Asteroids

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Past…

New Frontiers in the Solar System:
An Integrated Exploration Strategy

General:

“Primitive Bodies” defined as “substantially unaltered”
NOT never altered at all

Recommendations on asteroids:

Close to none (!)

Cross-cutting themes: One of 12 pertains directly to asteroids

10. What hazards do solar system objects present to Earth's biosphere?

Large Synoptic Survey Telescope

No spacecraft missions directly recommended

Primitive bodies concentrated on comets, Pluto, KBOs…

General spacecraft missions:

Discovery missions :

- specific missions not specified
- support for new missions once/18 mo.

New Frontiers missions:

- medium-class mission line established

Flagship missions:

- once/decade

…we exceeded the last decadal survey's asteroid recommendations for spacecraft missions…

Dawn: en route to (4) Vesta and (1) Ceres (does it still count?)

others? US only

…we failed to accomplish the one asteroid recommendation made by the previous survey…

No LSST yet: it is under construction as funding available

Asteroids: Key Questions Answered? None asked.

New ones?

Many!

Much new data on asteroids as a whole, driven by both space-based and ground-based observations (some U.S., some not)

What contributes to this? Some overarching drivers Primitive Bodies panel should consider in deliberations

“Granularity”

The more we investigate asteroids from Earth and space, the more we learn about the significant diversity among asteroids:

Currently 460,649 known asteroids (JPL Horizons 9/9/09) (compare that to known asteroids 10 years ago!)

We need to maximize our productivity in our exploration!

This relegates some of “exploration” to ground-based observations

HERESY

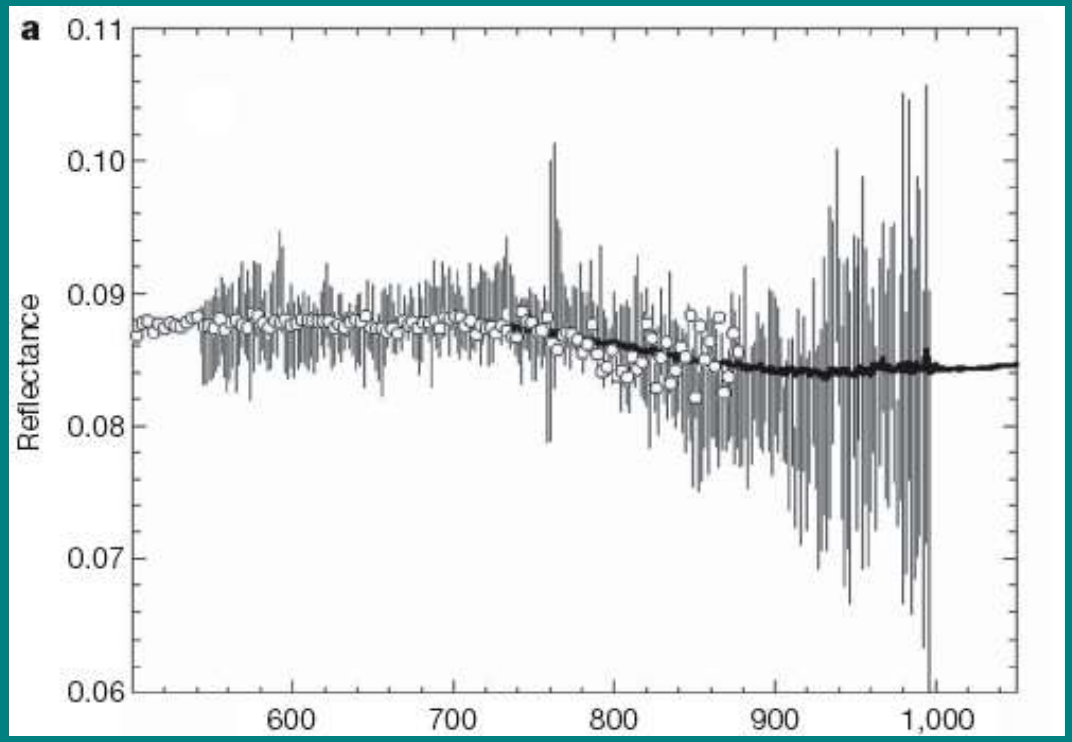
Composition: Mineralogy and Geochemistry

Significant diversity among asteroids:

- unexpected compositions not evident in spectra
- “space weathering” affects interpretation of spectra

e.g. 2008 TC_3

Classification?



From Jenniskens et al., 2009: TC3 spectrum acquired with 4.2-m Herschell telescope for 6 min; solar analogue 16 Cyg B. Each line represents std dev of 10 spectral points

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Composition: Physical Structure

- Density
- Porosity: rubble piles have been found now
- Binary asteroids common -
  key to density determinations

Hayabusa observations

Need to Study a Large Sample of Asteroids

- Requires combined ground-based and space-based campaigns

- Whither asteroid material sampling? (Either return or in-situ?)

Need Robust Research and Analysis Program!

Last decadal study also supported this approach.

For Solar System science, ground-based R&A (including optical and radar telescopic observations) should play a large role.

- Defines scientific questions driving space-based missions
- In concert with space-based observations, characterizes Solar System objects
- Provides context within which to study space-based results

Since last decadal study…

NEO population:

- The 1998 90% of 1-km NEO population goal met (or close to it)

- New mandate in 2005 (George E. Brown, Jr.) to discover 90% of PHOs 140-m diameter or larger by 2020 created by Congress

- Cannot be met with the existing or planned survey assets (including space-based)

- LSST called for in last decadal is not on line

Volume of (Future) Data

Need to develop ways to handle this data volume in:

- storage
- accessibility to scientists
- incorporation in future studies

Data Handling:

Expand PDS Small Bodies Node support and involvement

National Virtual Observatory

MPC already established capability to handle large data flow of NEO observations from proposed PanSTARRS-4 telescope system

Meteorite, lab studies?

Technological advances:

Be mindful of the rapid advances of technology that will render some methodology archaic within 10 years (or allow other technology to become usable).

e.g. (currently) size (both physical and number of pixels) of IR detectors

Key Questions Exercise:

What do I think?

What does asteroid community think?

What do I think?

Origin of asteroids - in all their diversity - will play a key role in our understanding of the origin of the Solar System, and provide a context for understanding extra-solar systems and circumstellar disks

We’re gonna get smacked sooner or later

What do colleagues think? Top level scientific questions from community white paper on Asteroids:

What was the compositional gradient of the asteroid belt at the time of initial protoplanetary accretion?

What fragments originated from the same primordial parent bodies, and what was the original distribution of those parent bodies?

What do asteroids tell us about the early steps in planet formation and evolution?

What are the characteristics of asteroids as individual worlds?

How about small, irregular satellites?

They are almost certainly captured asteroids, and we should weigh in here…

NEO studies…