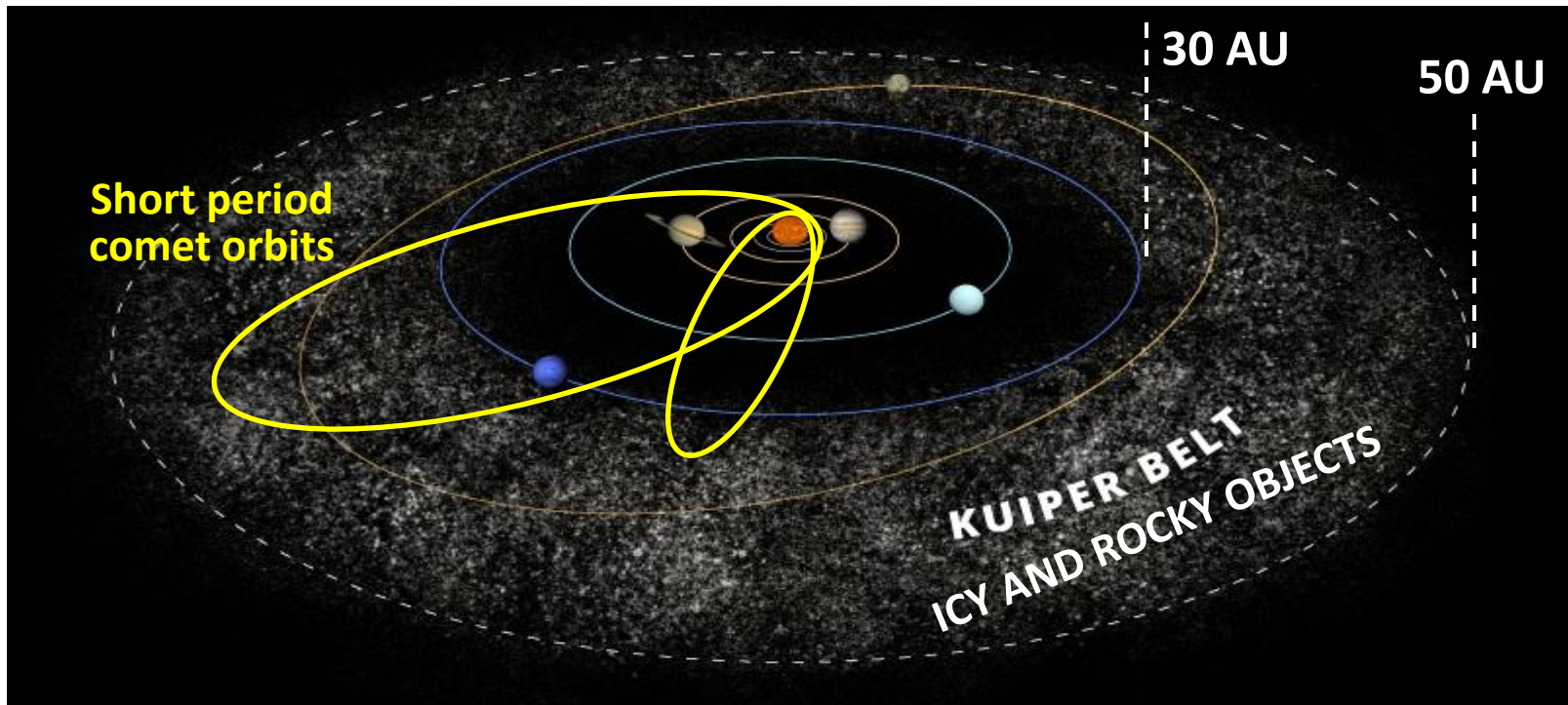


Comet Orbits: Short Period

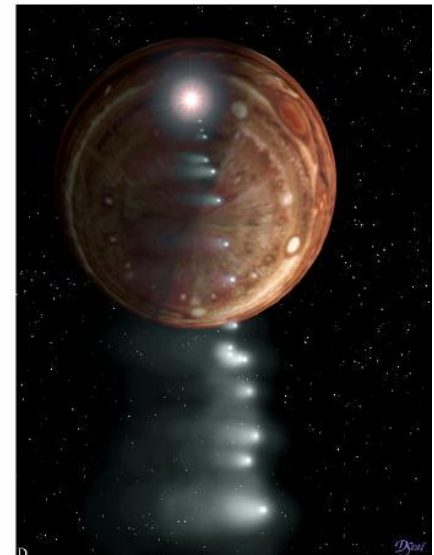
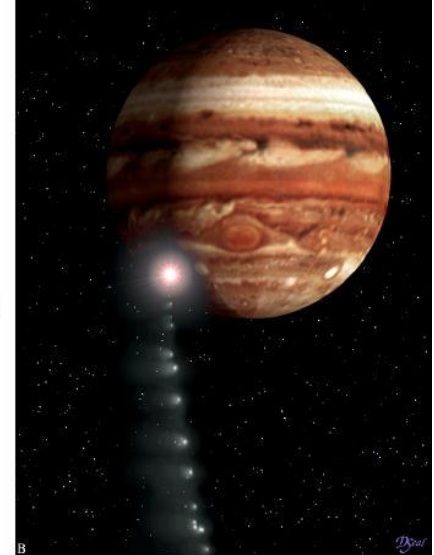
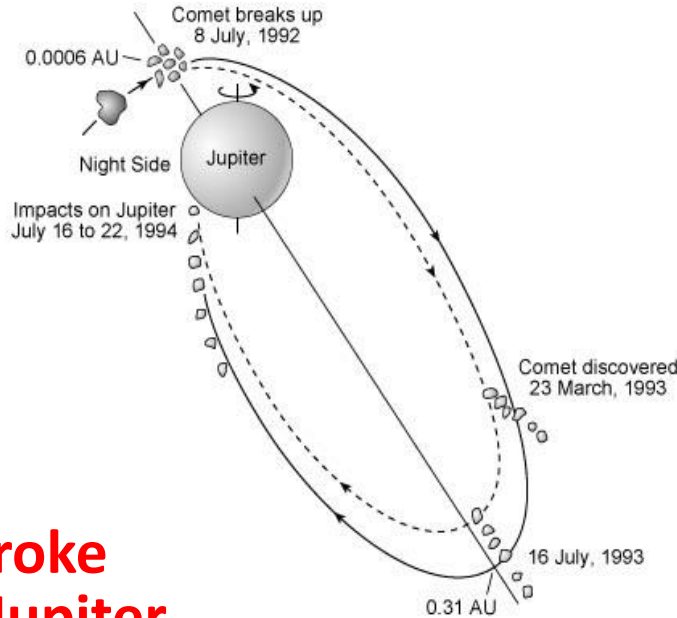
- **Short period comets** (those having orbital period less than 200 years) originate in the **Kuiper belt**, a donut-shaped cloud of icy and rocky objects located beyond the orbit of Neptune.



- About **60 Halley-type** (between 20-200 years) and more than **400 Jupiter-family** (orbital period <20 years) comets are known.

Comet Shoemaker-Levy 9

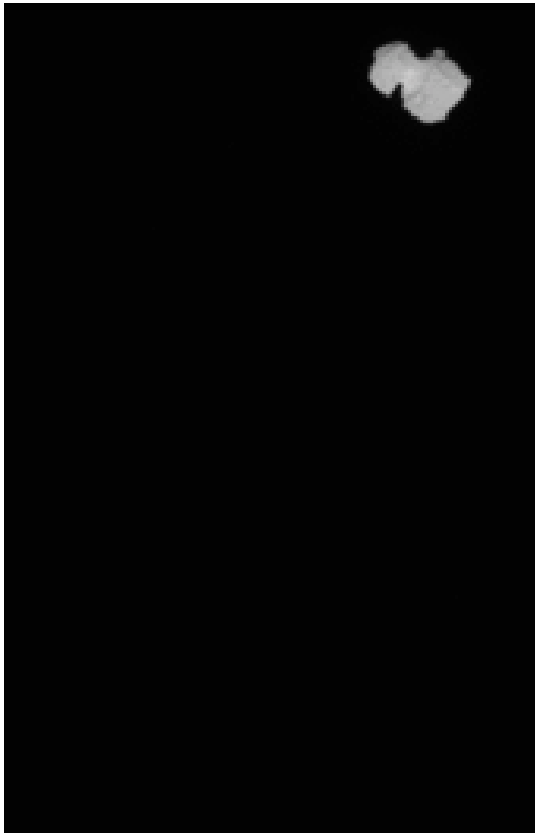
- Discovered in March 1993.
- Orbital studies of the comet revealed that it was *orbiting Jupiter* (captured about 20-30 years earlier) *rather than the Sun*, unlike all other comets known at the time.
- In July 1994 the comet **broke apart** and **collided with Jupiter**, providing the first direct observation of an extraterrestrial collision of Solar System objects.
- Hypothesis: Jupiter's huge mass acts as a "cosmic vacuum cleaner" to provide increased protection against asteroids and comets for the inner planets.



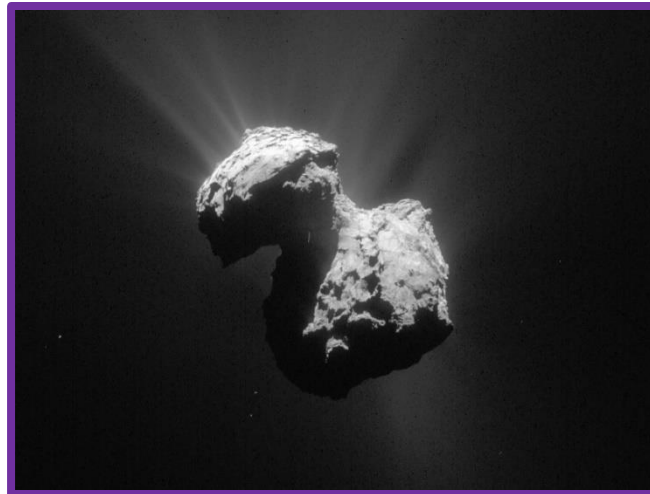
Comet Churyumov-Gerasimenko

The first comet to welcome a spacecraft to land on!

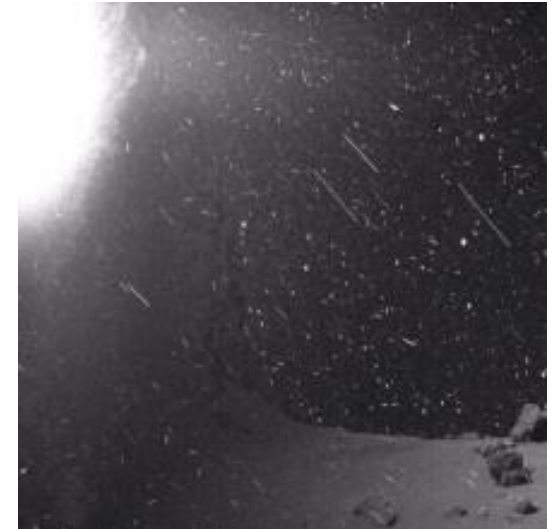
European Space Agency's **Rosetta** mission:
launched on 2 March 2004, entered the comet's
orbit on 10 September 2014, sent **Philae lander**
on 12 November 2014, Rosetta itself landed on
the comet's surface on 30 September 2016.



What is it like
approaching
a comet?



“**Rubber Duck**”
outgassing



Dust and cosmic rays

Review: Definitions

Asteroid: A relatively small (but >10 m size), inactive, **rocky body** orbiting the Sun. Also may be called “minor planets”.

Comet: A relatively small, at times active, **icy object** whose ices can vaporize in sunlight forming an atmosphere (*coma*) of dust and gas and, sometimes, a tail of dust and/or gas.

Meteoroid: A small particle from a comet or asteroid that is on a collision course with Earth.

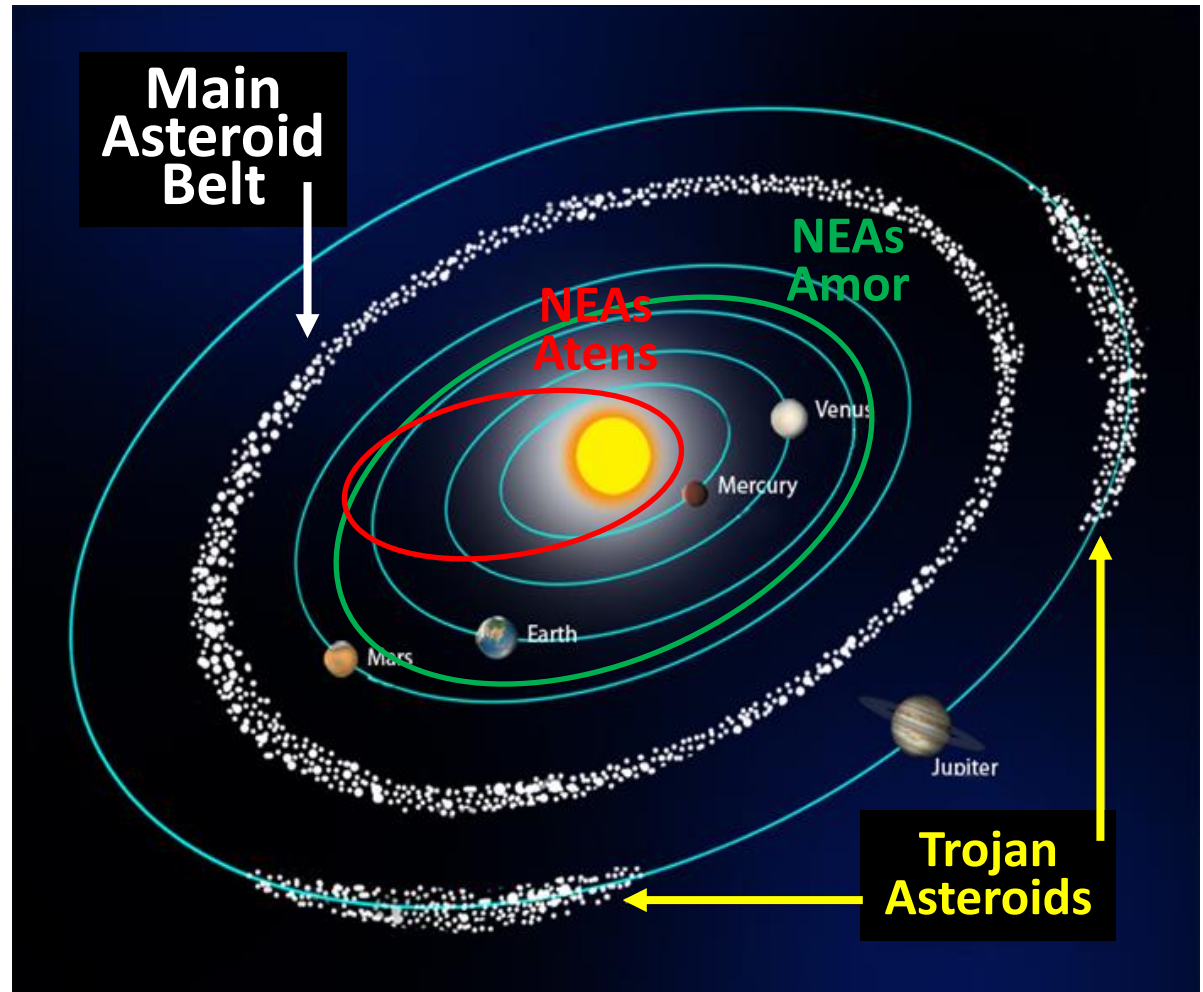
Meteor: The light phenomena which results when a meteoroid enters the Earth's atmosphere and vaporizes (a shooting star); **not an object!**

Meteorite: A meteoroid that survives its passage through the Earth's atmosphere and lands upon the Earth's surface.

Asteroids: Location

Most asteroids (*millions in total!*) are found between the orbits of Mars and Jupiter in the **main asteroid belt**.

- Additionally, some are located in the same orbit as Jupiter, but are separated from it by $\sim 60^\circ$ - **Trojans**.
- Some asteroids are in **highly elliptical orbits** that pass close to Earth: Near-Earth asteroids (NEAs), some of them are **Earth-approaching** or **Earth-crossing**.



Asteroid Facts

- **Total mass** of all asteroids: **~5% of the Moon mass**.
- Asteroids are **too small to be seen with the naked eye** – need large powerful telescopes (*one exception: Vesta*).
- The **average surface temperature** of a typical asteroid is **-100°F**.
- About 15 larger than 250 km (155 mi) are currently known.
- >1,000,000 larger than 1 km and the number increases rapidly with decreasing size.
- Asteroids are **irregularly shaped**; larger ones appear as “rubble piles”.




- Some even have **their own moon!**

Biggest Asteroids of the Solar System

Three larger than 500 km!

Four biggest asteroids in the Solar System

 /SpaceReloaded



Ceres
Mass: 9.47×10^{20} kg
Ceres makes up a third of the total mass of all asteroids in the Solar System. In 2006, it was classified as a dwarf planet.



Vesta
Mass: 2.59×10^{20} kg
NASA's Dawn space probe orbited Vesta for over a year, before heading towards Ceres in September. A significant find was evidence of water in the asteroid's composition.



Pallas
Mass: 2.11×10^{20} kg
The second-biggest in terms of average diameter, Pallas is the largest object in the Solar System that isn't spherical.



Hygeia
Mass: 8.67×10^{19} kg
Hygeia is the largest known C-type asteroid. Like other C-types, it has a dark surface, making it fairly difficult to see, despite its large size.

Largest (**Ceres**) is 940 km (590 miles) in diameter.