NEW HORIZONS, PLUTO & THE KUIPER BELT

Ice Worlds at the Edge of the Solar System

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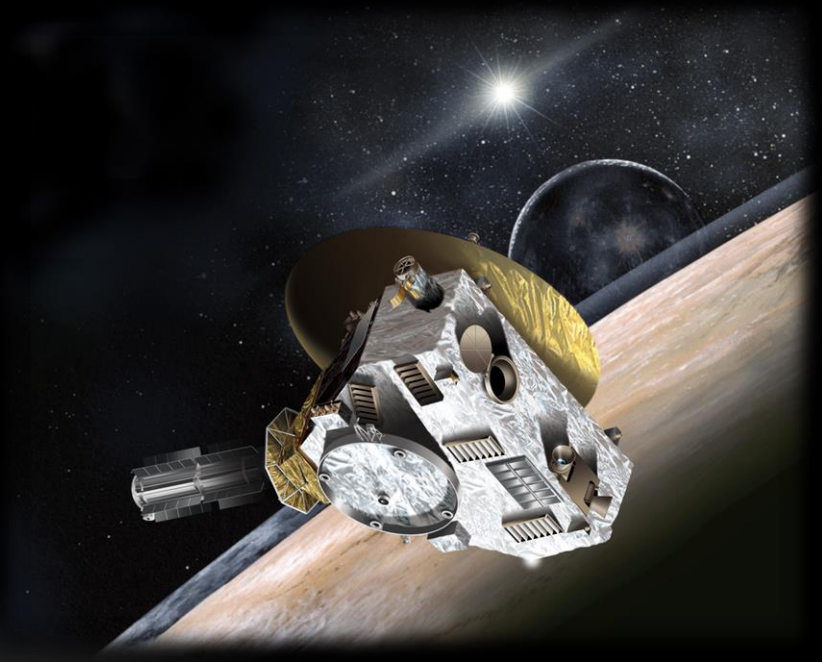
DISCLAIMER

- This talk is not about the definition of a “planet”.
- For full disclosure, however, I’m not a fan.
- This presentation is about the Kuiper Belt.
- I will try to refer to objects to be discussed by the more neutral term “KBO” which is short for “Kuiper Belt Object”.
- I can’t promise I won’t refer to objects as “planets”.

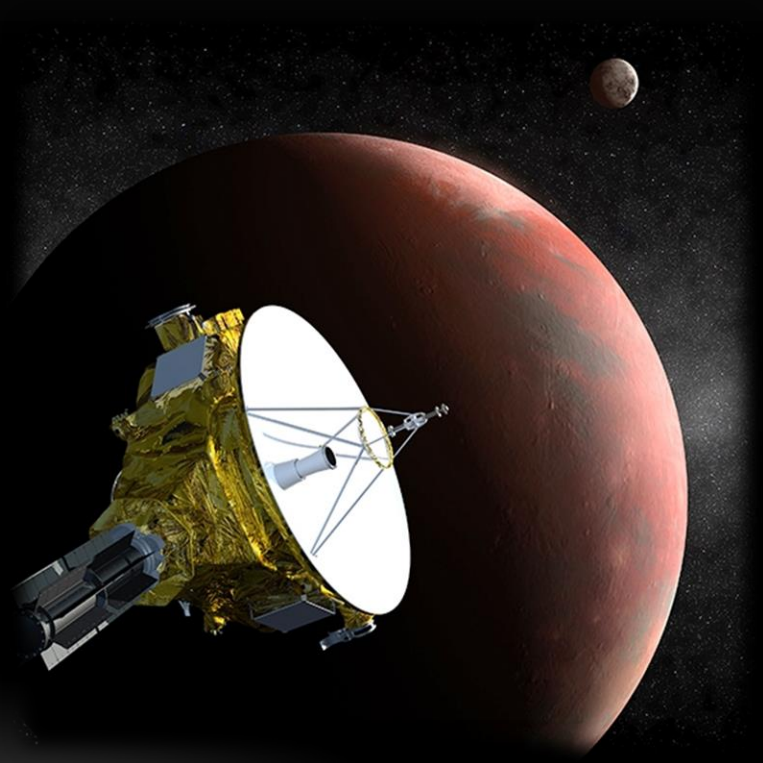
NEW HORIZONS

- On July 7th, 2014, the New Horizons spacecraft entered Pluto-space.
- Launched in 2006
- Expected to arrive at Pluto on July 14, 2015.
- Will fly past Pluto and photograph Pluto and its moons.



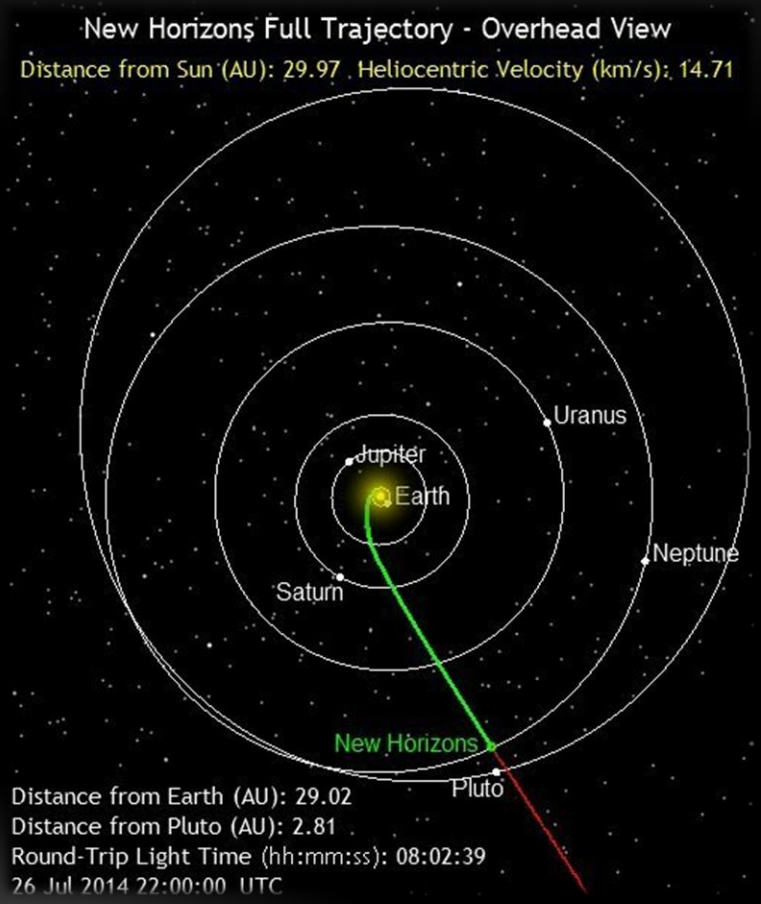
NEW HORIZONS

- The Hubble Space Telescope is currently seeking additional targets along its trajectory past Pluto.
- A number of KBOs past Pluto are known, but most are not within the New Horizons trajectory range.
- Fastest spacecraft ever launched



WHERE NEW HORIZONS IS NOW

- Currently past the innermost point of Pluto's orbit
- Currently, that's about 30 AU from Sun, or 5.7 billion miles
- It is only about 2.8 AU or 266 million miles from Pluto



KUIPER BELT

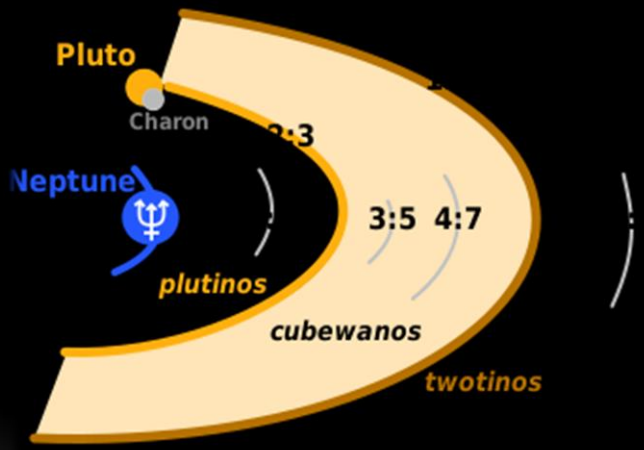
- The Kuiper Belt is a ring of debris leftover from the formation of the Solar System beginning beyond the orbit of Neptune (about 30 AU), and extending to around 50 AU.
- Pluto was the first object discovered in this part of space in 1930 by Clyde Tombaugh.

KUIPER BELT

- Objects in the Kuiper Belt can be classified into a number of different subcategories primarily by orbital characteristics.
- “Classical” KBOs have low eccentricity in their orbits and have orbits largely around 45-50 AU. They never approach Neptune and so have more stable orbits.

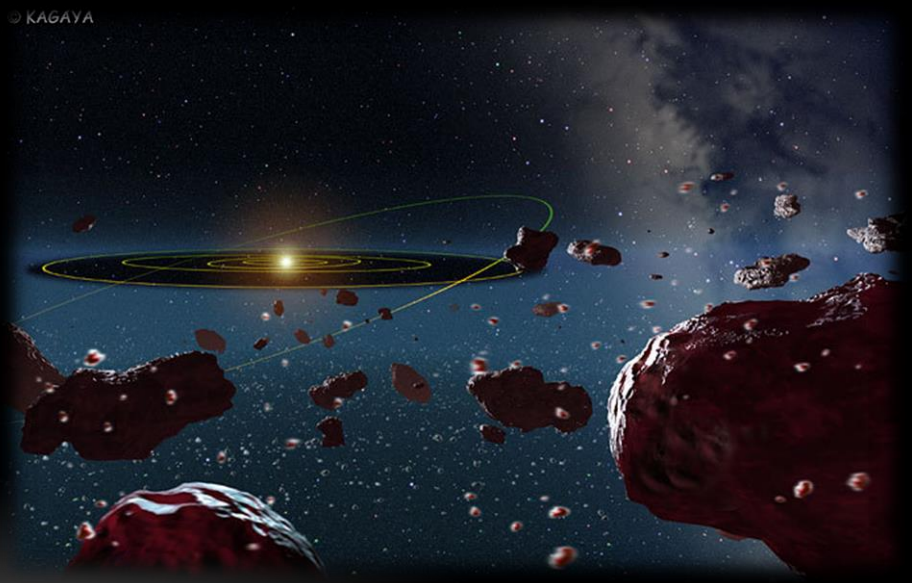
KUIPER BELT

- Resonant KBOs are in gravitational resonance with Neptune. Pluto falls into this category.
- Orbital periods are 'synced' with Neptune. Pluto is in 3:2 resonance with Neptune: completing 3 orbits every time Neptune completes 2. "Plutinos" is another name for objects with this ratio.



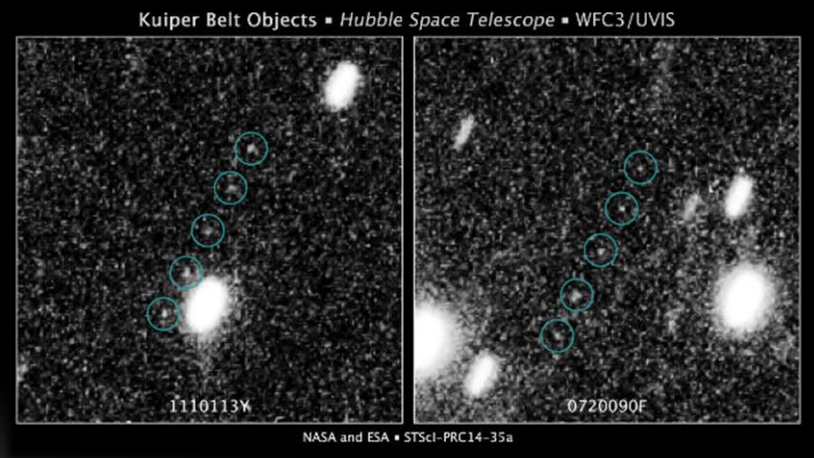
KUIPER BELT

- Scattered Object KBOs have high eccentricity and tend to have high inclination (tilted sharply with respect to the rest of the solar disk).
- Eris (the second-largest known KBO) is a scattered object KBO.
- Like Pluto, it is a double object, with a large moon.



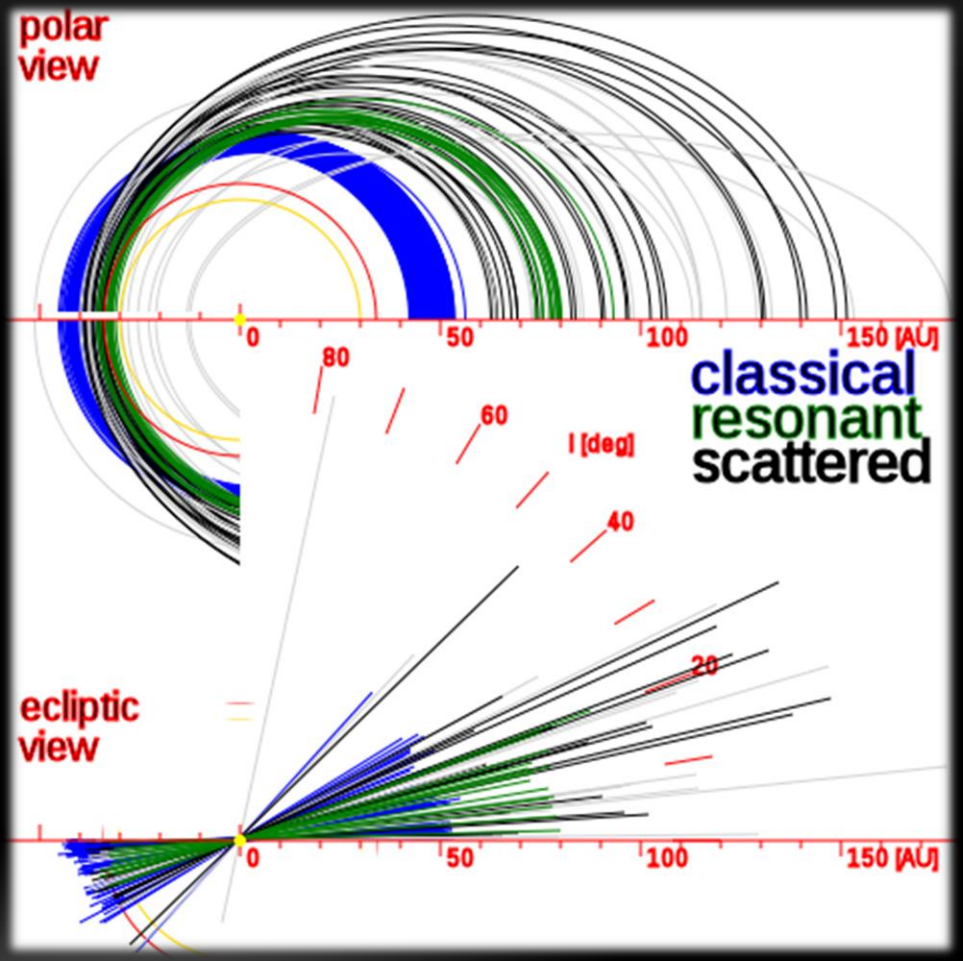
KUIPER BELT

- Detached KBOs have closest approach in the range of "classical" KBOs, but have the high eccentricity of Scattered Object KBOs suggesting some past encounter with a large gravitational disturbance. They are too far away to have been disrupted by Neptune, so they are a bit of a puzzle.



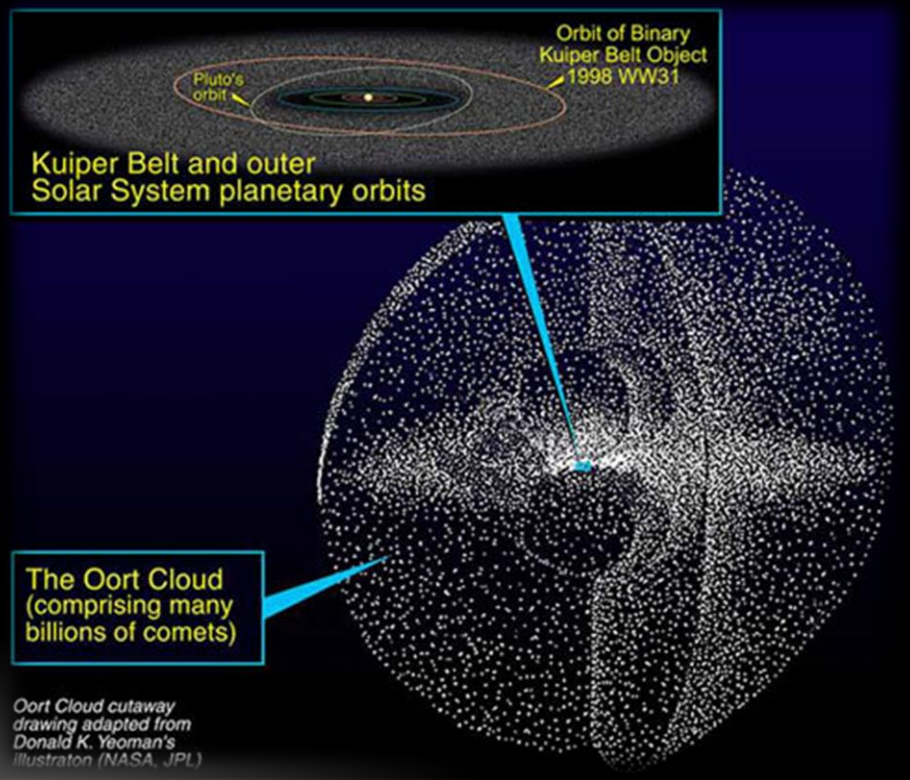
KUIPER BELT

- Eccentricity and inclination for KBOs varies greatly.
- Classical KBOs have most circular orbits and smallest inclinations.
- Scattered objects have large eccentricity and large inclinations.



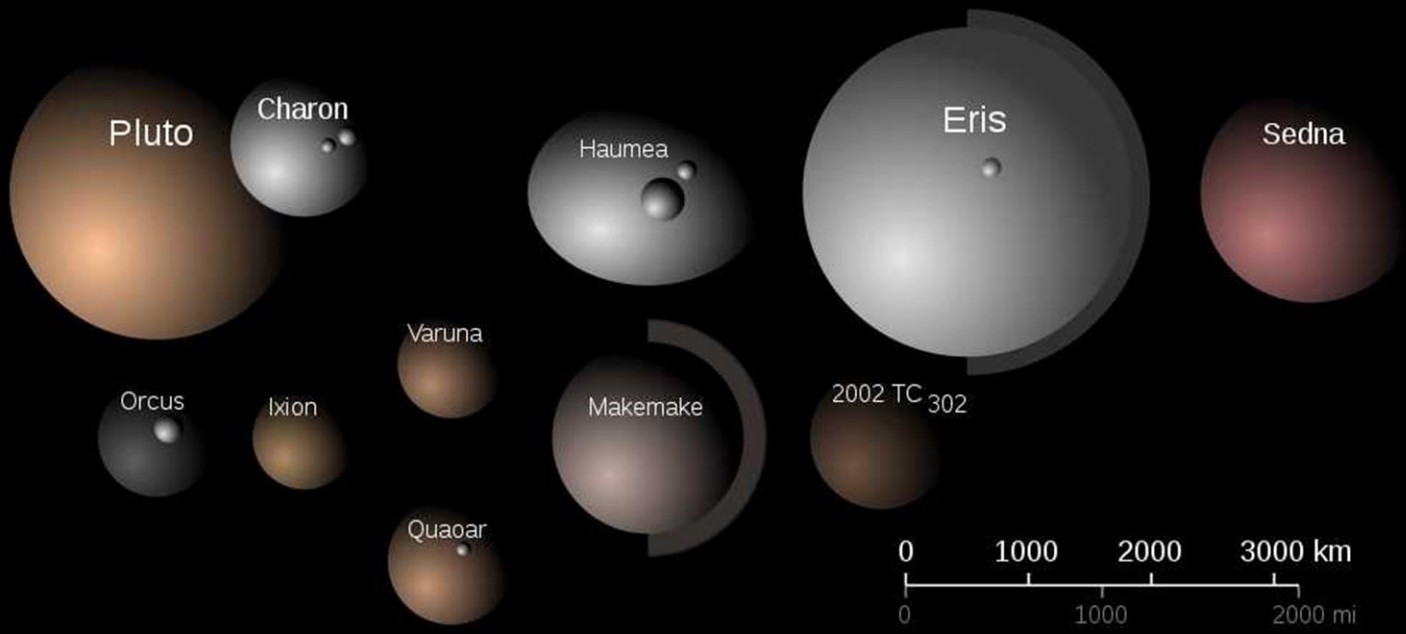
ORIGINS OF THE KUIPER BELT

- Kuiper Belt is a leftover from formation of Solar System.
- Along with the spherical Oort Cloud, it contains many small objects that did not form into planets.
- Kuiper Belt probably origin of short-period comets.
- Oort Cloud, long-period.



RED KBOS VS. WHITE KBOS

- Kuiper Belt objects seem to come with two distinct compositional flavours: Red and White.



RED KBOS VS. WHITE KBOS

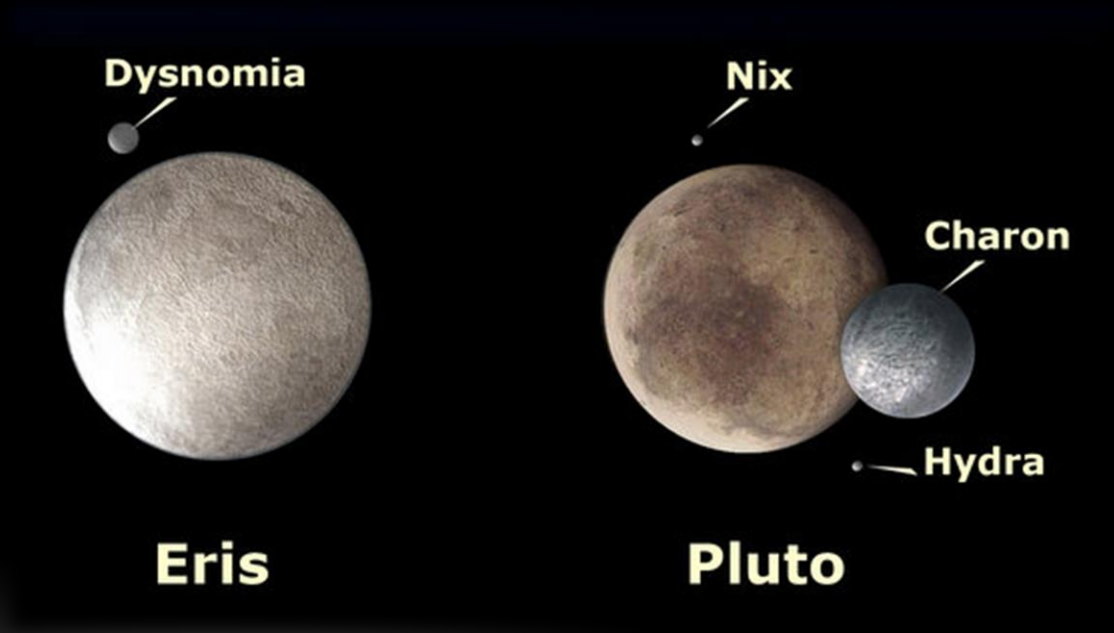
- Some KBOs are optically among the reddest objects in the solar system, possibly due to surface methane ice.
- Other KBOs are more white or grey, possibly due to surface ices like water or nitrogen.
- It is not known if these objects formed differently or how they obtained their different surface compositions.

CAPTURED KBOS

- Some moons in outer solar system are thought to be captured KBOs.
- The most likely is Neptune's largest moon: Triton.
- Phoebe, a moon of Saturn, may be another.

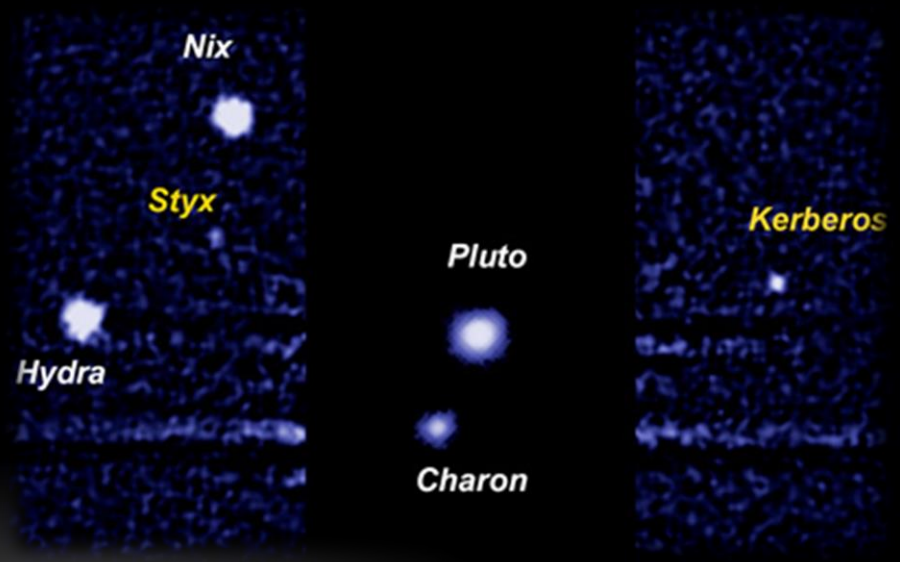
LARGEST KNOWN KBOS

- The two largest known KBOs are Pluto and Eris. It is currently thought that Pluto is a tiny bit larger than Eris.
- Eris is about 1163 km across.
- Pluto is about 1184 km across.
- Larger ones could still be discovered.

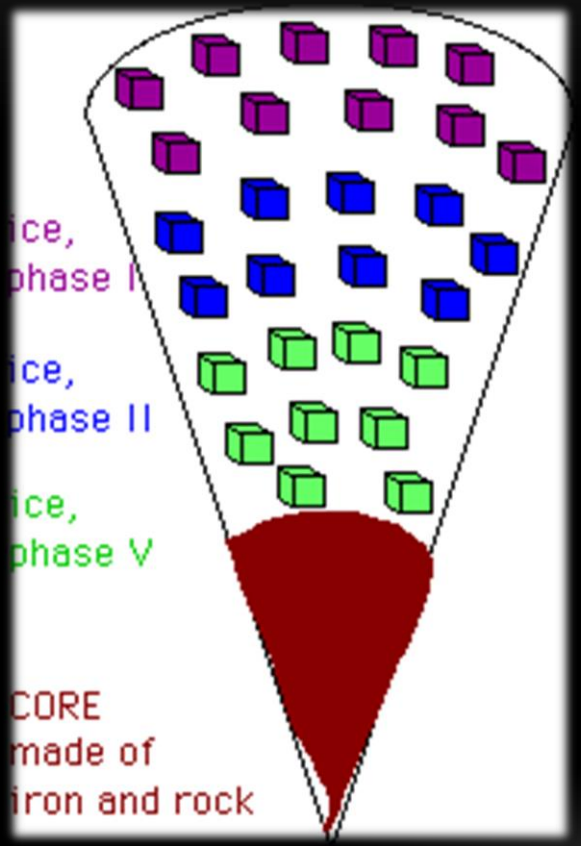


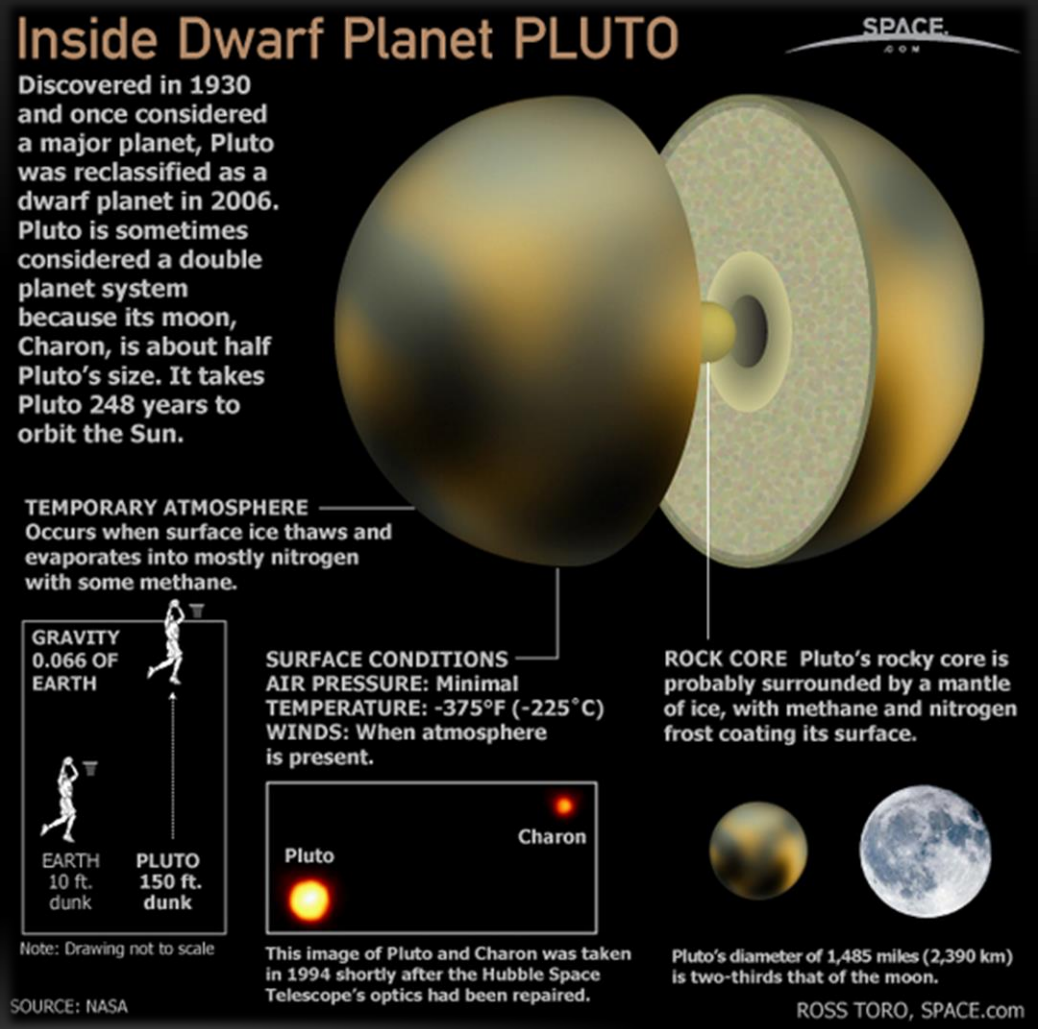
PLUTO SYSTEM

- Pluto has at least 5 moons.
- Charon, the largest, was discovered in 1978.
- Hydra and Nix were spotted in 2005.
- Kerberos and Styx in 2011 and 2012.
- Last 4 found by Hubble.



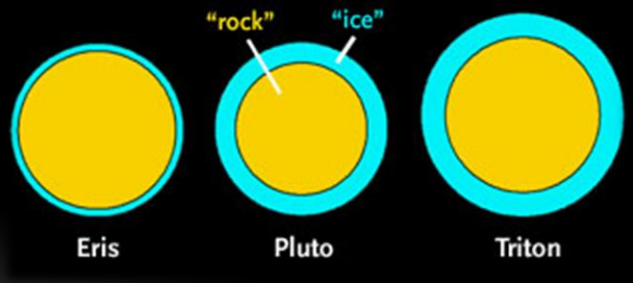
PLUTO INTERIOR





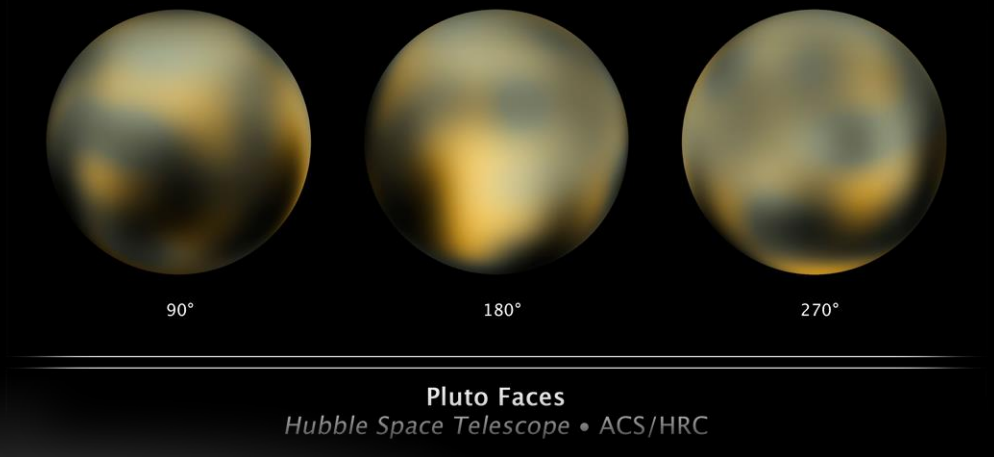
PLUTO INTERIOR

- Once thought to be geologically inactive, Pluto was essentially solid rock surrounded by a layer of ice.
- More recent evidence from large moons of the outer solar system suggest Pluto may have a liquid ocean surviving between the layer of ice above and rock below.
- Or possibly something more exotic, like a liquid nitrogen layer.



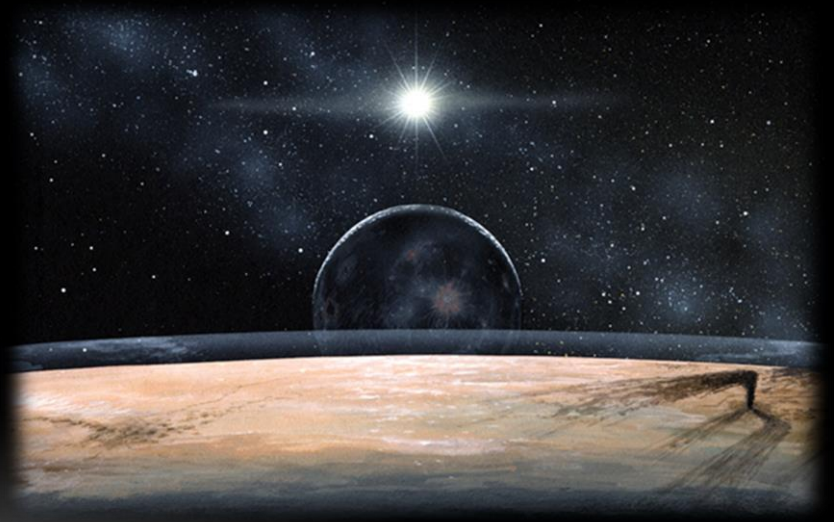
PLUTO

- At closest approach to the sun, Pluto's surface ices sublime and form a thin atmosphere, mostly of nitrogen.
- As Pluto moves away from the Sun, the atmosphere freezes back to the surface for a 200-year sleep.



PLUTO

- Pluto is 40 times further from the Sun on average than the Earth.
- The Sun appears 1600 times as faint as on Earth.
- Pluto's orbit is titled at 17° from the ecliptic where other planets orbit.
- This is probably due to past encounters with Neptune.

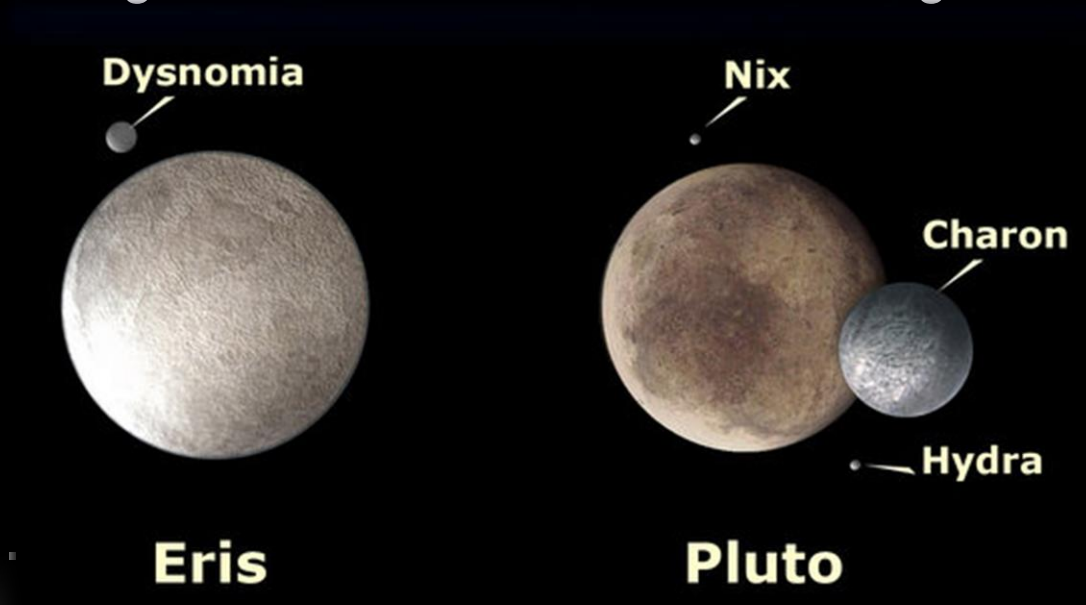


PLUTO

- Pluto has 5 moons: Charon, Nix, Hydra, Kerberos, & Styx.
- They are named after figures in the underworld.
- Charon may have been formed from a violent impact much like Earth's moon was.

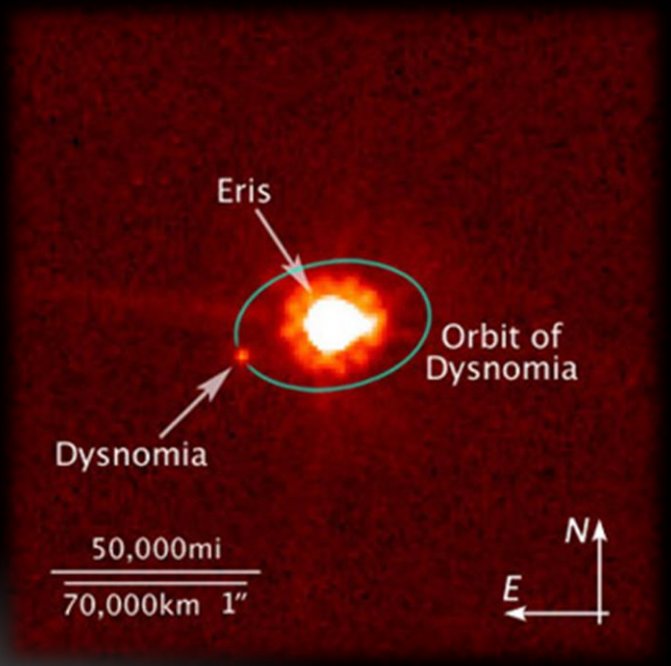
ERIS SYSTEM

- Eris is named for the Greek goddess of Discord.
- Once thought to be larger than Pluto, it is now thought to be slightly smaller.
- Eris was nicknamed Xena until an official name was chosen.

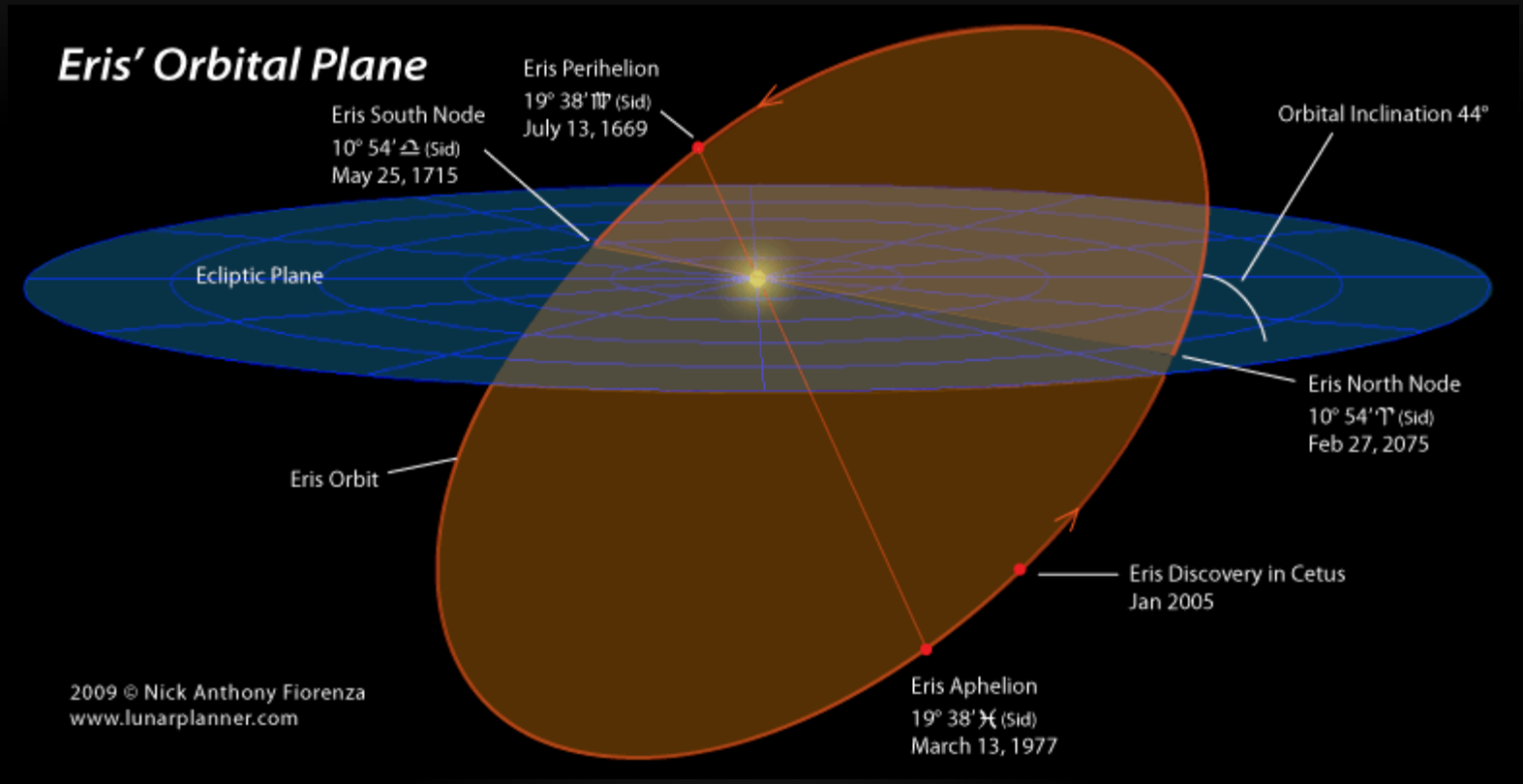


ERIS

- Takes 557 years to orbit the Sun (compared to Pluto's 248 years)
- Discovered only in 2003 by Mike Brown.
- Dysnomia is the goddess of lawlessness.
- While not larger in size than Pluto, it is more massive.

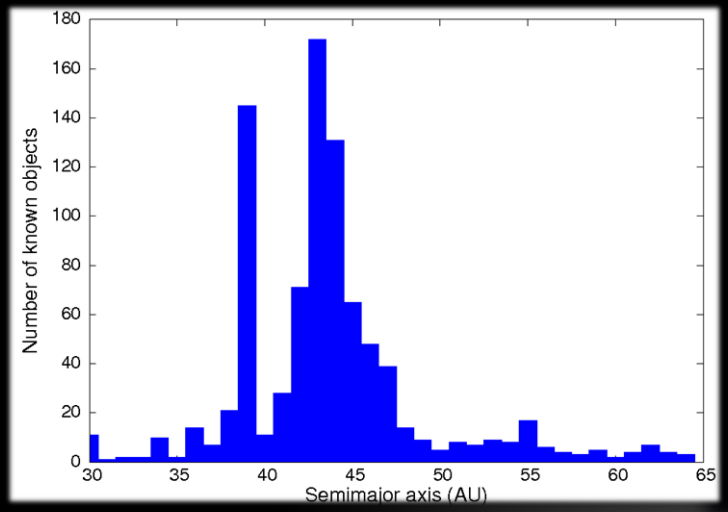


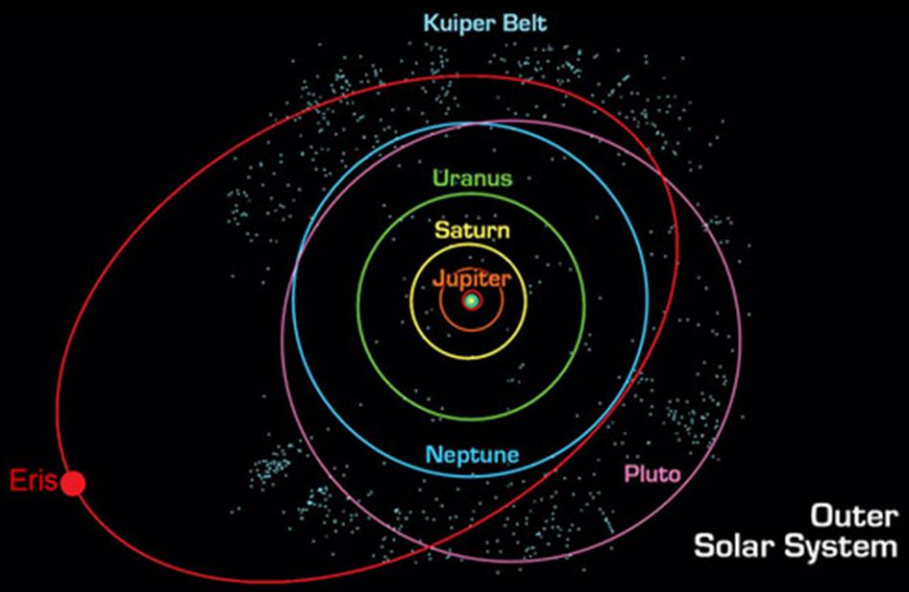
ERIS ORBIT


Eris' Orbital Plane
Eris Perihelion
19° 38' ♒ (Sid)
July 13, 1669
Eris South Node
10° 54' ♎ (Sid)
May 25, 1715
Orbital Inclination 44°
Ecliptic Plane
Eris North Node
10° 54' ♈ (Sid)
Feb 27, 2075
Eris Orbit
Eris Discovery in Cetus
Jan 2005
Eris Aphelion
19° 38' ♓ (Sid)
March 13, 1977
2009 © Nick Anthony Fiorenza
www.lunarplanner.com

ORBITS OF KBOS

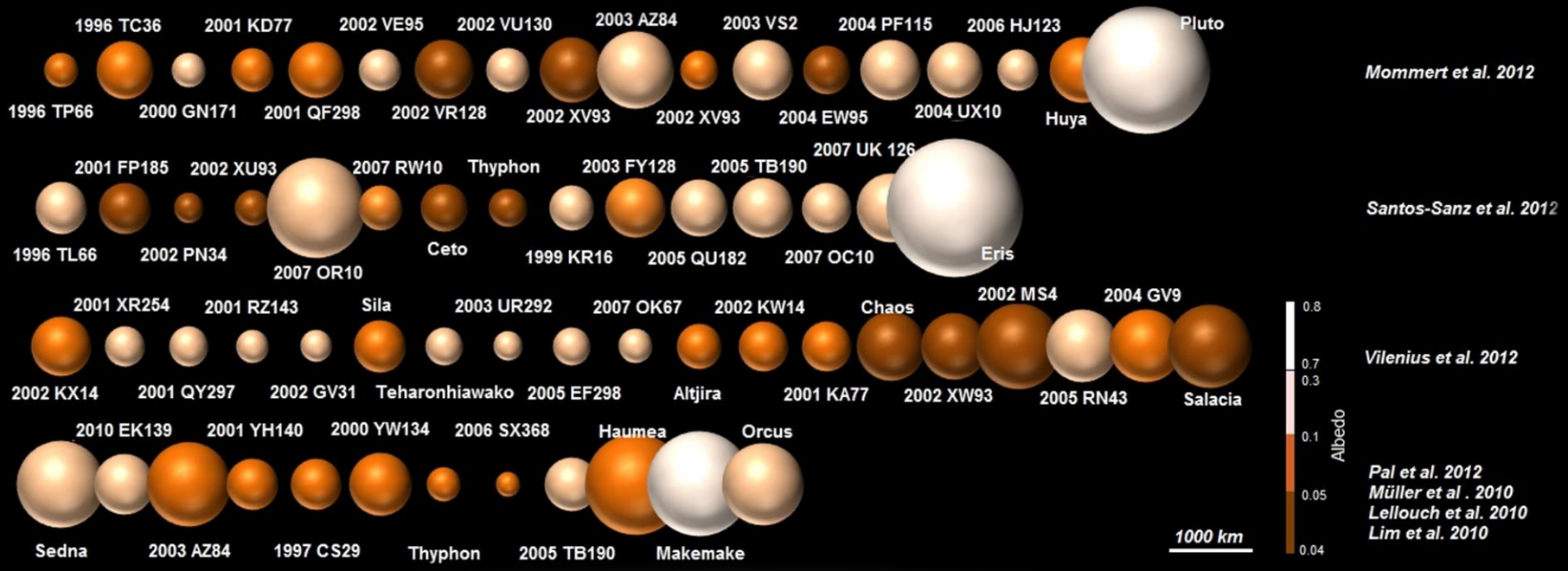
- KBOs are ‘clustered’ in two main orbital groups: those in resonance with Pluto and classical KBOs.





COMPOSITION

- Colors of KBOs are a clue to their composition.



COMPOSITION

- Most KBOs are too faint to get good spectral data to determine composition.
- Density suggests they are mostly composed of various ices: methane ice, water ice, CO_2 ice, and nitrogen ice.
- Our best information about composition comes from looking at Triton, Neptune's largest moon, thought to be a captured KBO.

NAMING CONVENTIONS

- The International Astronomical Union determines what naming conventions are used for object classes, and approves suggested names.
- KBOs are generally named for death or creation deities, following the pattern established by Pluto.
- Many KBOs take their names from mythical traditions other than the Greeks.
- Discoverers can suggest names for objects they find.

WHAT CAN WE HOPE TO LEARN

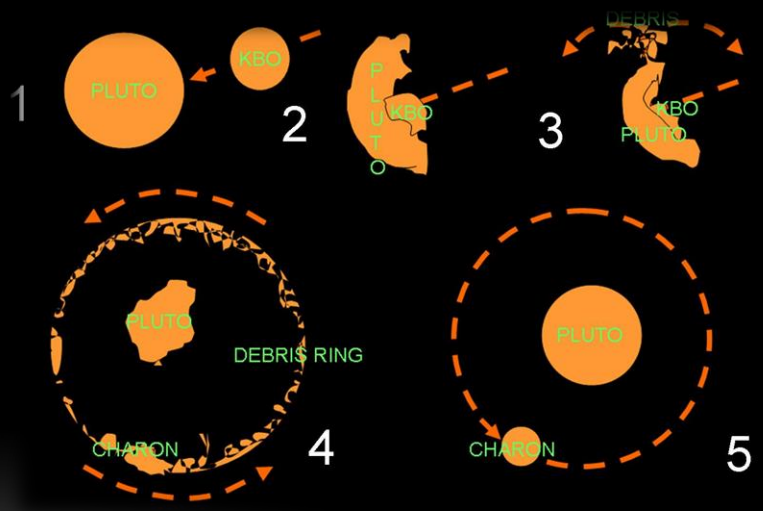
- Study origins of the solar system by seeing worlds frozen for millions or billions of years.
- Find out if Pluto might a liquid water mantle like Titan and Triton.
- Is Pluto geologically active?

WHAT WE CAN HOPE TO LEARN

- Composition of KBOs and early solar system formation.
- Photograph Pluto and Charon and other moons up-close.
- How do KBOs compare to other objects in the solar system?
- Are other large objects yet to be discovered?

POSTED ONLINE

- All my presentations, including this one can be found at my website:
- http://betsymccall.net/prof/writing/present/



REFERENCES

- http://www.nasa.gov/mission_pages/newhorizons/main/#.U8Ly0_ldWp0
- http://www.nasa.gov/content/goddard/hubble-to-proceed-with-full-search-for-new-horizons-targets/#.U8L1ZPldWp0
- http://www.slate.com/articles/health_and_science/mysteries_of_the_universe/2014/02/pluto_new_horizons_mission_the_dwarf_planet_explains_the_history_of_our.html
- http://www2.ess.ucla.edu/~jewitt/kb.html
- http://pluto.jhuapl.edu/mission/whereis_nh.php
- http://www.space.com/16144-kuiper-belt-objects.html
- http://www.nature.com/nature/journal/v407/n6807/full/407979a0.html
- http://solarsystem.nasa.gov/planets/profile.cfm?Object=Pluto&Display=Sats
- http://www.nature.com/nature/journal/v435/n7038/full/nature03558.html

REFERENCES

- http://solarsystem.nasa.gov/planets/profile.cfm?Object=Dwa_Eris
- http://space-facts.com/pluto/
- http://en.wikipedia.org/wiki/Kuiper_belt
- http://www.planetary.org/blogs/emily-lakdawalla/2012/3381.html
- http://www.noao.edu/outreach/current/kbohilite.html
- http://pluto.jhuapl.edu/
- http://pluto.jhuapl.edu/overview/ScienceShorts.php?page=ScienceShorts_07_24_2014
- http://blog.planethunters.org/2011/08/03/whats-in-a-name/