

Pluto and Impacts

11/30/2009

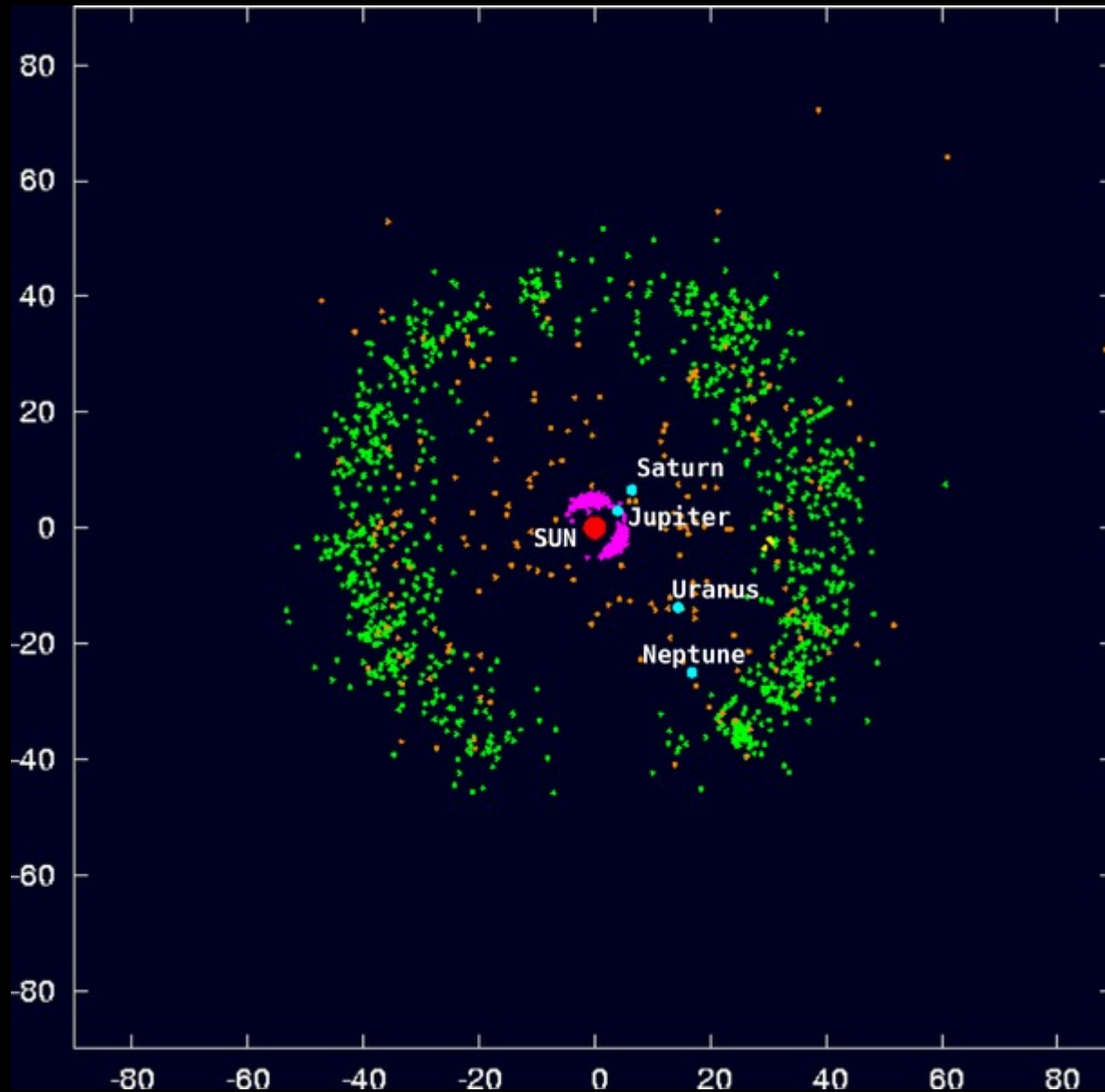
Opening Discussion

- <http://www.youtube.com/watch?v=5HIJWgBjd1g>
- Have you seen anything interesting in the news?
- What did we talk about last class?
- Level of course material.

Kuiper Belt

- Comets actually come from two sources. One source is a flat distribution beyond the orbit of Neptune called the Kuiper belt. These never passed very close to a planet. The Kuiper belt extends out to ~ 100 AU and likely contains $\sim 100,000$ comets 100 km across and a billion comets 10 km across.
- Evidence for the migration of Neptune comes from the fact that many of these bodies are trapped in resonances with Neptune. The lack of asteroids in the asteroid belt is likely evidence that Jupiter migrated inward as well.

Locations of KBOs

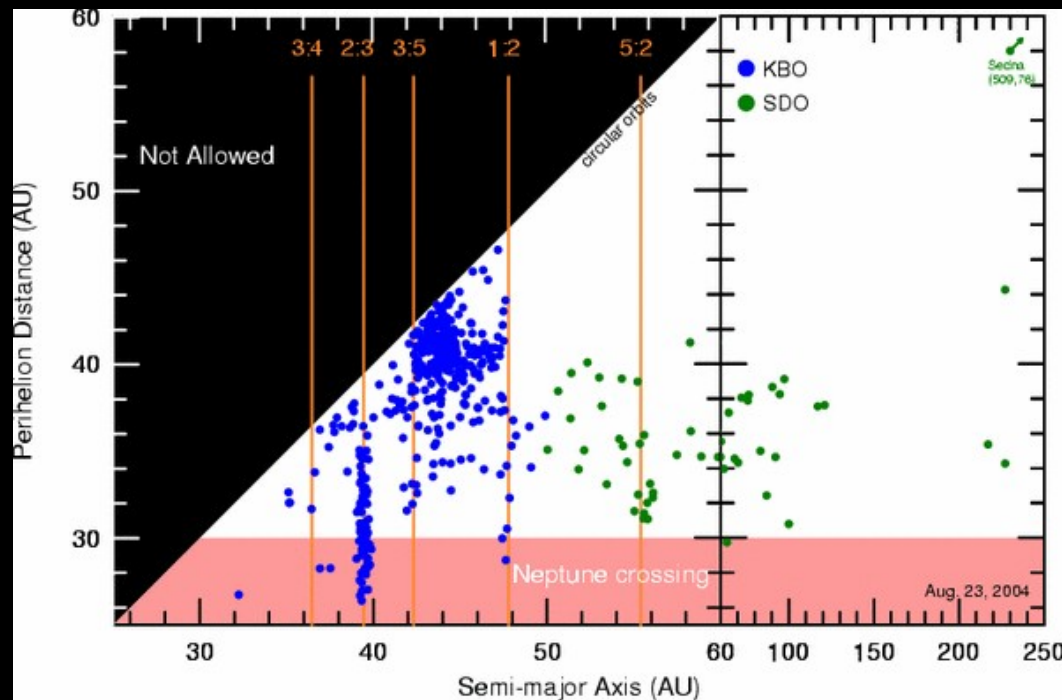


Oort Cloud

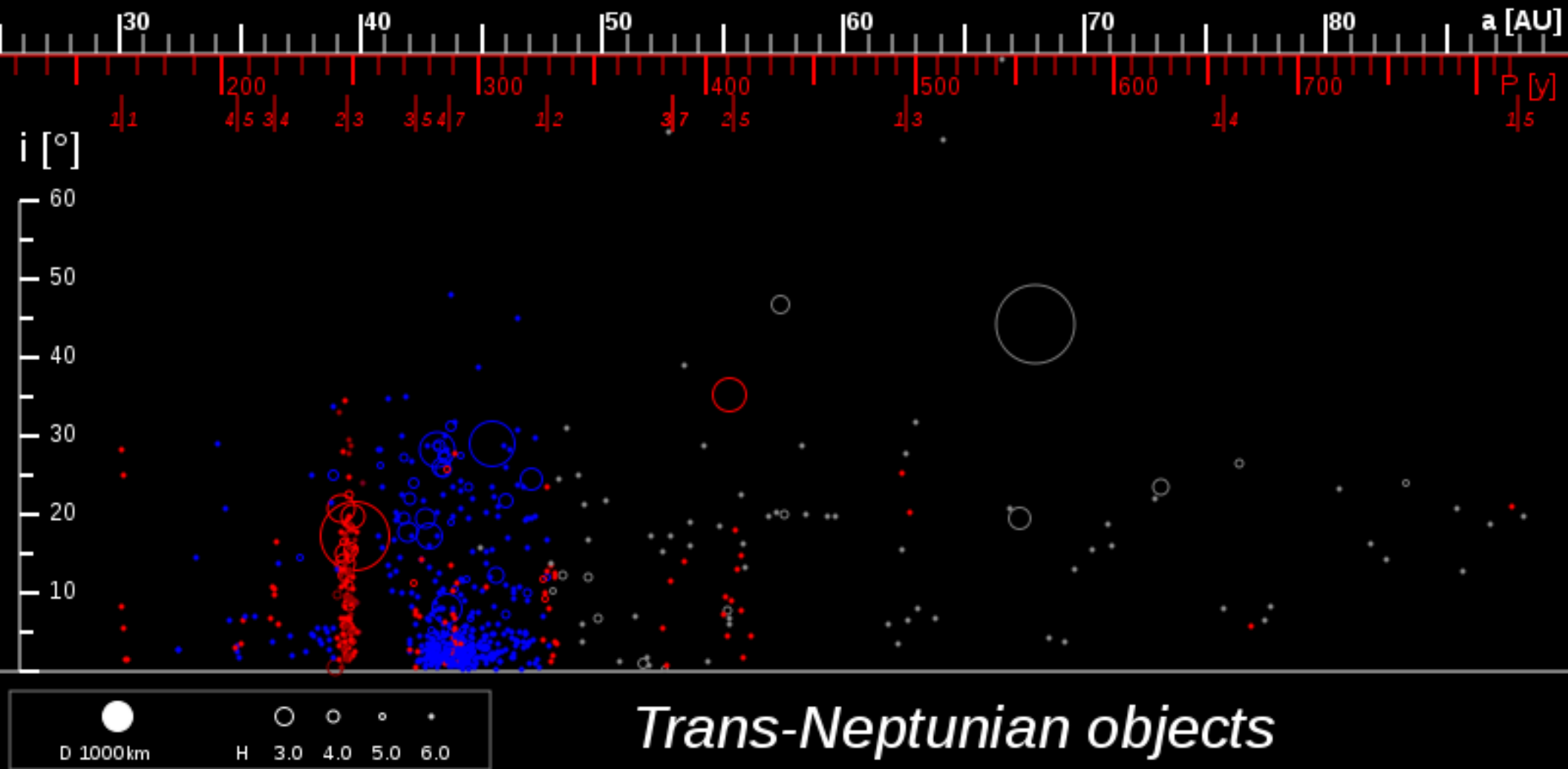
- The small icy bodies that did pass close to planets (and helped to move the Jovian planets to where they are today) generally didn't stay in the plane of the Solar System. Instead, they were thrown in random directions on extremely high eccentricity orbits. Some were even put on unbound orbits.
- The ones that stayed bound orbit our Sun in the Oort cloud. Their orbits extend out to 50,000 AU where they can even be perturbed by other stars passing by. There are likely 10^{12} comets in the Oort cloud.

Pluto and Eris

- Pluto is really a large KBO, not a planet. The discovery of Eris pushed this into an IAU definition.
- Studying Pluto could tell us a lot about this population of bodies.



A Different View



Large KBO/TNOs

Largest known trans-Neptunian objects (TNOs)



Eris



Pluto



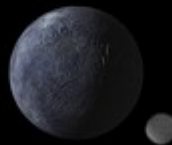
Makemake



Haumea



Sedna



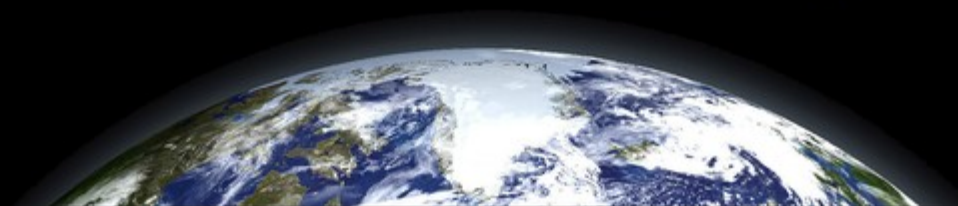
Orcus



2007 OR₁₀



Quaoar



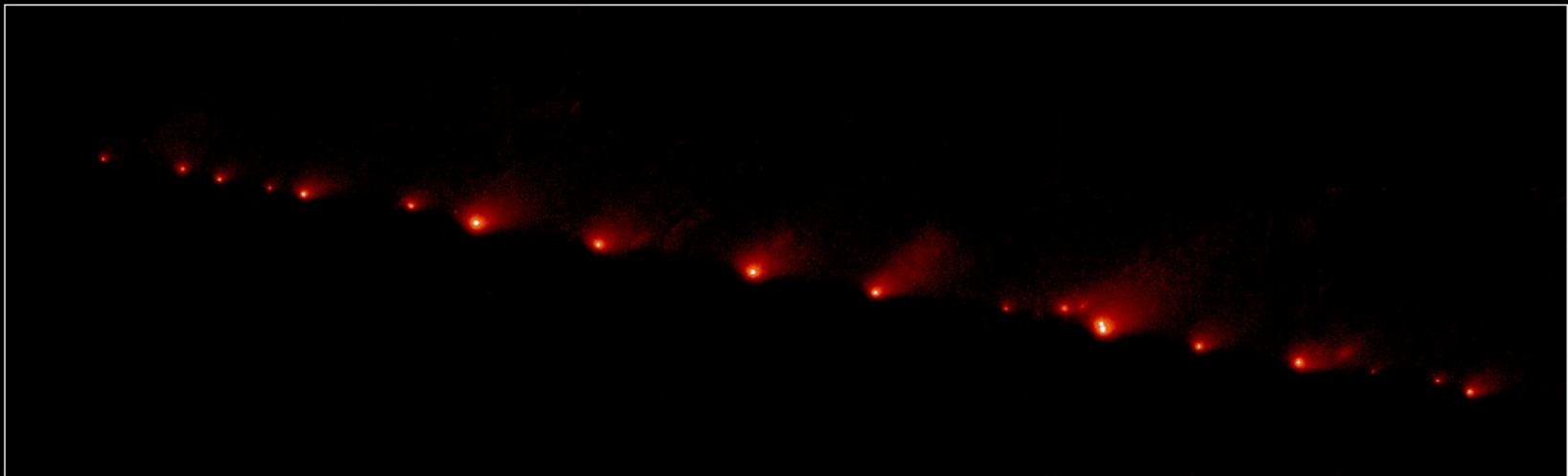
Impacts

- We have talked a lot about impacts in this class. We have stated that a giant impact likely formed our Moon. We see ample craters on many of the solid bodies in our solar system providing evidence of collisions.
- Not all of these collisions occurred in the ancient past. The highest rate of impacts was during the heavy bombardment when the extra material in the solar system was being cleared out. There are still many small bodies flying about though and occasionally they still run into the planets and moons.

Shoemaker-Levy 9

The assertion that impacts still happen went from theory to reality in 1994 when we were able to observe SL9 slamming into Jupiter.

Comet P/Shoemaker-Levy 9 (1993e) • May 1994



SPACE
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SCIENCE
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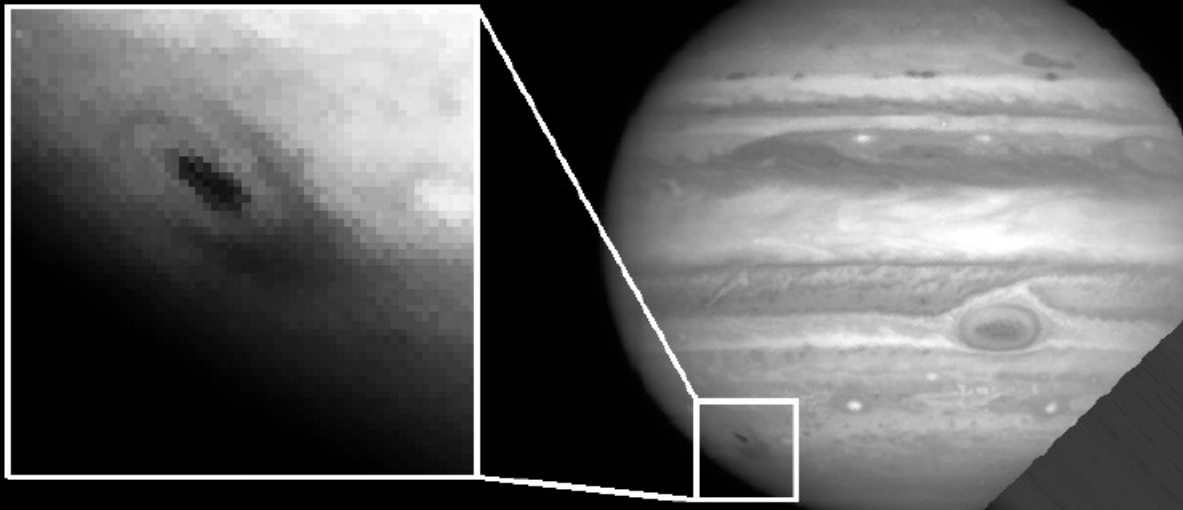
Hubble Space Telescope • Wide Field Planetary Camera 2

Impact Sites

Jupiter

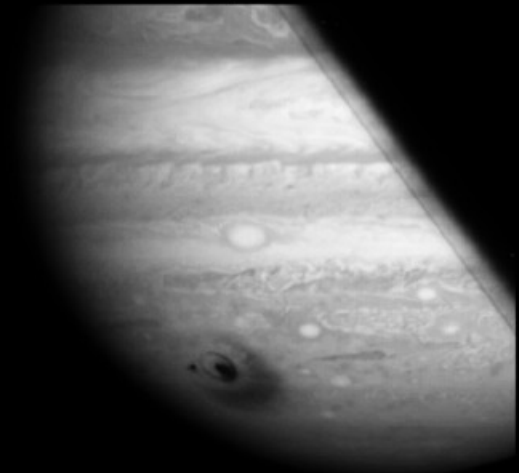
July 16, 1994

After
Impact site
Enlarged and Enhanced



Hubble Space Telescope
Wide Field Planetary Camera 2

Jupiter
18 July 1994



Hubble Space Telescope
Planetary Camera

Impacts on the Earth

- We see evidence of impacts on the Earth as well. Because of erosion, these are difficult to find unless they are fairly recent. More than 100 have been identified.
- Meteor crater shown here was made 50,000 years ago by an asteroid roughly 50m across.



Mass Extinctions

- The fossil record indicates that there have been several times during the history of the Earth when the vast majority of all life, and even the majority of all species, have been killed in a geologically short period of time.
- The most recent of these included the extinction of the dinosaurs 65 million years ago. Roughly 99% of all creatures and 75% of all species on Earth were killed.
- This was actually a fairly small extinction event compared to others in which 90% of all species have been killed.

Impacts and Mass Extinctions

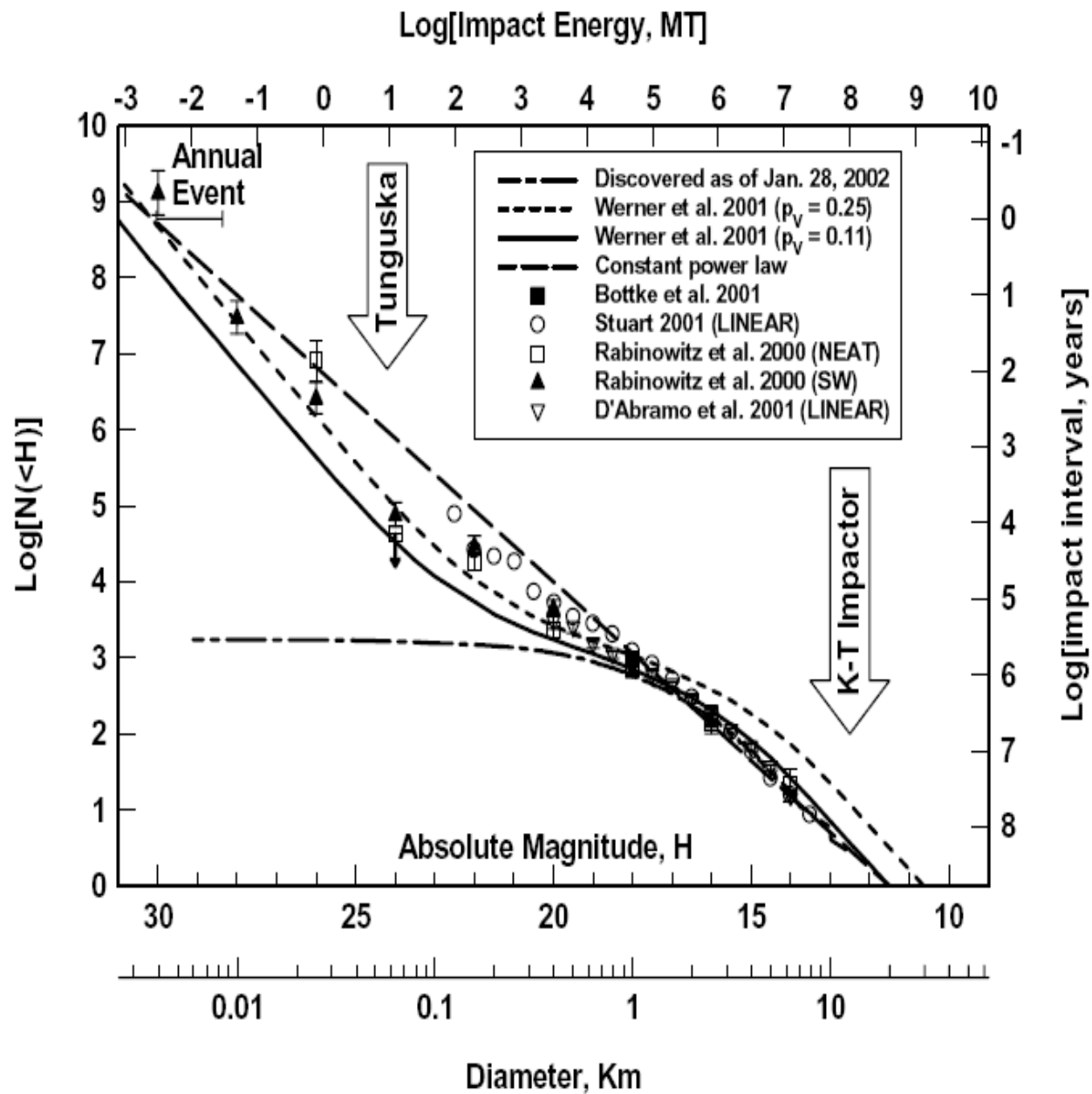
- The layer of dirt that separates the Cretaceous and Tertiary sediment layers (the point of dinosaur extinction) shows evidence of a large impact. The layer is high in iridium and other rare Earth metals. It has shocked quartz and spherical rock “droplets”. It also contains soot as would be produced by fires. In 1991 a crater from roughly the right time was found at the edge of the Yucatan peninsula. The crater is 200 km across indicating an impactor roughly 10 km across.
- The impact itself would only kill off things nearby. Ejecta and longer term atmospheric changes did the rest.

Recent Impacts

- In 1908 a fireball was seen streaking across the sky of Siberia. It exploded leveling trees, breaking windows, and knocking people off their feet hundreds of miles away.



Impact Probabilities



Minute Essay

- We only have four class days left. How does that make you feel?