

Other Objects in the Solar System

About 60 million years ago, the dinosaurs died out very quickly. Why?

Scientists have found evidence that a fast-moving object from outer space crashed into Earth, sending material flying into the atmosphere. This material reduced the amount of sunlight reaching Earth. The lack of sunlight caused the climate to change, and any organism that could not adapt to this change died.

Scientists hope that as they learn more about space, they will find clues to how life may have formed on Earth.

Planets and Their Moons

Objects that revolve around planets are called **satellites**. Satellites can be natural or artificial. The natural satellites are called **moons**. Several planets have more than one moon.

Earth has one moon, and astronauts visited it six times between 1969 and 1972 (**Figure 1**). The first successful mission was *Apollo 11*, which landed on the Moon on July 20, 1969. Scientists at NASA (National Aeronautics and Space Agency) are still analyzing the data from the *Apollo* missions.

The moons of other planets were discovered after the invention of the telescope. **Table 1** lists the number of known moons within our solar system. Some of the planetary moons have been investigated by space probes. We have gathered information about the two moons of Mars, Phobos and Deimos, and many of the moons of Jupiter, Saturn, Uranus, and Neptune (**Figure 2**).



Figure 1

The *Apollo 11* astronauts brought many samples to Earth for study and collected much data on the Moon.

Table 1

Planet	Number of known moons
Mercury	0
Venus	0
Earth	1
Mars	2
Jupiter	39
Saturn	30
Uranus	20
Neptune	8
Pluto	1



Figure 2

- (a) Jupiter's moon Europa has an icy surface with very few craters. It is nearly as big as Earth's Moon.
- (b) Io, the closest moon to Jupiter, is the only moon in the solar system to have active volcanoes, more violent than any on Earth.
- (c) Saturn's moon Hyperion is only 360 km across and has an irregular shape, possibly the result of repeated collisions with large space rocks.

Asteroids

Refer to the model of the solar system from section 4.1, page 192. Our solar system has a large gap between the orbits of Mars and Jupiter. In that gap is a ring of thousands of small, rocky objects called **asteroids**. They are materials that never formed into planets. This ring of asteroids, known as the **asteroid belt**, was investigated by several space probes.

Asteroids also share Jupiter's orbit, and others travel in paths that may take them closer to the Sun or Earth. In 1937 an asteroid called Hermes came within 800 000 km of Earth—that is really close for an asteroid! **Figure 3** shows the orbits of some asteroids and their names.

In February 2001 the *NEAR* spacecraft landed on Eros, an asteroid. This is a promising achievement as asteroids contain many minerals that we may someday mine. The largest asteroid is only 1000 km in diameter, so astronauts must be careful when navigating through the asteroid belt to avoid any collisions.

Meteors and Meteorites

A **meteoroid** is a lump of rock or metal that is pulled through Earth's atmosphere. As it falls, it rubs particles of the air, causing heat. As a result, the meteoroid burns up. This fireball shows up as a bright streak in the sky, called a **meteor**. Meteors are often mistakenly called shooting stars because of the light given off by the burning meteoroid.

If a meteor actually hits Earth before it completely burns up, then it is known as a **meteorite**. Meteorites can cause a lot of damage, because they are travelling very fast when they hit Earth (**Figure 4**).

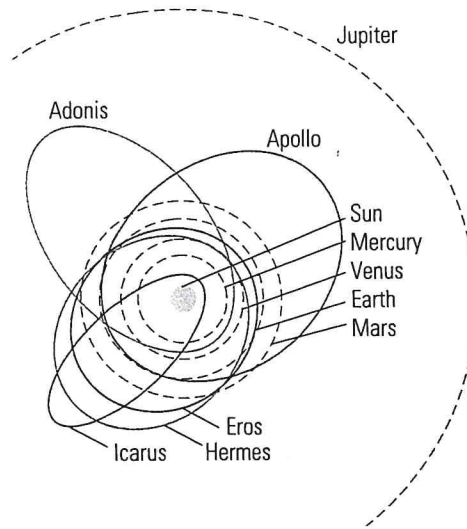


Figure 3

Orbits of several asteroids (not drawn to scale)



Figure 4

The Barringer Crater in Arizona was formed 20 000 to 30 000 years ago by a large meteorite. The crater is 1.2 km across and 120 m deep. Why are most craters this shape?

Did You Know

Have you heard of shooting stars or falling stars? They are not stars at all: they are meteors. If you look at the sky on a clear night, you might see a meteor. If you look at the sky during a meteor shower, your chances of seeing a meteor are high. The three most active meteor showers are the Perseid shower (August 12), the Geminid shower (December 14), and the Quadrantid shower (January 3 or 4).

Comets

One evening, an amateur astronomer from Japan was using binoculars to sky watch. He noticed an object that he had not seen before. He recorded what he saw, and then reported it to professional astronomers. To everyone's excitement, he had discovered a **comet**. A comet is a chunk of frozen ice and dust that travels in a very long orbit around the Sun. The comet was called Comet Hyakutake, after the man who first observed it (**Figure 5**).

The nucleus of a comet is only a few kilometres wide. However, its tail can be up to a million kilometres long. As a comet travels close to the Sun, it is warmed by the Sun. The frozen gases that make up the comet melt and then evaporate. These gases are pushed outward by the Sun's wind and rays. They form a bright glowing tail visible for several months as the comet passes close to the Sun.

Comets have fixed orbits, and astronomers can predict when we will see certain comets. The most famous comet, Halley's comet, was last seen in 1986. It has a revolution of 76 years.

Exploring Minor Bodies

Scientists are trying to figure out what formed Earth and other objects of the solar system. Scientists think that asteroids and comets are made of the same elements as planets and moons. Asteroids and comets are known as the **minor bodies** of the solar system. Unlike Earth, the minor bodies have not changed much. Scientists send probes to the minor bodies to learn more about them in hopes of learning about the origins of Earth and the solar system.

A probe called *Deep Space 1* was launched in 1998 (**Figure 6**). Its goal is to explore as many minor bodies as possible. The probe is different from other probes as it is lightweight, uses an efficient fuel, and has an onboard computer that will guide the probe to a safe landing on a minor body. This form of artificial intelligence has improved the chances of success on these unpiloted missions.



Figure 5

Comet Hyakutake, discovered in 1996, was the brightest comet seen in 20 years.

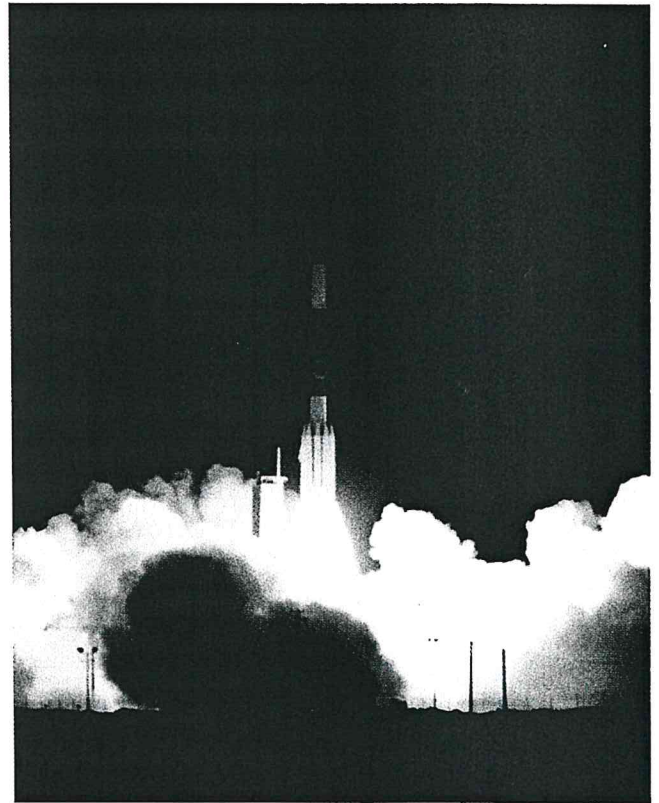


Figure 6

Deep Space 1, 1998

Galaxies and Star Clusters

When you look at a map of your province, you see cities, towns, and villages. These are places where people cluster or group together. The spaces between these regions are quite large and are called rural areas. Similarly, when you look at a map of the universe, you see different-sized clusters of stars with different features.

Galaxies

A **galaxy** is a huge collection of gas, dust, and hundreds of billions of stars. These stars are attracted to each other through the force of gravity, and they are always in motion.

Earth and the solar system are part of the Milky Way Galaxy. You may be able to see the Milky Way in the summer and winter. It looks like a trail of spilt milk across the sky. The Milky Way is the combined light of the 400 billion distant stars in our galaxy. The Milky Way is disk-shaped, with the Sun near the outer part of the disk (Figure 1). The central bulge contains the most stars. The spiral arms move around the central bulge.

The Milky Way Galaxy is called a **spiral galaxy** because of its shape. Figure 2 shows photographs of three other spiral galaxies.

Did You Know?

The universe has billions of galaxies. We call galaxies that gather in groups galaxy clusters or superclusters. The Milky Way Galaxy belongs to a group called the Local Group and to the supercluster called the Virgo Cluster.

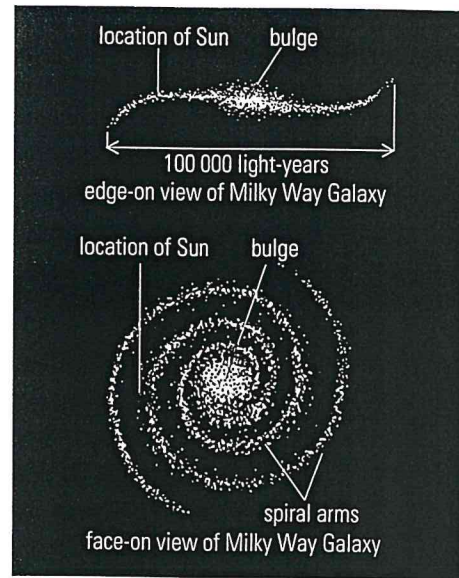


Figure 1

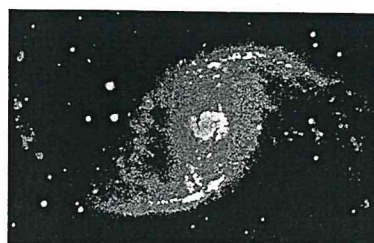
The spiral arms of the Milky Way Galaxy have huge concentrations of stars. The Sun is on one of the outer spirals.



a This giant spiral galaxy resembles the Milky Way Galaxy.



b This spiral galaxy is coloured to show young giant stars (blue).



c An example of a barred-spiral galaxy, coloured to show the central bar

Figure 2

Types of Galaxies

There are three types of galaxies. Figures 1 and 2 were examples of spiral galaxies. There are also **elliptical galaxies**, which are shaped like a football (Figure 3), and **irregular galaxies**, which have no familiar shape at all (Figure 4).

Unusual Galaxies

The further we see, the more discoveries we make, such as the following:

- Some galaxies appear to be in the process of colliding, recombining, and tearing away stars from one another.
- Smaller galaxies are “eaten” by larger ones.
- **Quasars** are very distant objects that look like faint stars, but they give off up to 100 times more energy than the Milky Way galaxy.

Star Clusters

Groups of stars that are close together and that travel together are called **star clusters**. A single cluster can have anywhere from 10 to a million stars. Clusters are part of galaxies.

A familiar star cluster is the Pleiades, from the constellation of Taurus, shown in Figure 5.



Figure 3
An elliptical galaxy



Figure 4
An irregular galaxy



Figure 5
The Pleiades

Try This Activity

Model a Spiral Galaxy

Make your own spiral galaxy model.

- Ⓒ2 One way is to use a plastic container, water, a stir stick, and a drop of food colouring. Place the water in the container, add a drop of food colouring, and stir. Make a prediction first.
 - Ⓔ1 What will happen? Record your
 - Ⓔ3 prediction and observations. Do not forget to draw a diagram.
- Show your model to your teacher.

Challenge

- 1 Some galaxies, such as the Andromeda Galaxy, are beautiful. Some people may enjoy a tour stop at a galaxy.
- 3 Would a space colony in another galaxy, so far away from home, be desirable?

Understanding Concepts

1. How are galaxies classified? Draw and label an example of each.
2. Arrange the following in order of size, starting with the largest: star cluster, galaxy, universe, star, planet.
3. How do you think the Milky Way galaxy got its name?

Work the Web

Which galaxy is your favourite? Find out more and summarize the information in a paragraph. Start your search by visiting www.science.nelson.com and following the links from Science 9: Concepts and Connections, 4.11.