figure below. There are many thousands of asteroids in the asteroid belt. Still, their total mass adds up to only about 4 percent of Earth's moon.

Asteroids formed at the same time as the rest of the solar system. Although there are many in the asteroid belt, Jupiter's gravity kept the material in this region from forming into a planet, throwing much of it either out of the solar system or into the Sun.



The asteroid belt is between Mars and Jupiter.

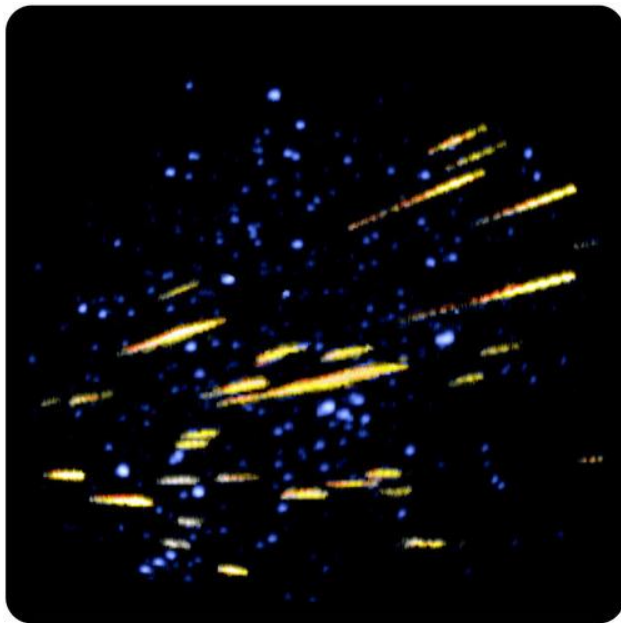
Near-Earth Asteroids

Near-Earth asteroids have orbits that come near to or cross Earth's orbit. This means that they could possibly collide with Earth. There are over 10,000 known near-Earth asteroids. Small asteroids do sometimes

collide with Earth. An asteroid about 5-10 m in diameter hits about once per year. About a thousand of the known near-Earth asteroids are much bigger. They are over 1 kilometer in diameter. When large asteroids hit Earth in the past, many organisms died. At times, many species became extinct. Astronomers keep looking for near-Earth asteroids. They hope to predict a possible collision early so they can try to stop it.

Section 2: Meteors

If you look at the sky on a dark night, you may see a meteor, like in the Figure below. A meteor forms a streak of light across the sky. People call them shooting stars because that's what they look like. But meteors are not stars at all. The light you see comes from a small piece of matter burning up as it flies through Earth's atmosphere.



Meteors burning up as they fall through Earth's atmosphere.

Meteoroids

Before these small pieces of matter enter Earth's atmosphere, they are called meteoroids. Meteoroids are as large as boulders or as small as tiny sand grains. Larger objects are called asteroids; smaller objects are interplanetary dust. Meteoroids sometimes cluster together in long trails. They are the debris left behind by comets. When Earth passes through

a comet trail, there is a meteor shower. During a meteor shower, there are many more meteors than normal for a night or two.

Meteorites

A meteoroid that passes very close to Earth is dragged towards Earth by gravity and enters the atmosphere. As it enters the atmosphere, it compresses the air in front of it, producing enormous heat and the meteoroid starts to vaporize. As it flies through the atmosphere, it leaves a trail of glowing gases. The object is now a meteor. Most meteors vaporize in the atmosphere. They never reach Earth's surface. Large meteoroids may not burn up entirely in the atmosphere. Some pieces of the rock may survive and land on Earth's surface. Once on the ground, it is called a meteorite.

Meteorites provide clues about our solar system. Almost all were formed in the early solar system (the Figure below). Some were part of larger asteroids that have been broken apart. A tiny fraction are rocks from nearby bodies like Mars or the Moon. For this to happen, an asteroid smashed into Mars or the Moon and sent up debris into space. After spending a long time orbiting the Sun, a bit of the debris landed on



Earth as a meteorite.

The Mars Rover, Opportunity, found a metal meteorite on the Red Planet.

Section 3: Comets

Comets are small, icy objects that orbit the Sun. Comets have highly elliptical orbits. Their orbits carry them from close to the Sun to the solar system's outer edges. When a comet gets close to the Sun, its outer layers of ice melt and evaporate. The vaporized gas and dust forms an atmosphere around the comet. This atmosphere is called a coma. Radiation and particles streaming from the Sun push some of this gas and dust into a long tail. A comet's tail always points away from the Sun, no matter which way the comet is moving. Why do you think that is? The Figure below shows Comet Hale-Bopp, which shone brightly for several months in 1997.

Gases in the coma and tail of a comet reflect light from the Sun. Because comets are very small, they are very hard to see except when they are surrounded by a coma. That is why they are more easily discovered and seen when they are in the inner solar system. They are nearly impossible to see as they move back to the outer solar system. The time it takes a comet to complete one orbit is called the comet's period. The first comet whose period was calculated was Halley's Comet. Its period is about 76 years. Halley's Comet last traveled through the inner solar system in 1986. The comet will appear to Earth observers again in 2061 and pass closest to the Sun in 2062. Who will look up at it?

Where Comets Come From

Some comets have periods of 200 years or less. They are called short period comets. Short period comets are from a region beyond the orbit of Neptune called the Kuiper Belt. Kuiper is pronounced "KI-per," rhyming with "viper." The Kuiper Belt is home to comets, asteroids, and at least two dwarf planets.

Some comets have periods of thousands or even millions of years. Most long-period comets come from a very distant region of the solar system. This region is called the Oort cloud. The Oort cloud is about 50,000-100,000 times the distance from the Sun to Earth. Comets carry materials in from the outer solar system. Comets may have brought water into the early Earth. Other substances could also have come from comets.

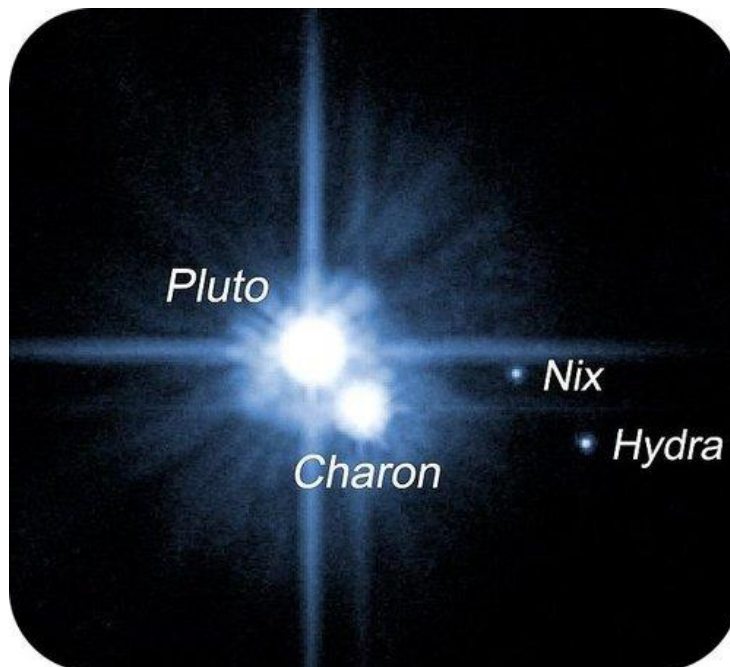
Section 4: Dwarf Planets

For over seven decades, Pluto was classified as a planet. But new solar system objects were discovered that were similar to Pluto. They were small like Pluto. Their orbits were also similar to Pluto's orbit in that they are more elliptical and tilted compared to planet orbits. These objects and many more small objects form a "belt" beyond Neptune. Astronomers debated whether to classify these new objects as planets. Eventually they decided to reclassify Pluto. Astronomers made a category called dwarf planets. There are five dwarf planets in our solar system: Ceres, Pluto, Makemake, Haumea and Eris.

Pluto

For decades Pluto was classified as a planet. But as they slowly discovered more about this object, scientists knew it was an unusual planet. The other outer planets are all gas giants. Pluto is small, icy and rocky. With a diameter of about 2400 kilometers, it has only about 1/5 the mass of Earth's Moon. The other planets orbit in nearly the same plane. Pluto's orbit is tilted. While most planets have nearly circular orbits, the orbit of Pluto is more elliptical. The orbit even crosses inside the orbit of Neptune. Pluto's orbit is in the Kuiper belt.

We have discovered more than 1000 Kuiper objects. Pluto has 5 moons of own. The largest, Charon, is A few astronomers classify Pluto and Charon as double dwarf planet (see the figure below). Two smaller



belt

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big.

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moons, Nix and Hydra, were discovered in 2005. The last two small moons, Kerberos and Styx were found in 2011 and 2012.

Pluto with its moons: Charon, Nix and Hydra.