

# Comet

## What is a Comet?

Comets are small members of the solar system, usually a few miles or kilometers in diameter. They have been described as "dirty snowballs" by astronomer Fred Whipple and are thought to be made of:

- dust
- ice (water, ammonia, methane, carbon dioxide)
- some carbon-containing (organic) materials (e.g., tar)
- a rocky center (some comets)

Comets are thought to be made from the earliest materials of the solar system. When the sun first formed, it blew lighter material (gases, dust) out into space. Some of this material (mainly gas) condensed to form the outer planets (Jupiter, Saturn, Uranus, Neptune) and some remains in orbit far from the sun in two areas:

- **Oort Cloud** - a sphere about 50,000 AUs from the sun; named after the Dutch astronomer Jan Oort who proposed it
- **Kuiper Belt** - an area within the plane of the solar system outside the orbit of Pluto



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## Parts of a Comet

As a comet approaches the sun, it warms up. During this warming, you can observe several distinct parts:

- nucleus
- coma
- hydrogen envelope
- dust tail
- ion tail

The **nucleus** is the main, solid part of the comet. The nucleus is usually 1 to 10 kilometers in diameter, but can be as big as 100 kilometers. It can be composed of rock.

The **coma** is a halo of evaporated gas (water vapor, ammonia, carbon dioxide) and dust that surrounds the nucleus. The coma is made as the comet warms up and is often 1,000 times larger than the nucleus. It can even become as big as Jupiter or Saturn (100,000 kilometers). The coma and nucleus together form the **head** of the comet.

Surrounding the coma is an invisible layer of hydrogen called the **hydrogen envelope**; the hydrogen may come from water molecules. It usually has an irregular shape because it is

distorted by the solar wind. The hydrogen envelope gets bigger as the comet approaches the sun.

The comet's **dust tail** always faces away from the sun. The tail is made of small (one micron) dust particles that have evaporated from the nucleus and are pushed away from the comet by the pressure of sunlight. The dust tail is the easiest part of the comet to see because it reflects sunlight and because it is long, several million kilometers (several degrees of the sky). The dust tail is often curved because the comet is moving in its orbit at the same speed that the dust is moving away, much as water curves away from the nozzle of a moving hose.

Comets often have a second tail called an **ion tail** (also called the **plasma** or **gas** tail). The ion tail is made of electrically charged gas molecules (carbon dioxide, nitrogen, water) that are pushed away from the nucleus by the solar wind. Sometimes, the gas tail disappears and later reappears when the comet crosses a boundary where direction of the sun's magnetic field is reversed.

### **The Path of a Comet**

Comets are thought to orbit the sun in either the Oort cloud or Kuiper belt. When another star passes by the solar system, its gravity pushes the Oort cloud and/or Kuiper belt and causes comets to descend toward the sun in a highly elliptical orbit with the sun at one focus of the ellipse. Comets can have short period orbits (less than 200 years such as Halley's comet) or long period orbits (greater than 200 years such as comet Hale-Bopp).

As the comet passes within six AUs of the sun, the ice begins to go directly from the solid to the gas state (**sublimation**) much like the way fog is formed. When the ice sublimates, the gas and dust particles flow away from the sun to form the comet's tail.