Roadmap: Population Identification and Characterization

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Right now this section covers:

1. Current Issues with Id. & Char.
2. The Future of Id. & Char.
3. Where we are now with Id. & Char. of various populations.

Current Issues

1. Identification issues
2. Characterization issues
3. Motivation issues

Identification issues

A. Debiassing the discovery rate is crucial, but can be difficult.

-- necessary for understanding the underlying true population since there are a range of sizes/compositions/orbits.

-- not yet done for many surveys.

-- is it especially hard for faint fuzzies (i.e. comets)?

-- comet/asteroid uncertainty needs to be addressed.

Identification issues

B. Follow-up astrometry is necessary.

- -- losing too many objects (e.g. NEAs, TNOs).
- -- many are picked up later on anyway, but it would be nice not to have to rely on that.
- -- objects in ‘strange’ orbits more likely to be lost.

Identification issues

C. Small irregular satellites.

- -- the very smallest ones can’t be seen from Earth, too faint.
- -- perhaps have a spacecraft do a search once it is orbiting a giant planet?

Characterization issues

A. Characterization lags behind.

-- e.g., only 2% of known NEAs have IR spectra; tiny fraction of TNOs have composition constraints; etc.

-- how many objects do you need to study before you ‘know’ enough about the ensemble properties?

-- important to find out just how much diversity there is.

-- hopefully the diversity (as measured with some rubric that you care about) isn’t too overwhelming!

-- a survey that gets us some simple characterization for lots and lots of objects (e.g. SDSS colors) could be used as a guide.

Characterization issues

B. Telescope access.

- -- we need both big and small telescopes.
- -- 8-m time is important for the smallest objects.
  - -- classical mode?
  - -- queue mode?
- -- lots of objects out there that can still be characterized just fine with meter or few-meter class telescopes.
- -- need to continue to have community access to small- and moderate-sized national facilities.

Characterization issues

C. Many ensemble properties change as a function of object size, so it is important to study the small-end members.

-- how small is ‘small’? 100 or 140 meters for asteroids?

-- depends somewhat on what property you care about.

-- smallest (= faintest) objects are often the most interesting!

-- they are different from the larger objects in e.g. porosity, internal processing, collision history…

Characterization issues

D. Studying the small-end members lets you do size-matching across groups.

-- many small-body populations are evolutionarily connected, requiring size-matching to make physical/compositional connections.

-- e.g. TNOs → Centaurs → JFCs, yet we're not yet studying the same size objects across these groups.

Characterization issues

E. We need to do temporal studies, not just snapshots.

-- different evolutionary processes have different timescales.

-- monitoring lets us see secular variations.

-- monitoring lets us catch unusual events (Scheila).

-- need to understand rotational variability and phase darkening if we are to properly interpret photometry, even though this can take a long time!

Characterization issues

F. Don’t let outliers fool us.

-- our understanding of the ‘average’ or ‘typical’ object is going to come from studies of lots of objects that would otherwise never call attention to themselves.

-- rare subtypes are interesting and can provide new insights, but should be placed in appropriate context.

Characterization issues

G. ‘Traditional’ observational methods can be limited.

-- visible and near-IR work samples a very thin surface layer. What’s underneath?

-- recently disrupted objects let us look inside.

-- when objects are sufficiently bright, we can bring many other observing techniques to bear on the characterization: mid-IR, radar, etc.

-- we still need lab work and in-situ studies to give us reality checks.

Motivation issues

A. Testing hypotheses of SS formation and evolution.

-- What observational experiments can we do to address this?

-- Don’t want to only do stamp collecting.

The Future

1. Existing ground-based facilities
2. New ground-based facilities
3. New space-based facilities
4. Archival data
5. New in-situ studies

Future: Existing ground-based

A. We need to continue to win time on small, medium, and large telescopes.
   - -- vital that IRTF continue to be available for planetary astronomy, and that we continue to do great science on it.
   - -- vital that Arecibo/Goldstone radar system continue to work.

Future: New ground-based

B. Pan-STARRS and LSST will give us tons of objects to play with, and do some characterization.

-- colors

-- sparse light curves

-- monitoring for random events

-- secular variation of comet behavior

-- though some objects will be missed….

Future: New space-based

C. Can address id. & char. Issues.

-- e.g. WISE gives us thermal measurements of thousands of objects.

-- better IR sensitivity from space makes many projects more feasible.

-- a survey telescope could find 90% of 140-m NEAs in a few years. (there are several designs that would work.)

-- potentially saves money in the long run, since such a mission would find better objects that could be visited in the future more cheaply.

Future: Archival data

D. Systematic rummaging through archival datasets -- even astrophysical datasets -- will be productive.

-- this is happening now with Spitzer imaging.

-- the fact that many datasets are online is useful.

Future: In-situ studies

E. There are potential (small/Disc/NF) spacecraft missions that would be useful for identification and characterization.

-- provide ground truth to all the remote work.

-- in-situ could mean flyby, orbit insertion, lander, sample return….

-- missions should try to be more efficient by visiting multiple objects (e.g. Contour-like missions).

Status of Id. & Char.

1. Comets
2. Asteroids
3. Trojans
4. Centaurs / TNOs
5. Irregular Sats
6. Dust

What else?

Small body groups

Jupiter-Family Comets
Halley-Family Comets
Sungrazing Families
Main-Belt Comets
Interstellar Comets
Extinct Ecliptic Comets
Damocloids
Centaurs
Scattered Disk Objects
Cold Classical TNOs

Near-Earth Asteroids
Inner Earth Objects
Mars-crossers
Main-Belt Asteroids
(field, families, groups)
Jovian Trojans
Trojans of other planets
Irregular Satellites
Resonant TNOs
Hot Classical TNOs