17. Comets & KBOs
Nucleus warms and begins to sublimate.

Gas coma begins to form around nucleus when comet is about 5 AU from Sun.

Tails form by about 1 AU from Sun; tails point away from Sun.

Dust tail is pushed by sunlight.

Solar heating diminishes; coma and tail disappear between 3 and 5 AU from Sun.

Larger particles are unaffected by sunlight or solar wind.

Plasma tail is swept back by solar wind.
Comets are icy objects which fall into the inner solar system. Warmed by the Sun, they may develop long tails. At other times, a comet is an inert lump of ice & dust.
Comet Nuclei

1P/Halley - 16 × 8 × 8 km
Vega 2, 1986

9P/Tempel 1
7.6 × 4.9 km
Deep Impact, 2005

19P/Borrelly
8 × 4 km
Deep Space 1, 2001

81P/Wild 2
5.5 × 4.0 × 3.3 km
Stardust, 2004
Deep Impact: the Nucleus of Tempel 1

Analysis of collision debris suggests Tempel formed ~ 30 AU from the Sun.
Comets and Meteor Showers

Comets shed dust, sand and gravel which slowly spread out as they move along the comet’s orbit.

If the Earth encounters one of these trails, we get a meteor shower.
Overview: Structure

**Inner system:** terrestrial planets, asteroids.

**Outer system:** giant planets and moons, “KBOs”.

**Oort Cloud:** comets.
KBO Orbits

- Scattered: highly elliptical
- Classical: outside Neptune's orbit
- Resonant: like Pluto's orbit
- Scattered: highly elliptical
Pluto’s Orbit

Pluto’s orbit is highly tilted (inclination $i = 17^\circ$) to the rest of the solar system.

Pluto is in a 3:2 resonance with Neptune. This is stable since Pluto avoids Neptune.
Orbital Populations

Resonant KBOs (plutinos) avoid Neptune’s influence.

Scattered KBOs which cross Neptune’s orbit are easily perturbed.

These scattered KBOs may become comets.
Pluto and Charon

Double planet; many small moons; possibly formed by giant impact (similar to Earth-Moon system).

• orbit ⇒ mass: \( M_{\text{Pluto}} = 0.002 \, M_{\text{E}} \)
• density: \( \sim 2 \, \text{g/cm}^3 \)
• composition: \( 1/3^{\text{rd}} \) rock, \( 2/3^{\text{rd}} \) ice
• thin atmosphere: \( \text{N}_2, \text{CH}_4, \text{CO} \)

Pluto has probably differentiated; Charon is too small to melt itself.