

Kuiper Belt Science Goals

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Science Questions from Last Survey

- Are there Pluto-size and larger bodies beyond Neptune?
- How do the compositions of Pluto-Charon and Triton relate to those of Kuiper Belt objects?
- What are the basic physical properties (mass, density, size) of Kuiper Belt objects, Centaurs, and comets?
- What are the interior properties of all these bodies, and how do they differ from the surface compositions and properties? Are they differentiated?

Science Questions from Last Survey

- What are the surface properties and compositions of these bodies, and how do endogenous and exogenous processes affect them?
- Do Pluto and/or large Kuiper Belt objects show internal activity, as Triton does?
- What are the compositions of comet nuclei, and how do they relate to Kuiper Belt objects?
- What are the albedo and color statistics of Centaurs, Kuiper Belt objects, and comets?

Important Questions from Last Survey

- What is the radial distribution of dust in the solar system?
- What is the frequency of binary systems among asteroids and trans-Neptunian objects?
- What are the orbital and size distributions of Centaurs and Kuiper Belt objects?
- What was the chronology of formation of small bodies, and how and when did Pluto-Charon and some Kuiper Belt objects become binaries?

Important Questions from Last Survey

- Where in the solar nebula did the classes of primitive bodies form? Which were subsequently transported, and which remain in place?
- How did the Kuiper disk and the Oort cloud form, and what degree of compositional mixing is preserved?
- What forces caused the orbits of the Kuiper Belt objects to display such a wide range of inclinations and eccentricities?

Important Questions from Last Survey

- What was the balance between accretion and collisional destruction at various heliocentric distances during the formation of the solar system?
- Are there Trojan populations for Saturn, Uranus, and Neptune?
- and much, much more...

Future developments recommended in last survey

- Power: Advanced RPS
- Propulsion: NEP
- Communication: Ka band, large antenna arrays
- Architecture: Autonomy, lower mass and power

Key mission recommendations

- Kuiper-Belt/Pluto Explorer
- Other recommendation: Triton/Neptune flyby

Additional recommendations

- Early inclusion of PDS into flight missions (at proposal stage and onward)
 - LCROSS and New Horizons good examples
- Healthy R&A program
- Partnering with NSF on LSST and other relevant GB projects
- Continued support of IRTF and Keck

Kuiper Belt-Pluto Explorer

- Called out with high priority in last survey
- New Horizons launched 2006
- Encounter July 14, 2015 with Pluto, Charon, Nix & Hydra
- Global geologic maps with compositional sub-text.
- Atmospheric characterization for Pluto *and Charon*
- New discoveries and more

Progress

- 10 years ago: ~100 objects
- Now: ~1000 objects
- Optical GB surveys, DES, CFEPs
- HST: Binaries!
- HST: Binaries have same color!
- SST: Thermal properties
- New Horizons mission to Pluto and beyond
- Nice Model

Dwarf Planet Executive Summary

1. NASA should encourage and support ground- and space-based observations along with associated theoretical and laboratory work to investigate the ice dwarfs as a population, to motivate missions to individual objects and to provide context for mission results.
2. A New Frontiers class mission to an unexplored ice dwarf should be a candidate for NASA AOs during the next decade. The Haumea system could be a particularly compelling target.
3. NASA should flight-qualify ASRG power systems, secure an adequate supply of ^{238}Pu , and develop the long-lived, low-mass, low-power instruments and flight systems necessary to enable new missions to the edge of the solar system.

TNO/Centaur Questions

- What are the physical properties of TNOs?
- What are the compositions of TNOs?
- What chemical and physical processes affect TNOs, and how?
- What is the dynamical structure of the TNO region?

Research Tools

- On-orbit assets
- Ground-based
- Laboratory
- Theoretical
- Missions
- Data Archives

Suggestions

- Neptune/Triton flyby (or any other outer solar system flyby) should work to get Centaur and/or TNO as well. (Also goes for irregular satellites.)
- Second KBO flyby launch, Haumea? (NH clone)
- Need better support for laboratory investigations into cryogenic material properties (spectral and physical).
- Improved census, eg., LSST
- Observatory-style flight missions: eg., HST successor, occultation network

Technology development

- Propulsion
- Automation
- Telecommunications
- Radar ranging for flybys
- Instrumentation (flight, lab, telescope)