National Aeronautics and Space Administration

Comets vs. Asteroids!

Comets and asteroids orbit the Sun similar to the way the Earth does. Scientists believe many of these small worlds have changed very little since they first formed. They are unlike Earth with all its weathering, volcanoes and earthquakes. Asteroids and comets can tell us what the early solar system was like.

NASA likes it when scientists use their imaginations to find creative ways to explore our solar system. With NASA's help, scientists use small, robotic spacecraft—no humans on board—to be their eyes and unlock the mysteries of comets and asteroids—and our solar system itself.

Join us on a journey as we explore small worlds in our solar system.

Comets

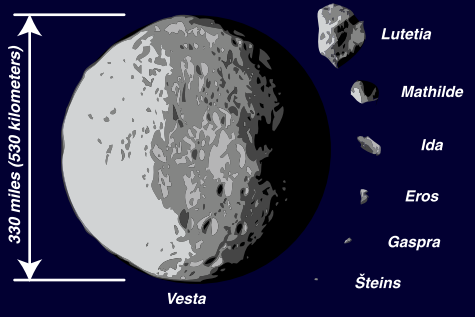
- Reside mostly in Kuiper Belt beyond orbit of Neptune, and in Oort Cloud in outer solar system.
- Probably formed in the outer solar system.
- Diameters range from about 6 - 25 miles.
- Contain a lot of ice, along with rock, and hydrocarbons.
- Surface is very unstable and changeable, as ice boils off when comet approaches Sun.
- Develop comas and tails as they approach the Sun.
- Orbit can be disturbed to toss comet into elongated orbit, so we see it in the inner solar system.
- May have contributed large part of Earth's water.

Both

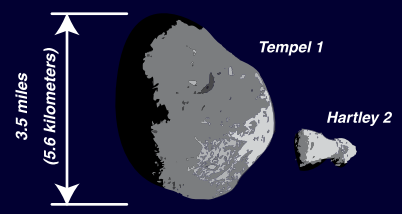
- Part of solar system, leftovers from its formation.
- Orbit the Sun.
- Irregular shapes. Not massive enough to be spherical like a planet. May spin like a badly thrown football because of irregular shape.
- Have crashed into Earth.

Asteroids

- Most reside in Asteroid Belt between orbits of Mars and Jupiter.
- Probably formed inside the orbit of Jupiter.
- Diameters range from the size of small rocks to more than 600 miles.
- Composed of rock and metals.
- Surface is solid and stable, showing craters where other objects have crashed into it.
- Surface does not boil off, thus no coma or tails.
- Orbit is stable and fairly circular.
- Have left craters on Earth, and may have caused mass extinctions, such as of the dinosaurs.



Asteroids come in a large range of sizes.



A comet nucleus comes in a smaller range of sizes. Tempel 1 is about 3.5 miles across.

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What is a comet?

For centuries, astronomers were baffled by these strange and unpredictable visitors in Earth's sky. Now we know that comets are part of our solar system family. They are smallish bodies made of dust, ice, and rocks left over after the Sun, the planets, and the moons formed.

Old woodcut depicting the great comet of 1577.

Why do we study comets?

Scientists want to find out all about comets to help them understand better how the solar system began and evolved to what it is today.

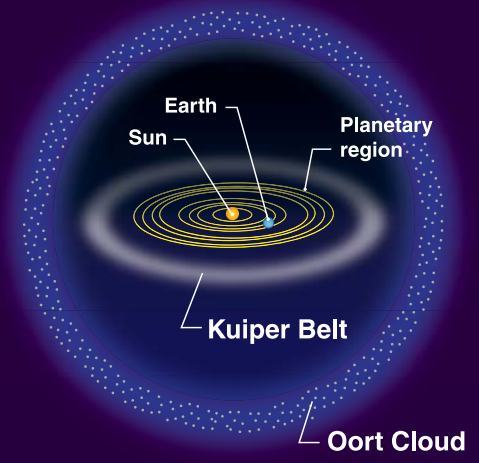
NASA has sent several spacecraft to visit comets. Deep Space 1 flew by Comet Borrelly. The Stardust spacecraft collected dust from the coma of Comet Wild 2 and returned the samples to Earth. The Deep Impact spacecraft sent a smaller impactor craft directly into the path of Comet Tempel 1 to learn more about the inside of a comet nucleus (the solid part). EPOXI took pictures of Comet Hartley 2 as jets of gas erupted from its surface. In 2011, Stardust-NExT returned to Comet Tempel 1 to see how the surface had changed after the comet completed one full orbit around the Sun.

Where do comets come from?

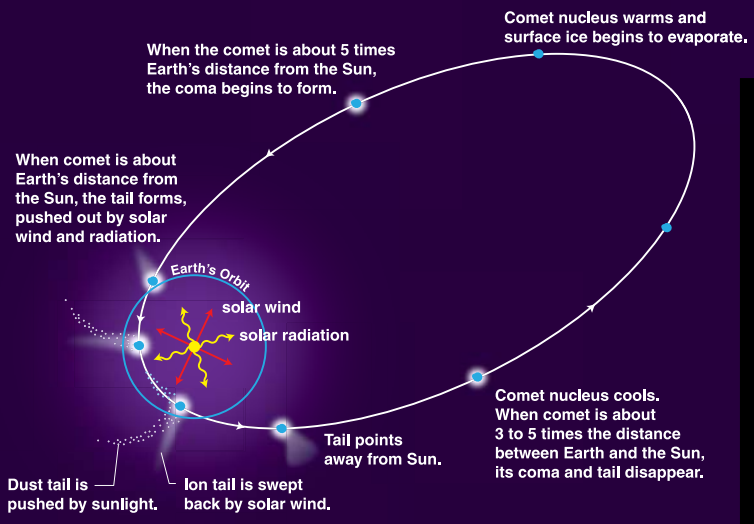
Most comets come from the *Kuiper Belt*, a region beyond the orbit of Neptune. Comets from this neighborhood usually take 200 years or less to make one orbit around the Sun. These are called short-period comets.

Comets also come from their other hangout, the *Oort Cloud*, a far-far-distant cloud of possibly a trillion comets that surrounds the solar system. One trip around the Sun could take one of these comets 30 million years! They are called *long-period comets*.

Sometimes the gravitational pull of a passing star stirs up comets in the Oort Cloud, sending some flying into the inner solar system. Sometimes the gravitational pull of a planet can disturb comets in the Kuiper Belt and fling one headlong toward the Sun. Jupiter's strong gravity can turn a long-period comet into a short-period one.



The Sun's gravitational pull takes over, shaping the comet's path into an *elliptical* (elongated) *orbit*. The comet travels faster and faster as it nears the Sun, swings around close to the back-side, then it heads back to more or less where it came from.



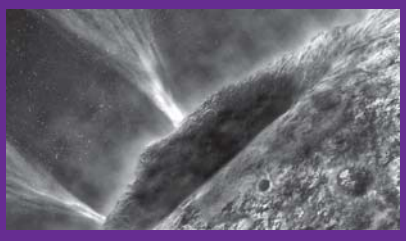
What do comets look like?

Space missions have shown us close-up photos of the *nucleus*, or solid part, of a comet. Of course, comets may not all look the same. So far, Deep Space 1 found that Comet Borrelly has rugged terrain, smooth rolling plains, deep fractures and is covered with very, very dark material. Deep Impact and Stardust-NExT showed Comet Tempel 1 as very black on the outside, looking something like charcoal briquettes.

On the inside, comets seem to be mostly ice, some rocks and dust, and some gas. Deep Impact crashed a "smart impactor" into Comet Tempel 1 and found a very fragile and weak surface. Inside it is spongy, with lots of holes. It has ice beneath its surface. Other comets may be different.

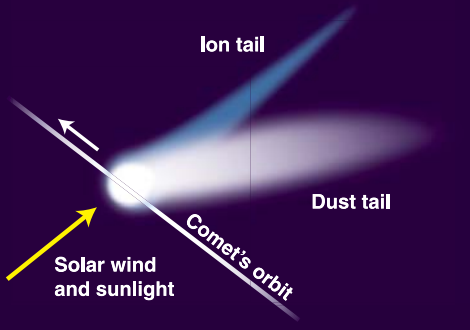
What makes comets look fuzzy and have tails?

When they are at home in the Oort Cloud or Kuiper Belt, comets are just dull, dark chunks of ice, dust, and rock. In this state, they may not be much different from asteroids. But as comets get closer to the Sun and begin to warm up, some of their materials start to boil off. This material forms a cloud around the nucleus. The cloud is called the *coma* and may be hundreds of thousands of miles across.



Wild2 artists rendering

Comet tails appear as the comet approaches the Sun and can grow to be millions of miles long. The particles in the *solar wind* push the small dust particles in the coma into a long curved path. This tail is known as the *dust tail*. Another tail, the *ion tail*, is made of electrically charged molecules of gas. The ion tail points directly away from the Sun.



What is an asteroid?

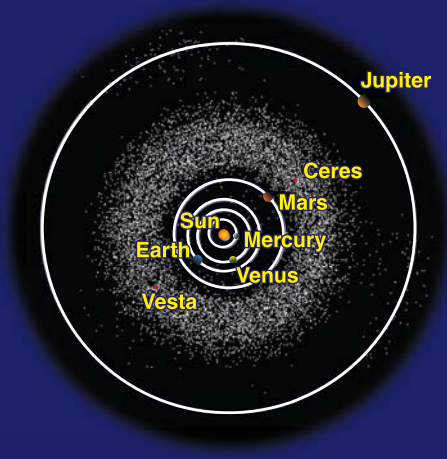
Ancient astronomers studied the night sky, mapping everything they saw. Giuseppe Piazzi found the first (and largest) asteroid in 1801 and named it “Ceres.”

Compare the sizes of asteroid Vesta (left) with dwarf planet Ceres (center) and Earth’s Moon (right).

Asteroids are small rocky objects left over from the formation of our solar system. They range from the size of small rocks to the size of asteroid Ceres, which is more than 600 miles across. Ceres is so large it’s often called a *dwarf planet* (like Pluto), rather than an asteroid.

Where do asteroids hang out?

Most asteroids orbit the Sun in nearly circular orbits in the *Asteroid Belt* between Mars and Jupiter. There are probably millions of asteroids here. Even so, all of them put together don’t contain as much material as Earth’s Moon.



What do asteroids find disturbing?

The gravity of Jupiter or Mars sometimes tosses asteroids out of their main belt, hurling them in all directions. Some of Jupiter’s moons used to be Asteroid Belt asteroids.

Within the Asteroid Belt, asteroids may collide, breaking into smaller pieces. If a larger asteroid with a separate outer rocky mantle and iron core breaks up, bits of the iron core could make their way to Earth and become iron *meteorites*. It was probably a sizable piece of an asteroid or a comet impact that caused a sudden climate change that killed off all the dinosaurs 65 million years ago.

What are asteroids made of?

Scientists have put asteroids into three different categories. One type is very dark and probably contains clay and silicate rock. Silicates are the most common forms of rocks, minerals, and sand on Earth. Another type is made of silicate and metals. The third type is mostly metals.

Asteroids have irregular shapes and are often covered with craters from having been hit by smaller objects over billions of years.

How do asteroids move?

Besides their orbital motion around the Sun, asteroids also rotate, or spin. But since they are oddly shaped, they may tumble like a badly thrown football rather than spin gracefully, like a spherical planet or moon. Oblong-shaped Asteroid 2008 HJ is 12 meters wide and 24 meters long (smaller than a tennis court) and rotates every 42.7 seconds. It is the fastest known rotating natural object in the solar system.

Why do we study asteroids?

Asteroids have not changed much in billions of years. They can tell us a lot about what the early solar system was like.

NASA’s Dawn mission is studying the two most massive asteroids up close. It is orbiting Vesta for 13 months, and then going on to orbit Ceres. Another asteroid mission, NEAR (for Near-Earth Asteroid Rendezvous) Shoemaker orbited asteroid Eros for about one year, and then landed on its surface. It sent back amazing images and lots of other data about the asteroid. Studying asteroids closely will help scientists understand the conditions and processes that went into making our solar system what it is today.

Image of Vesta taken from the Dawn Spacecraft.

Word Search

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Fun facts about comets and asteroids:

Although comets may look bright in our night skies as their comas and tails reflect sunlight, the nucleus of a comet is black as charcoal.

Comets may have delivered a lot of water to early Earth, as well as the molecules needed to give life its start.

Although a comet nucleus is usually smaller than 25 miles across, the coma may be as big as 2 million miles across!

Asteroid Ceres is about the same distance across as Texas.

Asteroid Vesta is about the same distance across as Arizona.

Vesta and Ceres contain more than one-third of all the mass of all the millions of asteroids in the main Asteroid Belt.

Vesta has a mountain 13 miles high! That's more than twice as high as Mt. Everest!

Pieces of Vesta may be found on Earth! Scientists have studied a number of meteorites they believe originated on Vesta, when it was bombarded by objects that blasted chunks of its surface into space.

Learn more!

NASA's Planetary Science website: http://nssdc.gsfc.nasa.gov/planetary
NASA's Solar System Exploration website: http://solarsystem.nasa.gov/planets