

There, there. Halley will
come back. You'll see.

In addition to planets and their moons the solar system is also littered with three kinds of space debris

- Asteroids
- Comets
- Meteoroids
- Whatever Pluto is



What is a comet?

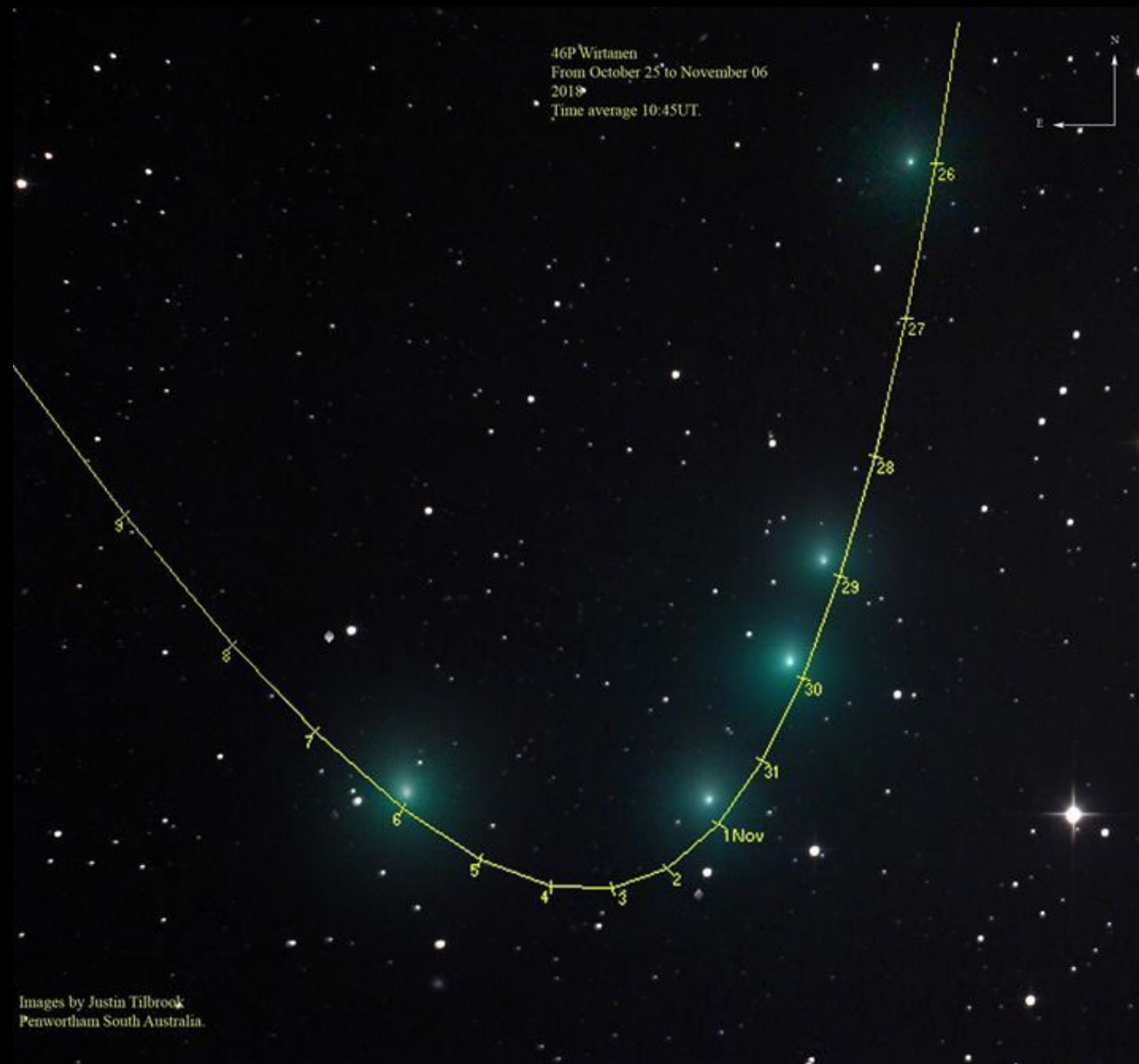
(a.k.a. a “hairy star”)

- Essentially a small (several km), dirty ice ball on an orbit that reaches the outer parts of our solar system
- They are generally faint/diffuse, but some are quite dramatic on our sky



Comets move across our sky

- They are *not* shooting stars; movement is much slower (weeks/months!) and *not* related to Earth's atmosphere.



A bit of history...

- We have records of comets being observed in the *BC* times!
- Comets later identified in medieval tapestries and other artwork
- Edmund Halley realized that one particular comet (“Halley’s Comet”) returned ever 76 years- it’s orbital period



Halley's Comet

As seen in 1986:



...it will next return in 2061.

Comet orbits

- Comets go around the Sun in elliptical orbits
- Long period (most): hundreds to thousands of years
- Short period: they come by on “human” timescales; many have had their orbits perturbed by Jupiter

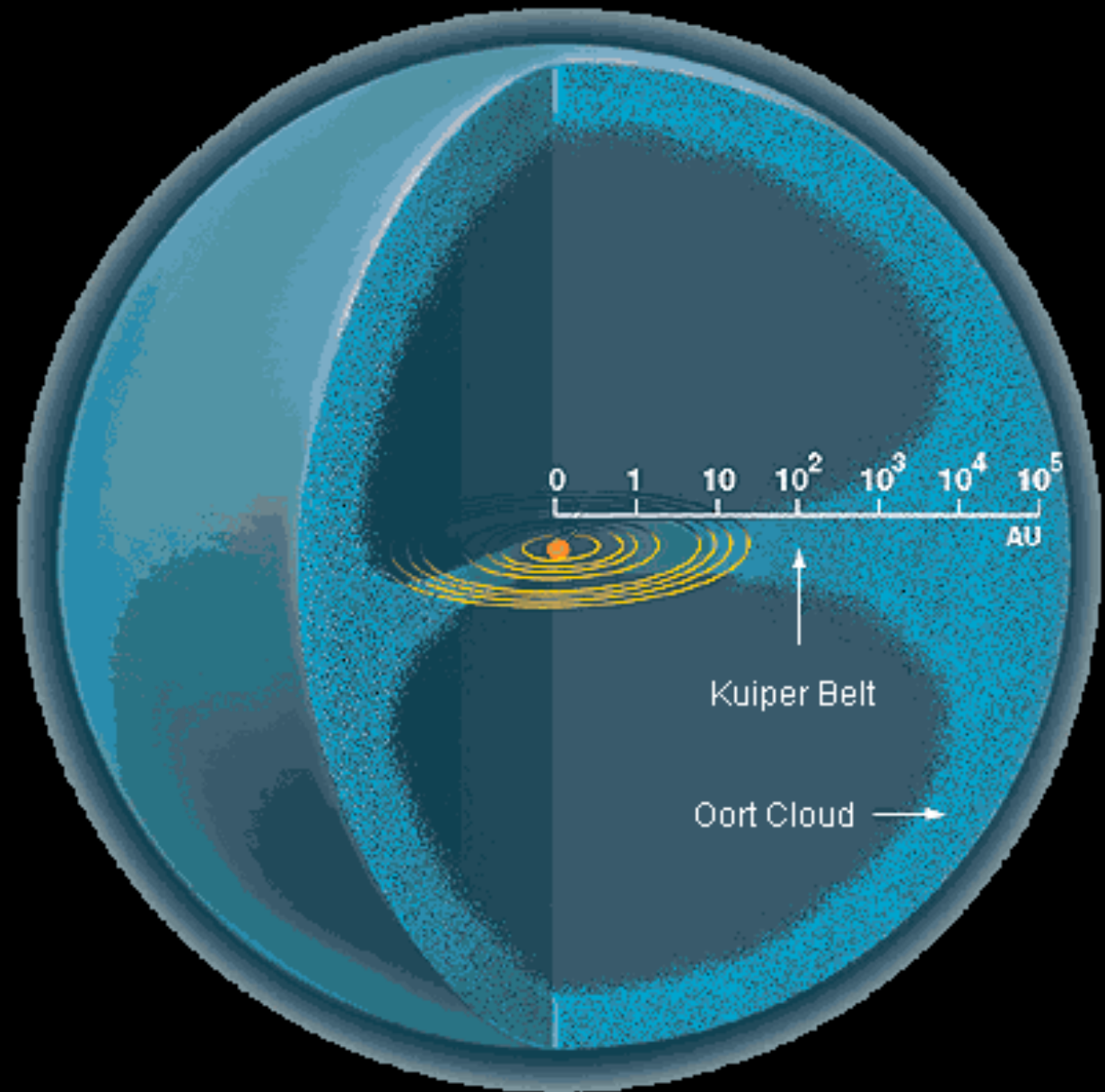
The Kuiper Belt

- Region beyond Neptune's orbit, containing thousands of icy bodies
- Origin of short-period comets



The Oort Cloud

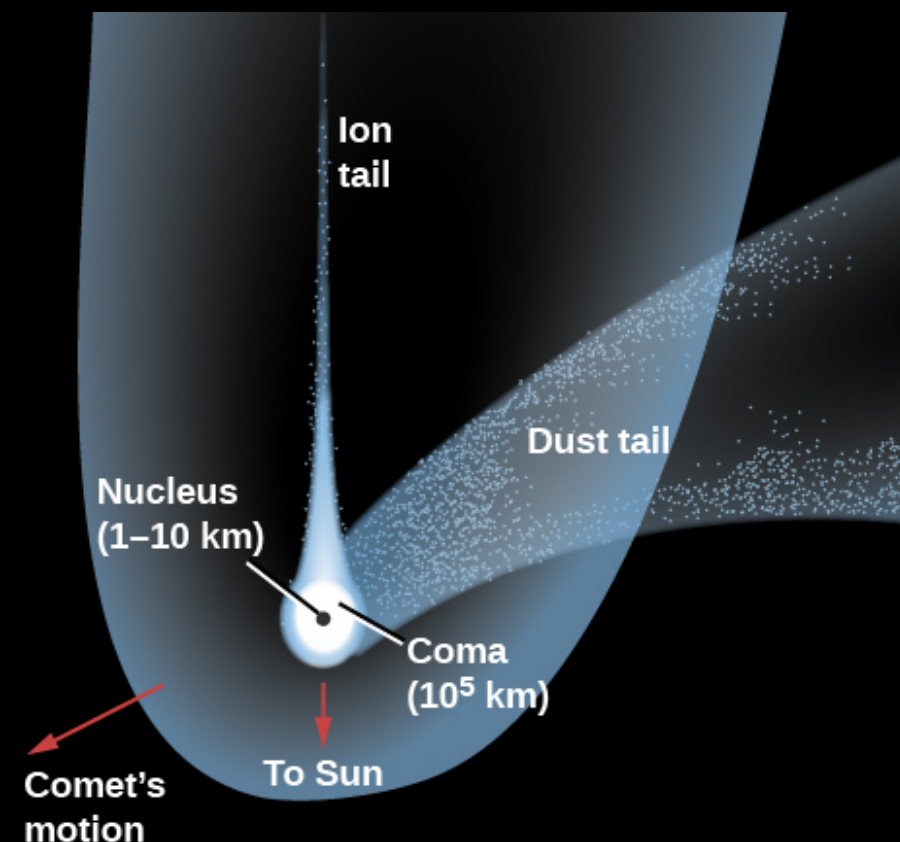
- Spherical region up to 100,000 AU from the Sun
- Could contain trillions of icy bodies
- Origin of long-period comets



Parts of a comet

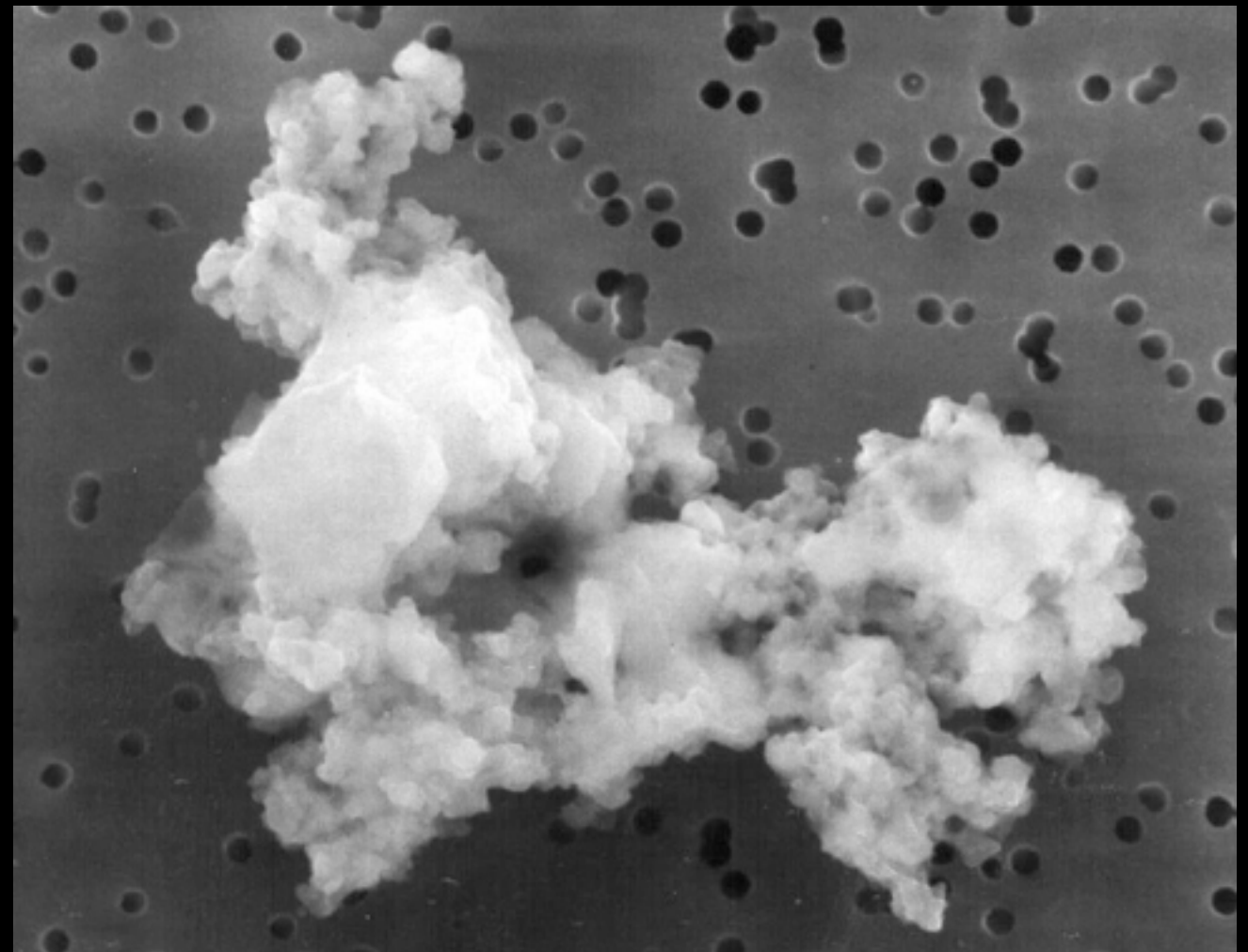
- **Nucleus:** A cold, dark ice ball a few km across
- **Coma:** Melted region around the nucleus that develops when the comet approaches the Sun
- **Tail:** glowing sheath of hydrogen gas extending millions of km

They are mostly made of H_2O And CO_2 .



“Dirty snowball” model

- Nucleus could be a solid ball of ices mixed with silicates and dust
- When heated, water and other molecules are released.
- The other component is less well studied, but perhaps mix of silicates and hydrocarbons.

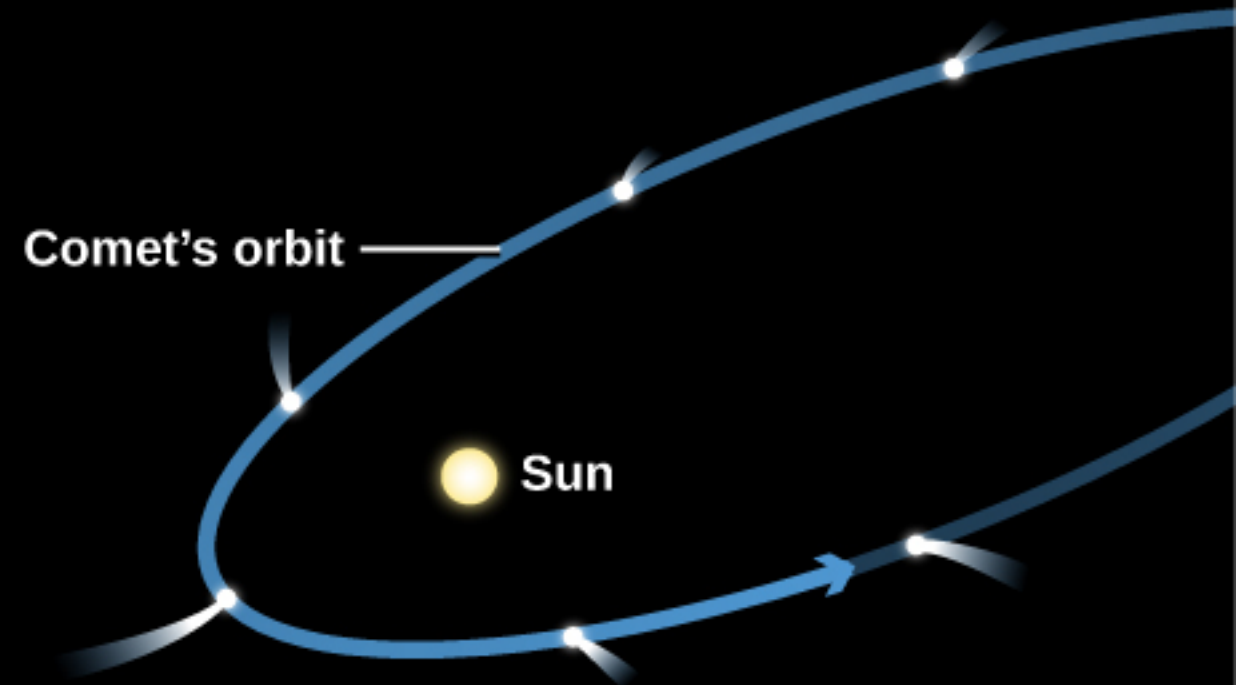


Comet atmospheres

- Once a comet reaches the region near Mars' orbit, water ice locked up in its nucleus begins to melt.
- The nucleus does not have much mass, so there's not enough gravity to hold the dust in
- → Everything flies into space at $\sim 1\text{km/s}$!
- Comet head can be as large as Jupiter

Comet atmosphere

- Extension of the head
- Always points away from the *Sun*
- Dust tail = bright part
- Gas tail = fainter ions



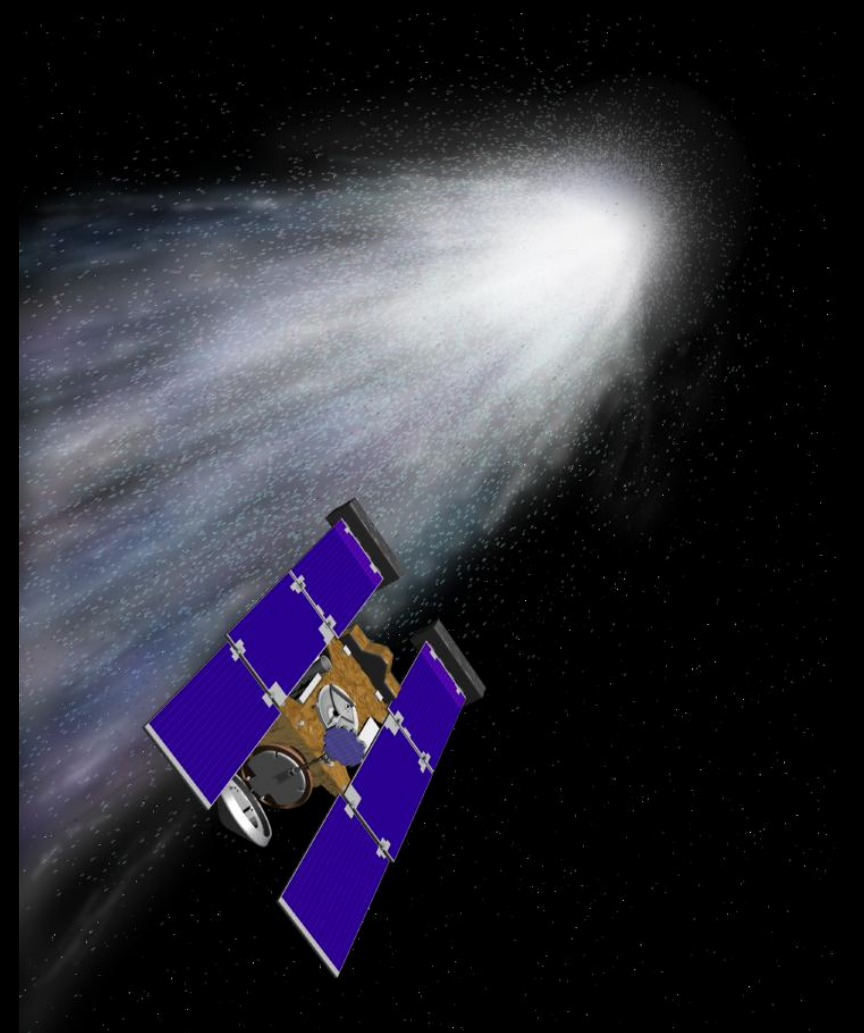
Comet impacts

- Comets *may* have delivered quite a bit of Earth's water supply in the past
- We have seen a comet impact Jupiter (Shoemaker-Levy 9)



Missions to Comets: Stardust

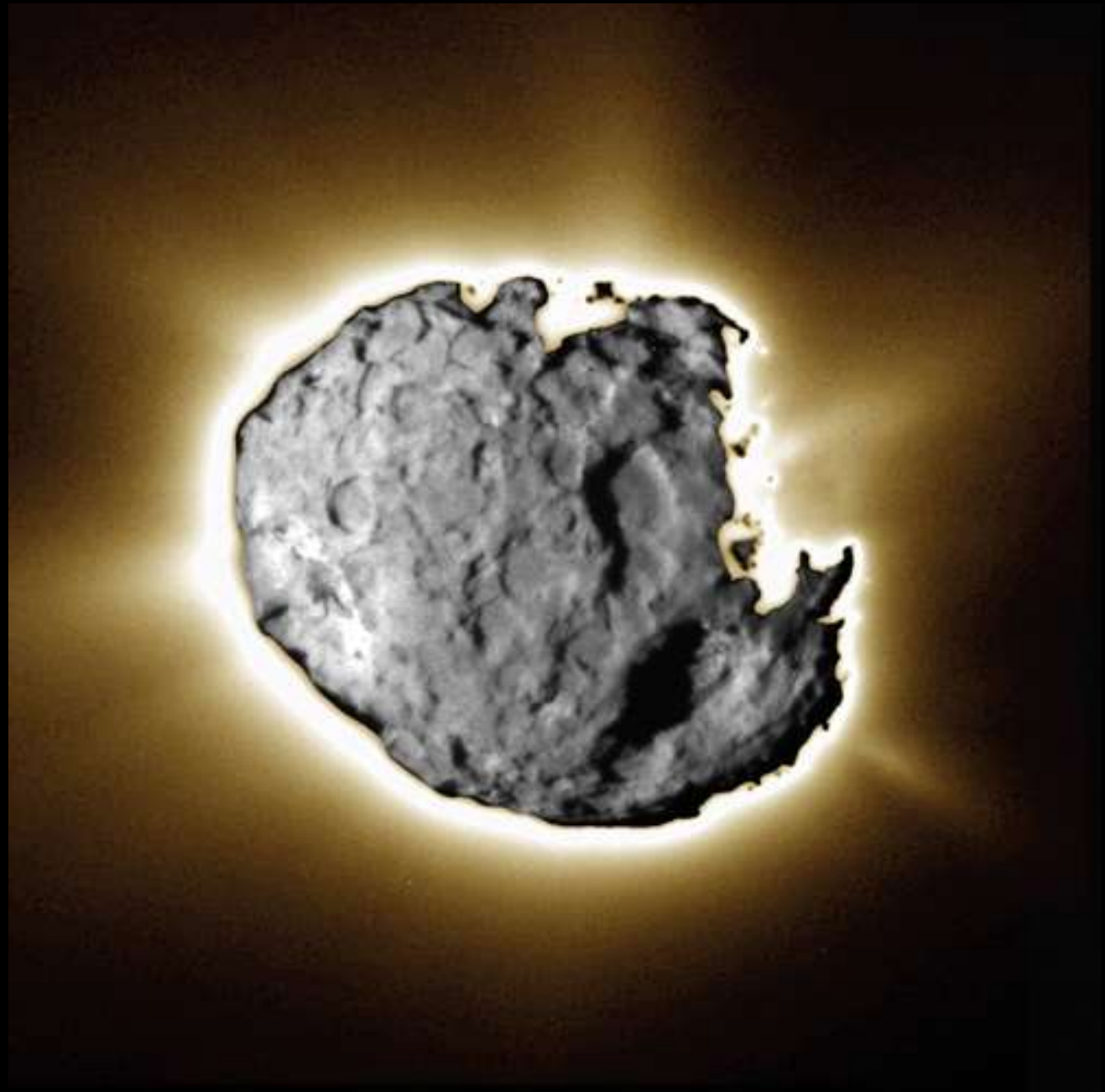
- NASA's first sample return mission from a comet!
- Launched 1999 - gathered dust from comet Wild 2
- Returned in 2006: It dropped off collected material over a landing site in Utah!
- Then it continued on to take images of another comet, Tempel 1.



Missions to Comets: Stardust

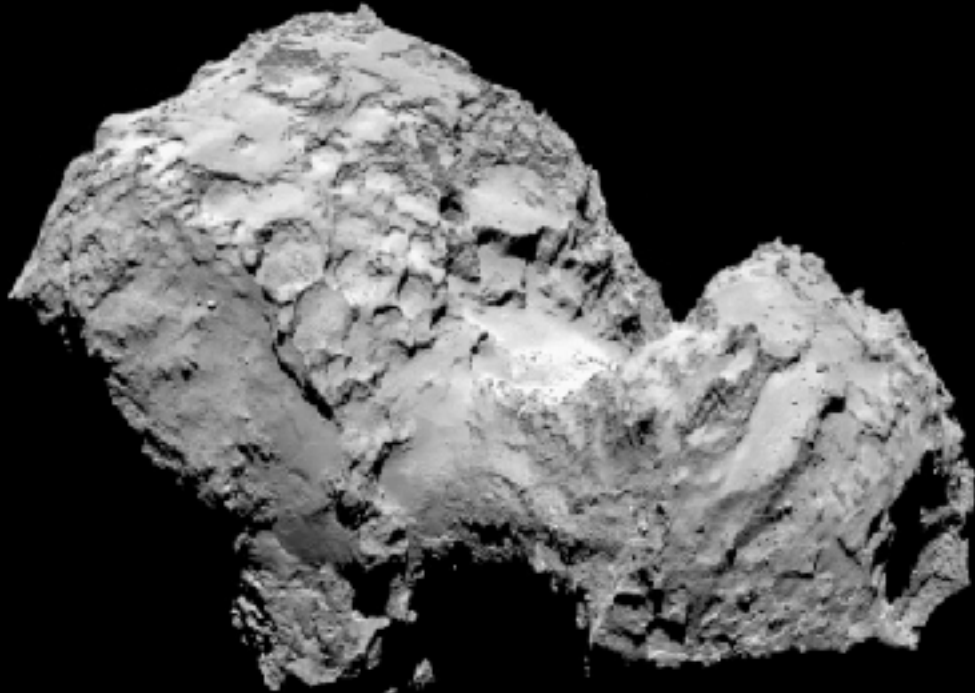
- Dust grains collected from comet Wild 2 indicate high temperature processes
- It's possible that they were formed in the inner solar system and then ejected outward.

Wild 2 nucleus

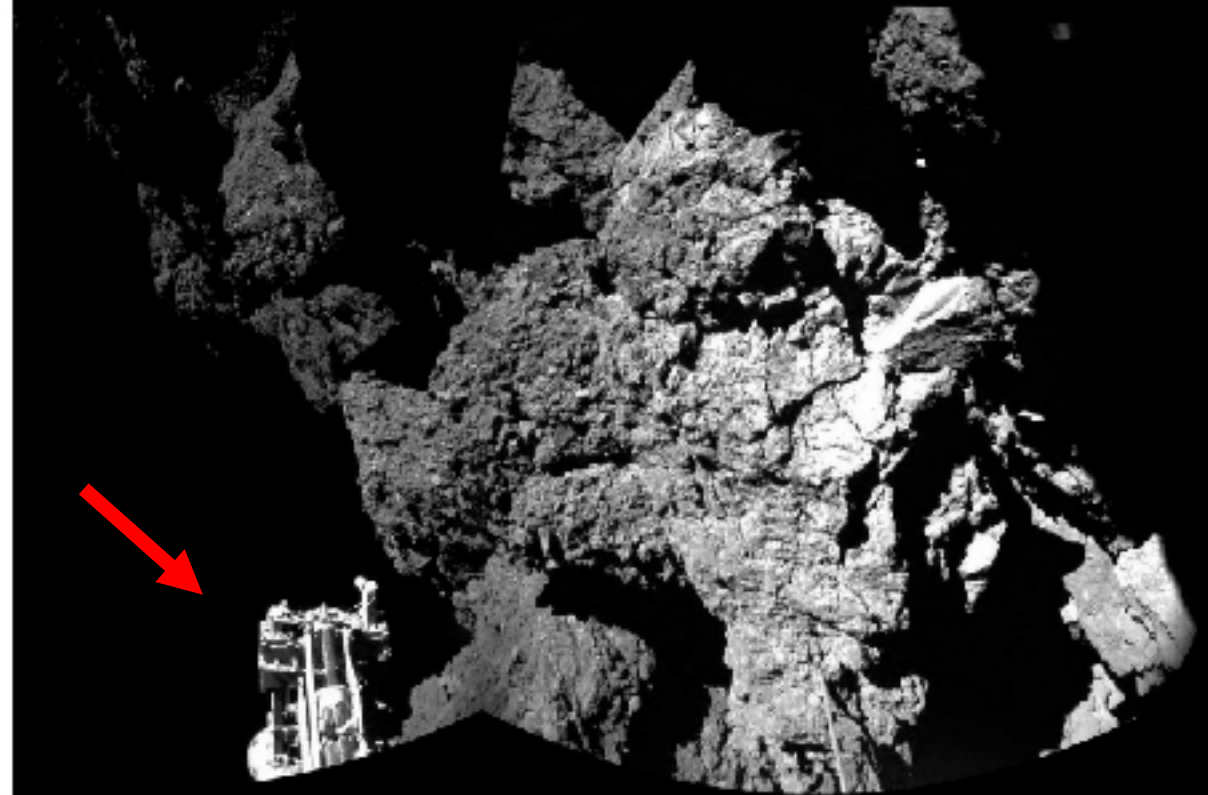


Missions to Comets: Rosetta

- ESA mission launched in 2004
- Goal: land on a comet!
- 10 years later (2014), a lander was dropped here:



(a)



(b)

Missions to Comets: Rosetta

- Philae lander ended up under a ledge
- It transmitted a few days' worth of data:
- First ever images from surface of a comet!



Missions to Comets: Rosetta

- Comet 67P has a double lobed shape-merger of two bodies?
- Carbon-rich compounds cover its surface
- Biological building blocks (e.g., glycine) found in this comet
- Transient jets spraying out!



When will the next bright comet come?

- We're not sure, because the brightness of the tail is actually quite unpredictable!
- There have only been 8 bright (naked-eye) comets since 1969
- The rest require binoculars or a telescope to see
- But... we are overdue for a new bright comet!



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