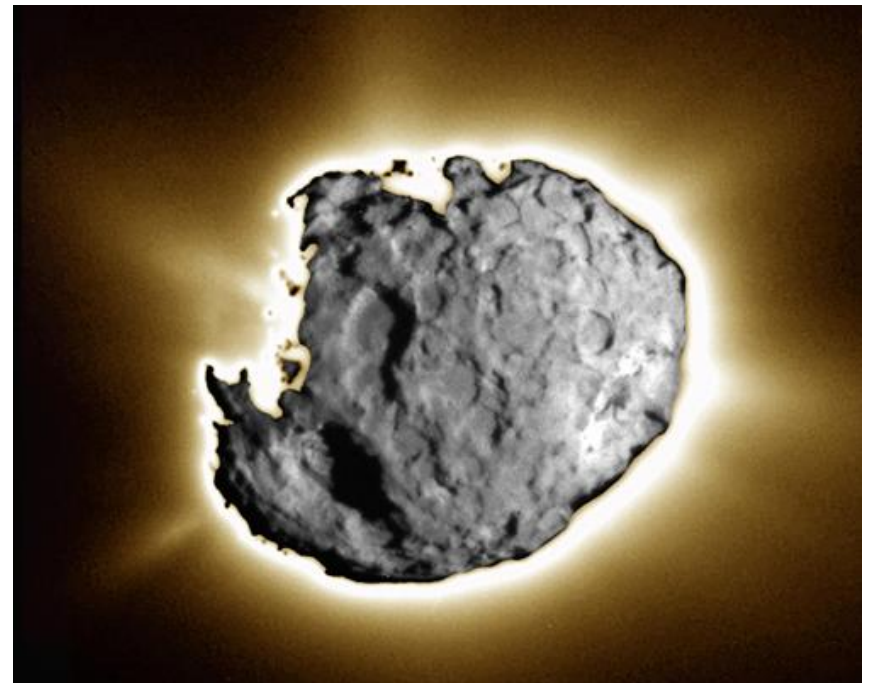


The Oort Cloud and Comets

PHYS 2070 – Observational Astronomy
Lee Clement

What is a comet?

- “Dirty snowball”
 - Nucleus
 - Rock
 - Dust
 - Water ice
 - Frozen gases
 - eg. CO₂
- Blasted by the Sun
 - Coma
 - Fuzzy temporary atmosphere



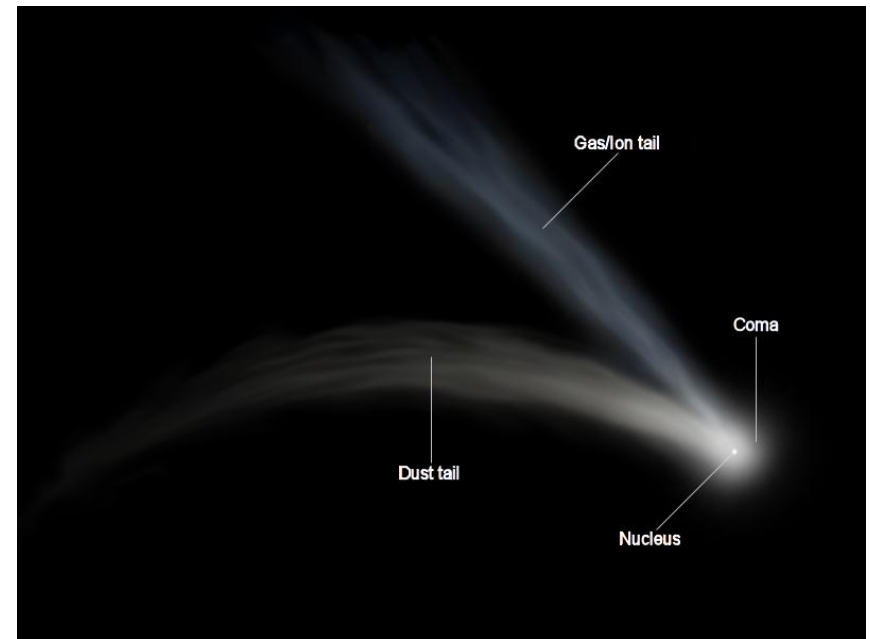
Flyby image of comet Wild 2

Source: NASA

<http://solarsystem.nasa.gov/multimedia/gallery/Wild21.jpg>

What is a comet?

- Has two tails
 - Dust tail
 - Solar radiation knocking dust away from the coma
 - Gas/ Ion tail
 - Solar wind
 - High-speed charged particles



Comet Structure

Source: Wikimedia Commons (Translated from Finnish)

http://upload.wikimedia.org/wikipedia/commons/4/4d/Komeetan_rakenne.jpg

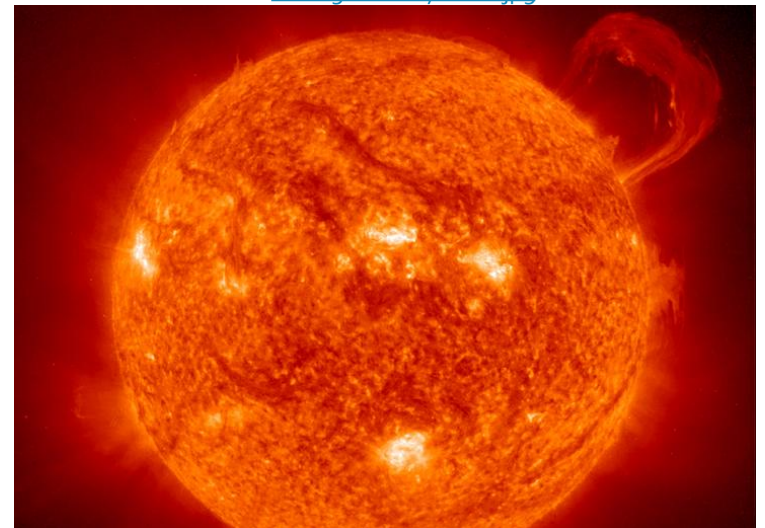
How big are comets?

- Small(ish) nucleus
 - 16km across on average
 - Half the size of Winnipeg
- HUGE coma
 - Can be 1.6 million km across
 - Bigger than the Sun!



Source: CBC

<http://www.cbc.ca/gfx/images/news/photos/2008/07/04/lwpg-one-great-city-wide.jpg>



Source: NASA

<http://solarsystem.nasa.gov/multimedia/gallery/PIA03149.jpg>

How bright are comets?

- Size in the sky
 - Depends on size and distance
 - Usually 1 – 3 arcminutes across
- Magnitude
 - Varies
 - Usually around 9 – 13 magnitude



Comet Hale-Bopp

Source: Wikimedia Commons

http://upload.wikimedia.org/wikipedia/commons/d/df/Comet-Hale-Bopp-29-03-1997_hires_adj.jpg

Why are comets interesting?

- Eye candy
- Very old
 - Earliest record of material from the nebula our solar system formed from
 - 4.6 billion years old
- Could be the source of Earth's water
 - Maybe even organic molecules!
 - Great bombardment
 - Rosetta Mission (ESA)



Comet McNaught
Source: NASA

<http://solarsystem.nasa.gov/multimedia/gallery/McNaught2.jpg>

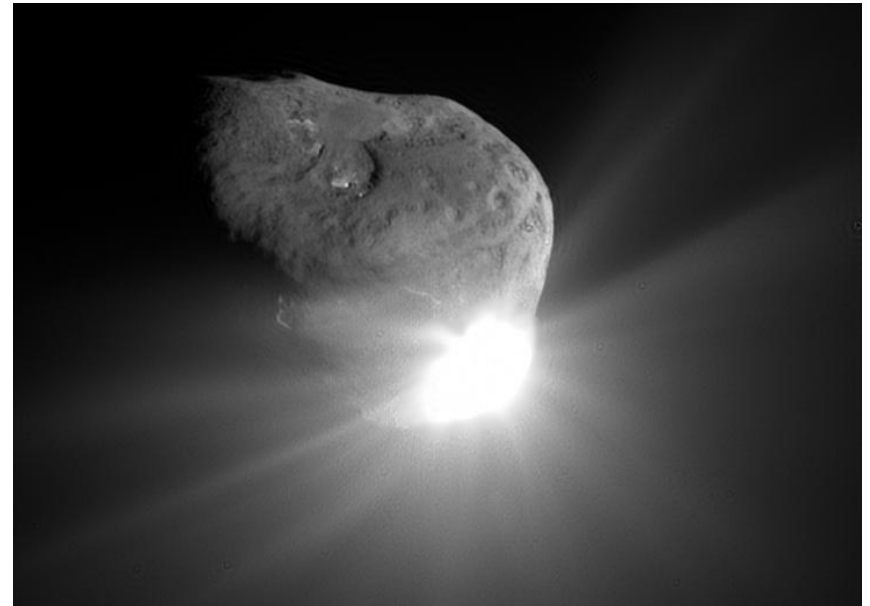


The Pacific Ocean from the ISS
Source: NASA

<http://spaceflight.nasa.gov/gallery/images/station/crew-7/hires/iss007e10807.jpg>

How do we study comets?

- Look at them
 - Watching the tails and comas
- Fly by them
 - Pick up debris and analyze composition
 - Look at nucleus
 - Eg. Stardust mission
- Throw stuff at them
 - Analyze ejecta
 - Eg. Deep Impact mission

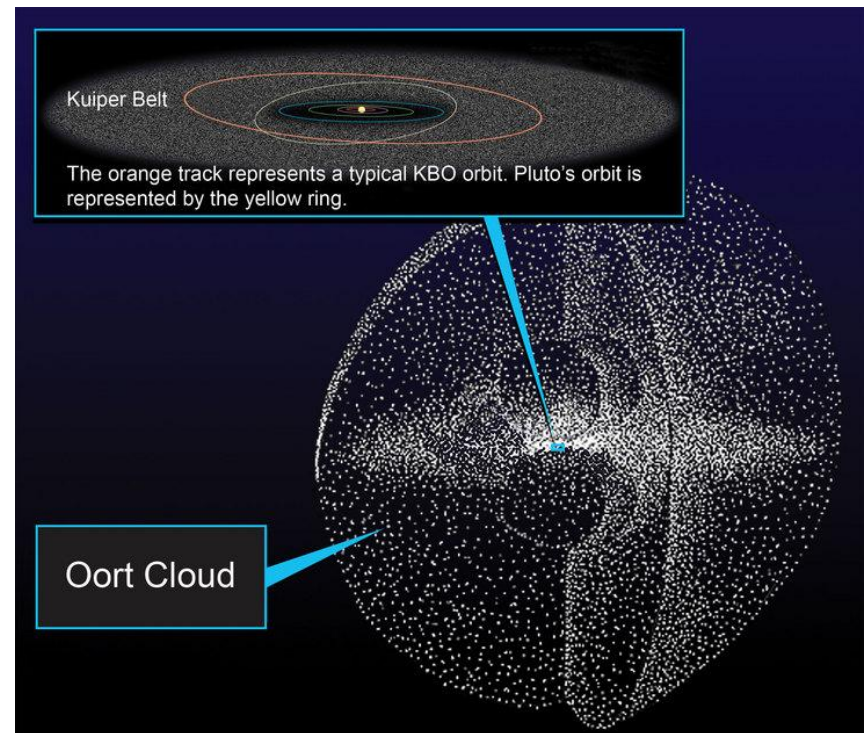


Deep Impact
Source: NASA

http://solarsystem.nasa.gov/multimedia/gallery/Tempel_Impact.jpg

Where do comets come from?

- Kuiper Belt
 - Short period comets
 - Orbital periods < 200 years
 - Eg. Halley's Comet
- Oort Cloud
 - Long period comets
 - Orbital periods > 200 years
 - Some we have only seen once



Source: NASA

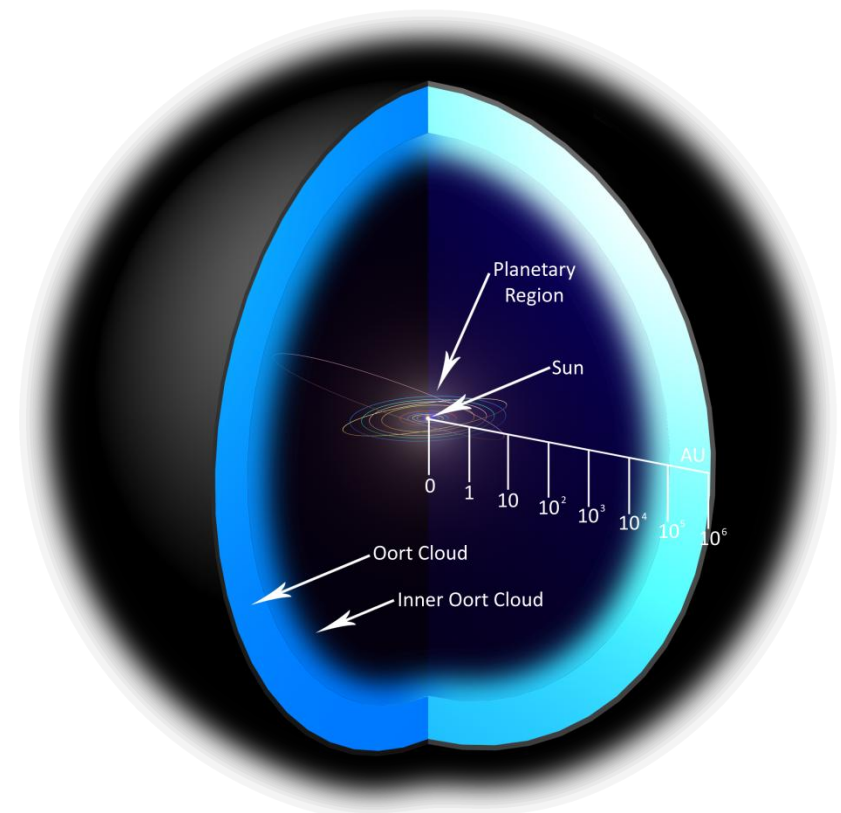
http://solarsystem.nasa.gov/multimedia/gallery/Oort_Cloud.jpg

What's an Oort Cloud?

- Theoretical
 - Jan Oort, 1950
 - Where do long period comets come from?
- Spherical cloud of icy chunks
 - Probably 0.1 – 2 trillion of them
 - Leftover material from the formation of the solar system
 - “Storage” of future comets
 - Knocked out of place by
 - Passing stars
 - Molecular clouds
 - Tidal interactions with the Milky Way

Where is the Oort Cloud?

- The “edge” of our solar system
 - Where the Sun stops having any significant gravitational or physical influence
 - 5,000 – 100,000 AU radius
 - 0.0032% the radius of the Milky Way!
 - Kuiper Belt’s radius is only 30 – 55 AU



Source: Wikimedia Commons

[http://upload.wikimedia.org/wikipedia/commons/5/5d/OortCloud_Psys\(PNG-fin\)1.png](http://upload.wikimedia.org/wikipedia/commons/5/5d/OortCloud_Psys(PNG-fin)1.png)

How can we study the Oort Cloud?

- Problems:
 - Sparse
 - Volume $\sim 4.2 \times 10^{15} \text{ AU}^3$
 - Small
 - Not very luminous
 - Really far away (5,000 – 100,000 AU)
 - Pluto is only 30 – 40 AU from the Sun

How can we study the Oort Cloud?

- Cosmic Microwave Background Radiation
 - Leftover “backdrop” from the Big Bang
 - Look for asymmetries to determine:
 - Mass
 - Distance
 - Size distribution
 - Babich D, Blake CH, Steinhardt CL. 2007. *What can the cosmic microwave background tell us about the outer solar system?* ApJ. 669 : 1406-13
 - Babich D, Loeb A. 2009. *Imprint of distortions in the oort cloud on the CMB anisotropies.* NewA. 14 : 166-79

How can we study the Oort Cloud?

- Kepler Mission
 - Space observatory designed to detect planets in other solar systems
 - Transit method
 - Could be able to detect Oort Cloud objects as well
 - Ofek EO, Nakar E. 2010. *Detectability of oort cloud objects using kepler*. ApJL. 711 : L7-L11

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