Building the Reference Small Body Population Model (RSBPM)

TEAM: A WHOLE BUNCH OF NEOCAM PEOPLE

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OUTLINE

- What is the RSBPM? Why do we need it for NEOCam?
- Determining the ‘complete’ population
- Absolute Magnitude and Diameter issues
- Fun orbital element correlations
- Size-dependent variations (!)

What is the RSBPM?

- The Reference Small Body Population Model or **RSBPM** represents our best estimate of the population of small solar system bodies from Atiras out to Centaurs. Includes comets!
- Mimic actual orbital element and size distribution down to 20 meters for NEOs and a few hundred meters for main-belt objects
- The RSBPM is ***essential*** for the NEOCam mission!
- Will use it directly for modeling expected performance of NEOCam, as well as engineering design tradeoffs and even linking studies
- ***The RSBPM is stable yardstick to measure progress against Level 1 Requirements***
- ***The RSBPM will be peer reviewed and set in stone before launch***

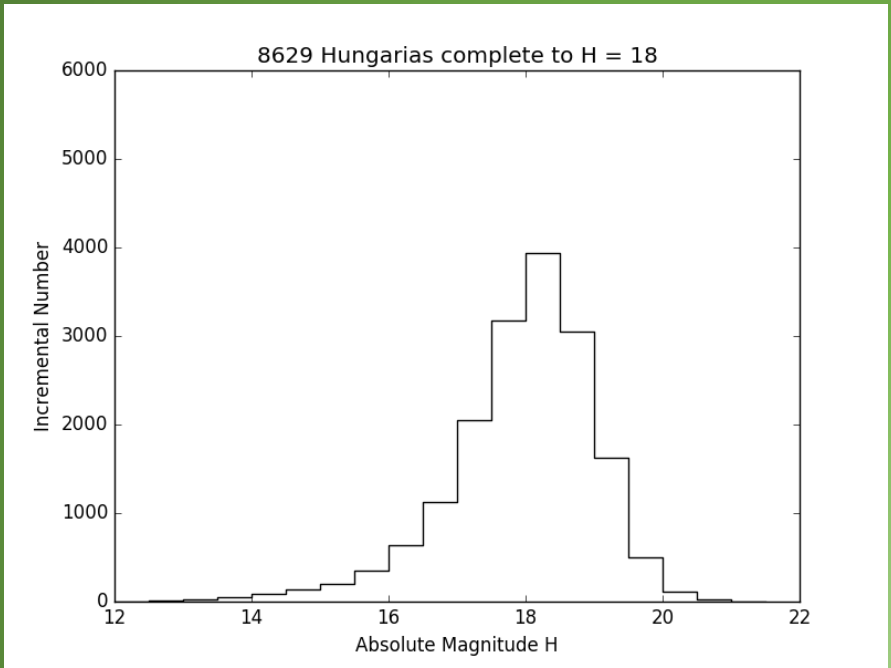
Determining the Complete Population

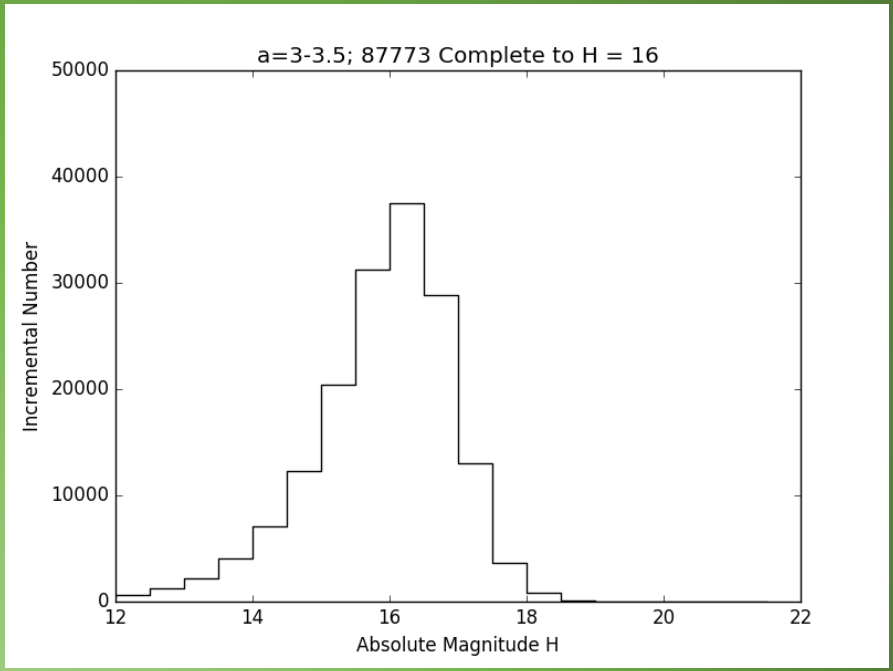
- We need a set of orbital elements objects in each class for which we are free of observational bias
- Look at MBA discoveries as a function of absolute magnitude (H)
- Also can use NEOWISE MBA detections since diameter is determined
- Note we have limited information on the diameter distribution for various populations at small sizes
- Pull from literature any other information we can get and exploit (Example Granvik et al 2018 for NEOs)

Notes on complete population

- Around 340,000 MBAs in complete population right now (sky complete to V ~ 20 for new main-belt asteroid discoveries)
- When I defended thesis (1998) the complete population was around 3000 objects(!!). Discoveries at V = 15 were routine (I found MBAs as bright as V = 15 and even an H = 10 outer-belt object with film in 1995)

Examples of determining complete population





21-year old plots--< 3000 objects

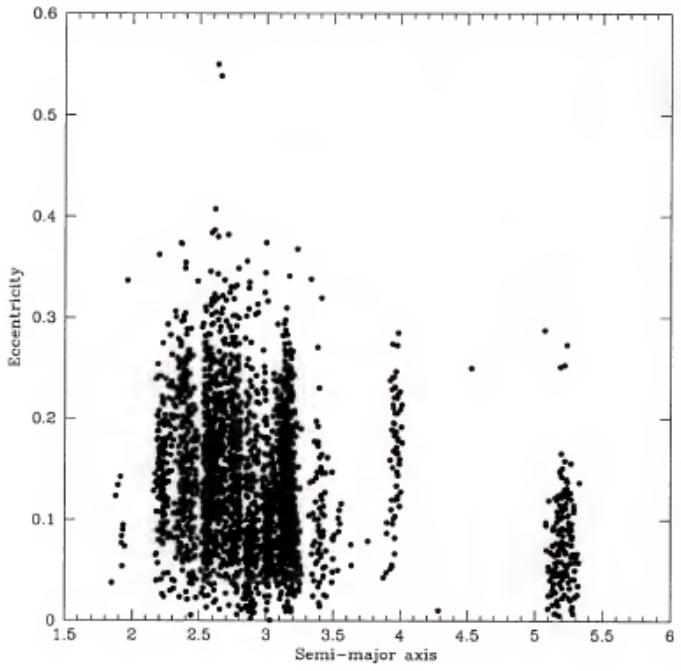


Figure 4. a and e for the observationally complete set.

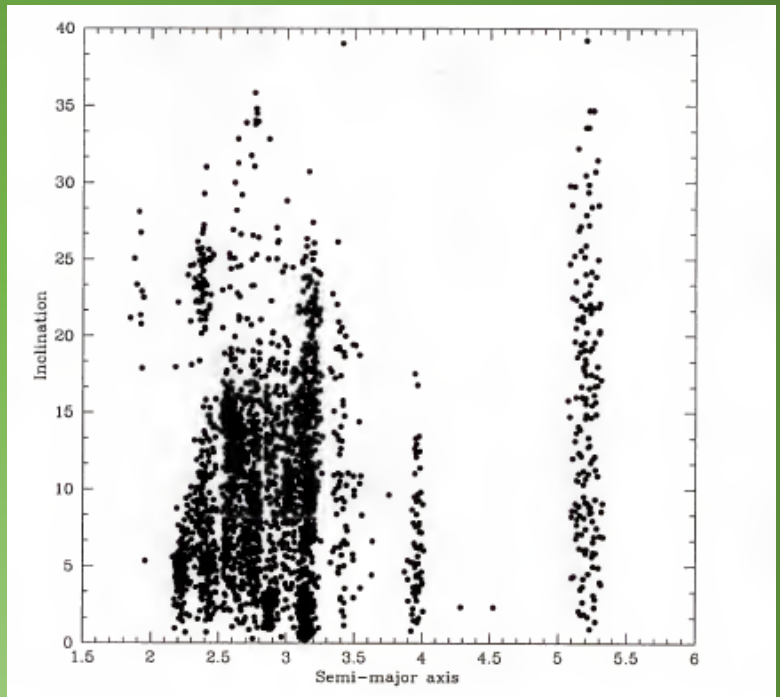
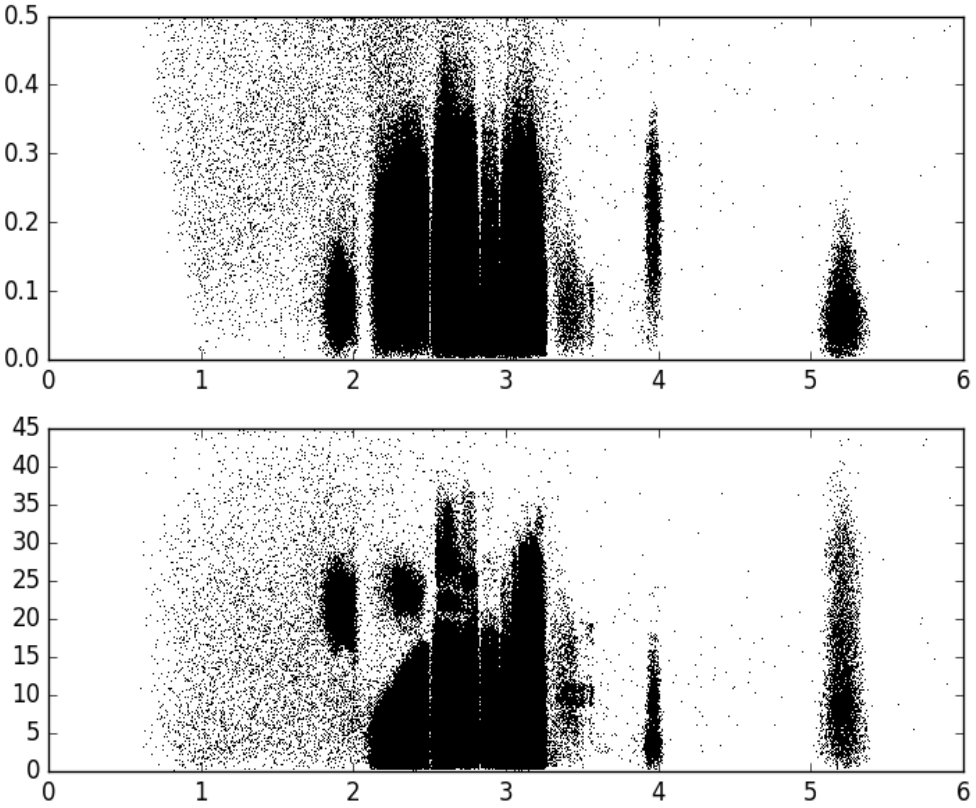
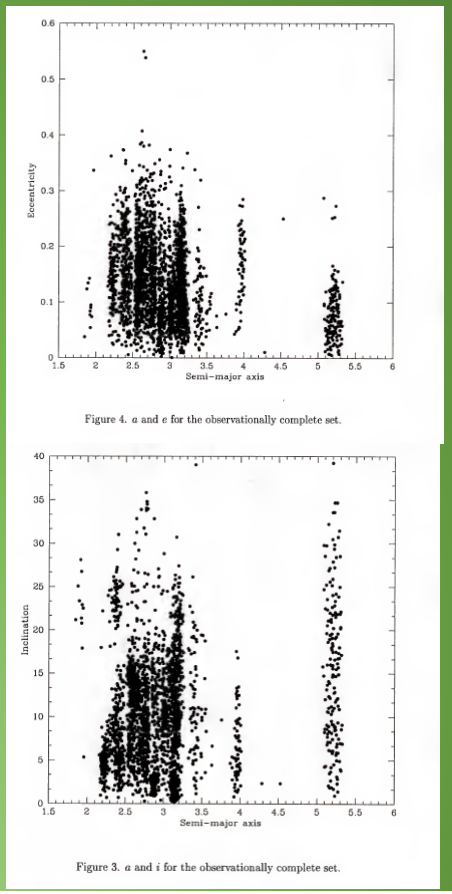


Figure 3. a and i for the observationally complete set.

Comparison plot! New & old



NOW



1998

Orbital Element Space is Fun

- Loads of fun implicit variations in orbital elements for specific populations (classic Kresak and Klacka 1989 is awesome)
- MBA Longitude of Perihelia align with Jupiter (difference between free & forced elements)
- Hungaria population (a ~ 1.85, e ~ 0.05, i ~ 22) has strong correlation between longitude of ascending node and inclination
- Asteroid families have unique size-frequency distributions (SFDs)!
- NEOs have size-dependent orbital element and physical properties at small sizes
- Short version: better do your homework or you'll make populations that don't make sense and don't represent reality

A few more ancient plots

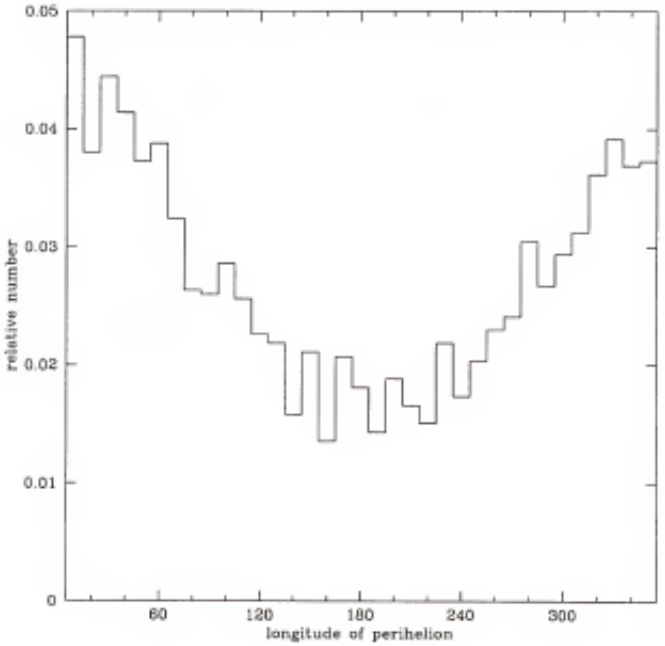


Figure 2. Trend in ϖ for the observationally complete set.

ALL MBAS

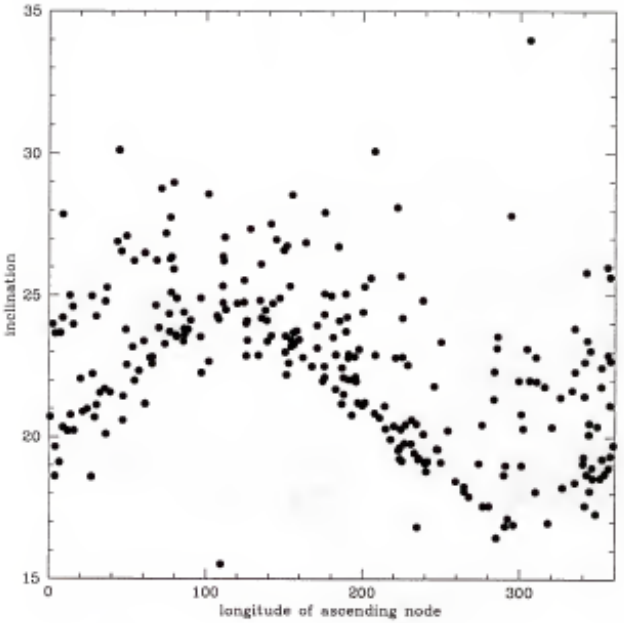


Figure 32. Trend in inclination and longitude of ascending node for known Hungarias.

Hungaria Population

RSBPM will include population uncertainties

- The RSBPM will consist of at least 25 different ‘representations’ of the solar system (Monte Carlo sims)
- We need to vary the SFD within our uncertainties but also will need to vary orbital elements a fair bit as well in each population
- Note NEO SFD at small sizes is extremely confusing (bolide data do not jive with extensions of SFDs from literature; possible wave in SFD???—see Granvik et al 2018 and Durda work from early 1990s)

Concluding…

- NEOCam will use the RSBPM for many aspects of mission planning and operations
- The RSBPM will be our best estimate of various small-body populations in the solar system.
- Where we have information from observations and literature, we will use it. Expect lots of extrapolating and guessing, though, as information is scant at smaller sizes
- Small-body populations are varied and unique