

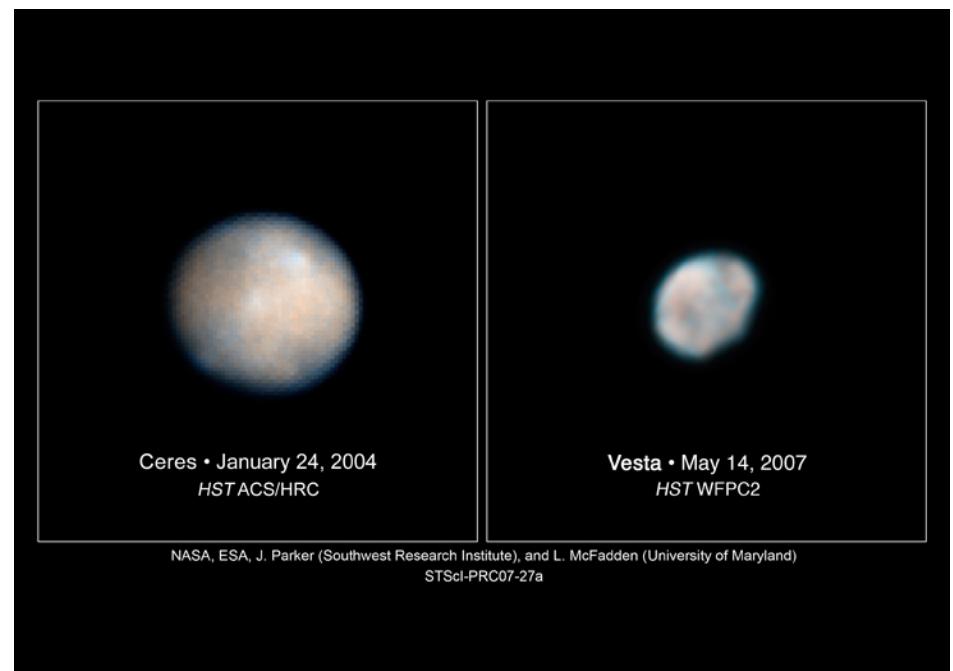
Introductory Astronomy

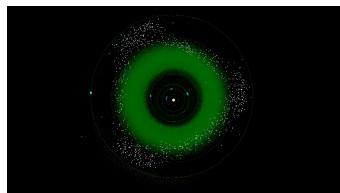
Week 3: Solar System(s)

Clip 10: Asteroids and Comets

Asteroids

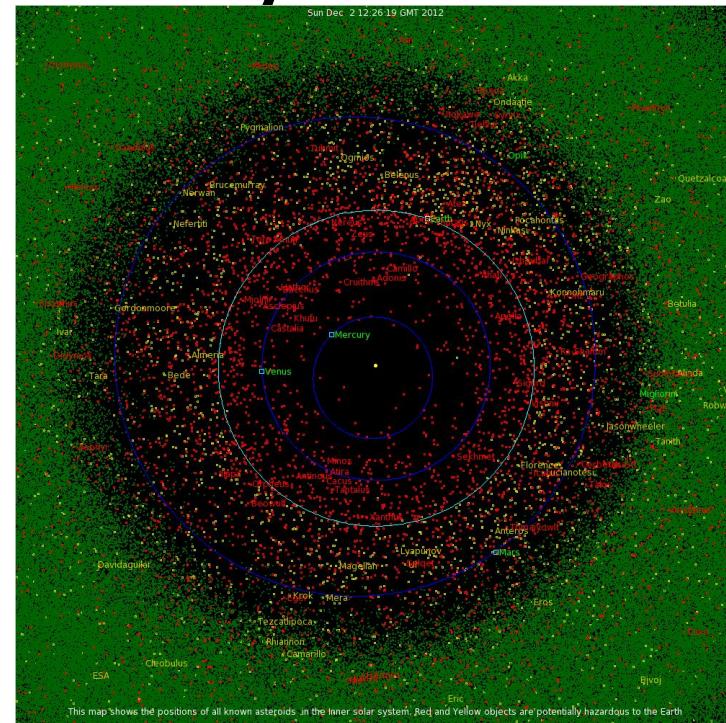
- Asteroids are planetesimals that never accreted to planets
- Most – but not all – never melted and differentiated so preserve chemistry of nebula on surface
- Some are debris of late collisions
- Some melted and are **dwarf planets**: in Solar orbit, big enough to melt, did not clear it's orbit





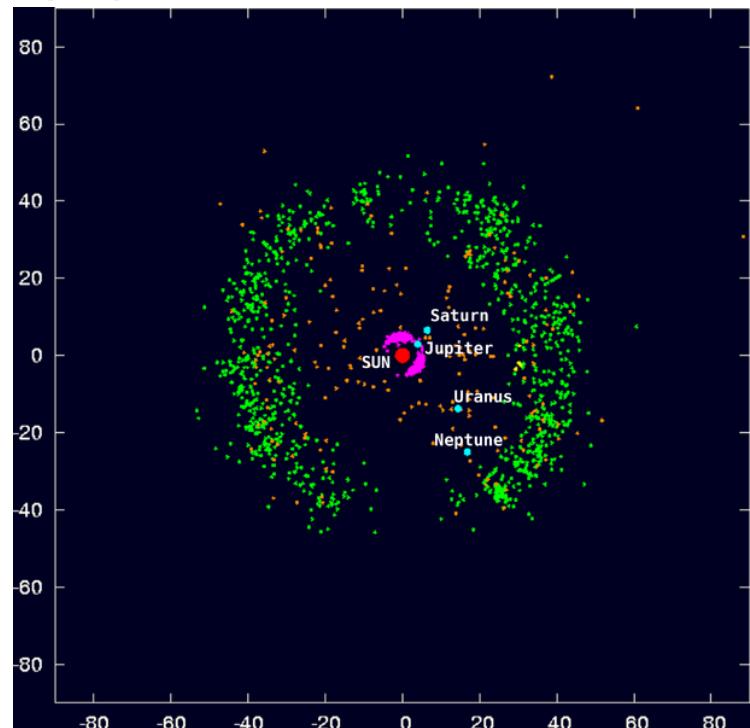
Where Are They?

- Most – in **belt** at **2-3.5AU**
- Some in **resonance** with **Jupiter**
- Minor planets orbiting between **Jupiter** and **Neptune** are **centaurs**
- Some in **Near Earth** orbits or deflected near Earth
- Most **meteors** burn in atmosphere as **shooting stars**
- Surviving to ground makes a **meteorite**



Farther Out

- Trans-Neptunian objects include Kuiper belt (Quaoar, Pluto, Makemake) at 30-50AU and moderate inclination
- Rich in Ices
- Over 1000 found
- From prevalence of short-period comets over 10^5 over 100km
- Long-period comets predict Oort cloud



Comets

- Collisions or effect of Neptune can slow these down into eccentric orbits taking them into inner Solar system
- Interaction with sunlight and Solar wind creates a comet
- Coma, Ion tail, Dust tail



Anatomy of a Comet

- Nucleus: original planetesimal. Dirty snowball??
- Sublimating volatiles carry away dust in jets
- Tenuous dusty atmosphere – coma – can be size of Sun and visible in Sunlight



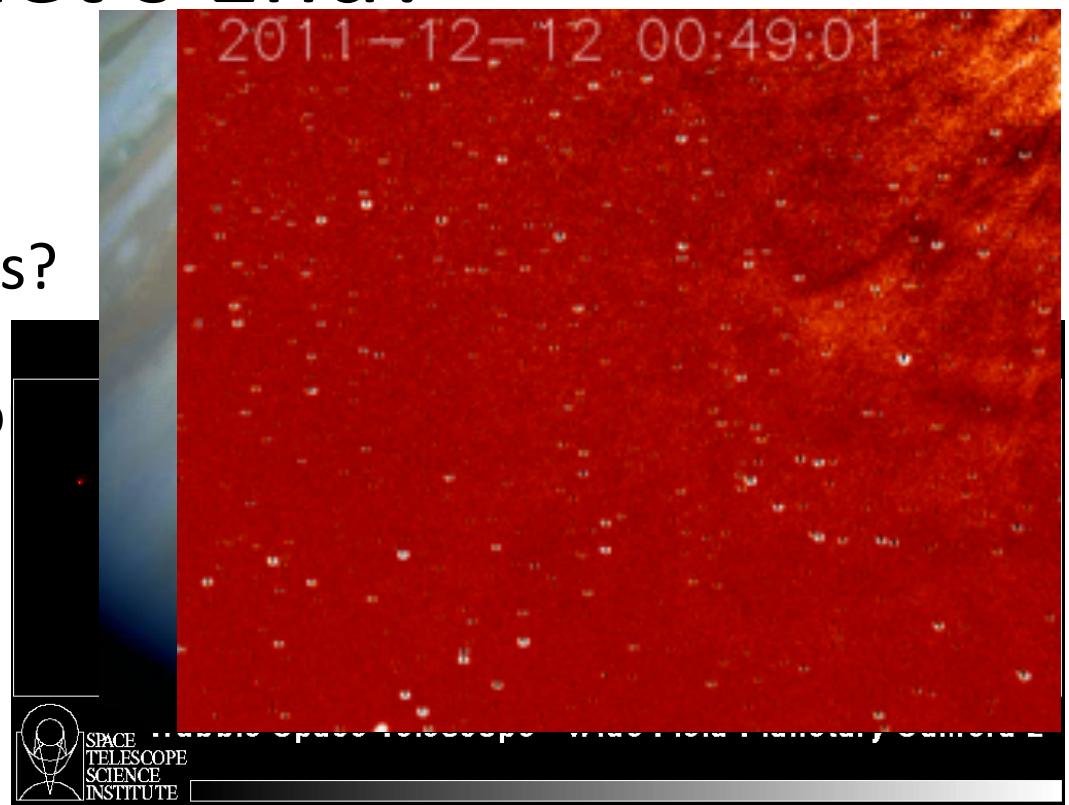
Tale of Two Tails

- Dust and gas pushed by **radiation pressure** and **Solar wind** into tail pointing **away** from Sun
- Can be over **2AU** long!
- **Dust** tail lags – arched – white in reflected Sunlight
- **Ion** tail governed by **magnetic** interaction with Solar wind – **straight** – glows blue



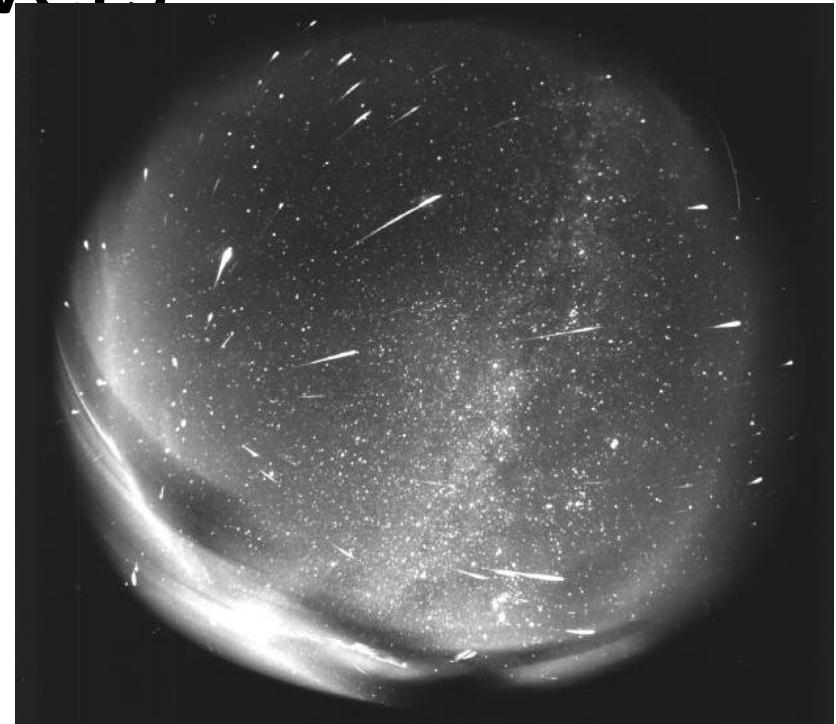
Comet's End?

- Ejection
- Extinction by loss of volatiles. Are some asteroids extinct comets?
- Disintegration with loss icy glue under recoil from jets or tidal forces
- Collision with planet or Sun



Leftovers

- Every pass leaves **debris** in orbit
- Radial dispersion spreads debris along orbit
- If Earth encounters orbit – **meter shower**



Credits

- Asteroid PA8: NASA/JPL-Caltech http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=15204
- Ceres and Vesta: NASA/European Space Agency http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=9885
- Asteroid Map and Animations: [S. Manley http://www.arm.ac.uk/neos/JupiterResonance/](http://www.arm.ac.uk/neos/JupiterResonance/)
- Comet West: Akira Fujii/DMI http://www.davidmalin.com/fujii/source/af12-04_72.html
- Comet Temple: NASA/JPS/UMD http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=4043
- Deep Impact: NASA/JPL-Caltech/UMD http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=9367
- Hartley 2: NASA/JPL-Caltech/UMD http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=11263
- Comet McNaught 2006: Akira Fujii/DMI <http://www.davidmalin.com/fujii/source/af12-34.html>
- Comet Hale-Bopp 1996: Akira Fujii/DMI http://www.davidmalin.com/fujii/source/af12-19_72.html
- Comet 73P: NASA, ESA, H. Weaver (JHU/APL), M. Mutchler and Z. Levay (STScI)/G. Rhemann and M. Jager <http://hubblesite.org/newscenter/archive/releases/2006/18/image/a/>
- Comet SL9: H.A. Weaver, T. E. Smith (Space Telescope Science Institute), and NASA <http://www2.jpl.nasa.gov/sl9/image2.html>
- Jupiter after SL9 Collision: Hubble Space Telescope Comet Team and [NASA http://www.nasa.gov/centers/goddard/multimedia/largest/EdulImageGallery.html](http://www.nasa.gov/centers/goddard/multimedia/largest/EdulImageGallery.html)
- Comet Lovejoy Encounter: NASA/STEREO/
- 2001 Leonid meteors: Juraj Toth (Comenius U. Bratislava), Modra Observatory <http://apod.nasa.gov/apod/ap011104.html>