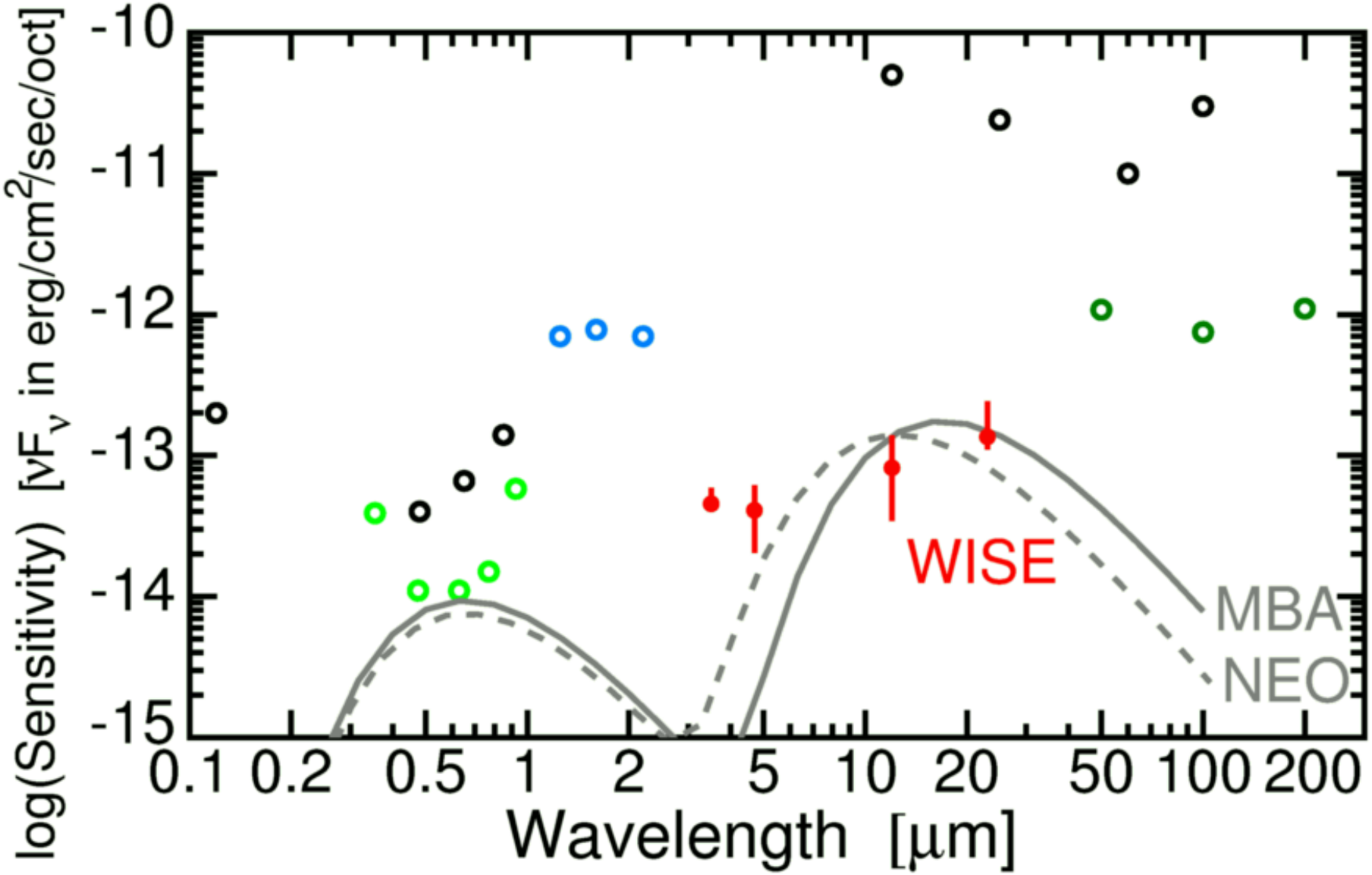
Solar System Science

- Mid-IR wavelengths near peaks of black body curves.
- Analogies with IRAS in 1983, but hundreds of times more sensitive.
- Detect both known and previously unknown…
  - Asteroids.
  - Comets.
  - Comet nuclei.
  - Zodiacal dust bands.
  - Cometary debris trails, etc…?
- Draw inferences about physical properties & processes.

Solar System Science

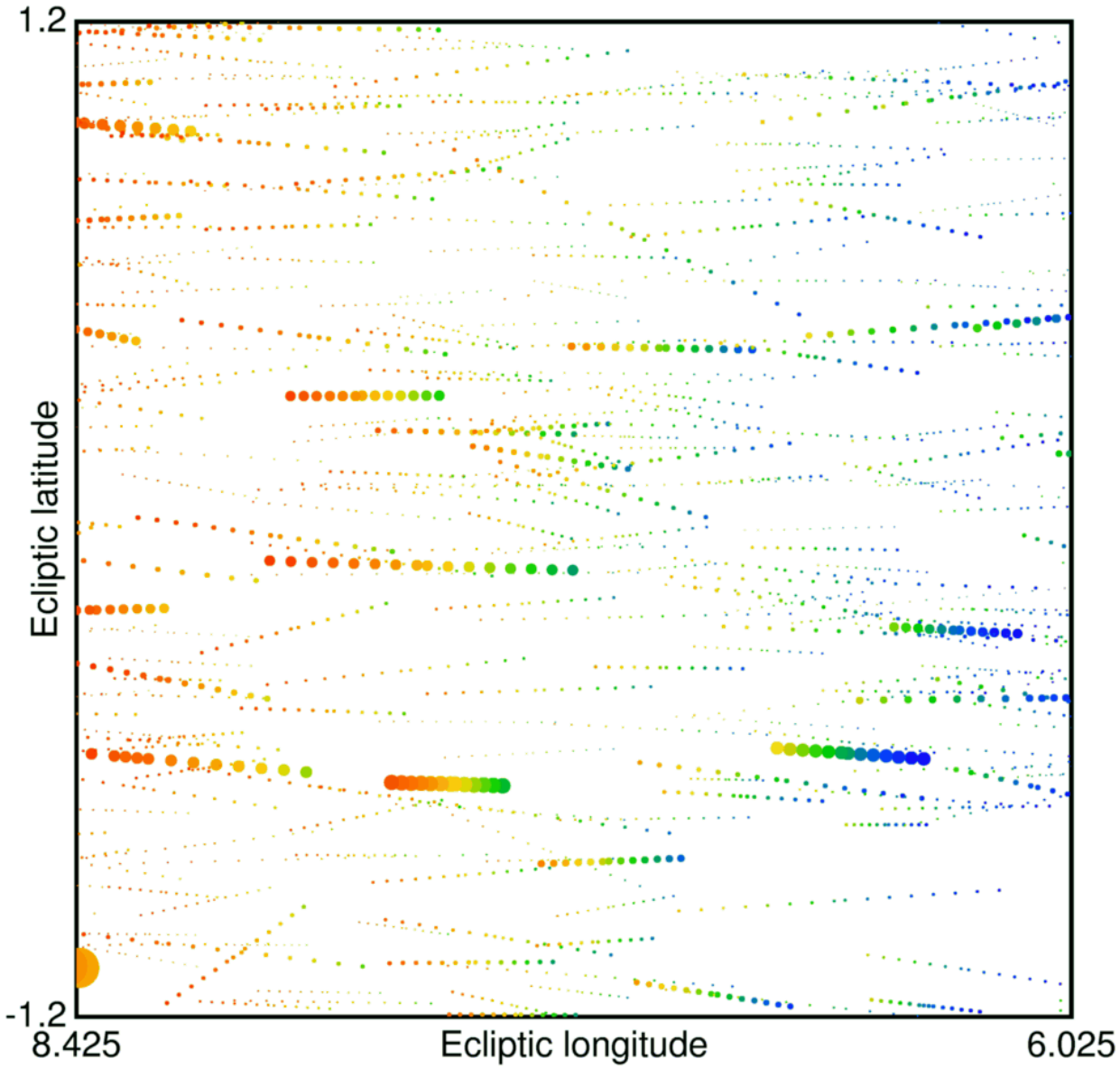
- Science Team members w/ planetary science interests:
  - Ned Wright (PI), Amy Mainzer (NEOWISE PI), Russ Walker, Bob McMillan, Roc Cutri.
- "NEOWISE" Enhancements:
  - Rapid reporting.
  - Archival studies.
  - Additional NEOWISE Science Working Group members: James Bauer, Tommy Grav, Rob Jedicke, Dave Tholen.

Detectability of Asteroids by WISE



Simulated WISE Detections of Asteroids

- Color encodes time of obs., early to late.
- Interval simulated = 2004 Dec 27 - 2005 Jan 7.
- Each dot is a detectable single frame observation by WISE at 12 microns of an asteroid in Bowell's ASTORB list.

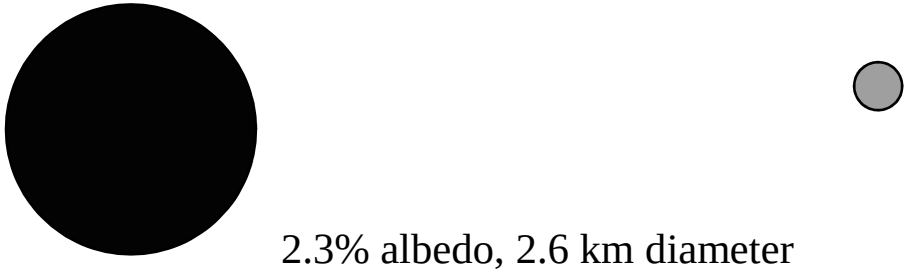


Known Asteroids to be Detected by WISE

- ~20,000 detections per day in simulations.
  - Several $\times 10^5$ tracklets @ 12 & 22 μm.
- Most main belt asteroids $\geq$ 4 km in diameter.
- ~10-20 detections of NEOs per day.
- Net hundreds of NEOs w/ diams. $\geq$ 300 m.

Flux Near bb peak Gives Better Diameters

- Visible-light albedos range from 0.02 – 0.63, making size ambiguous.



2.3% albedo, 2.6 km diameter

63% albedo, 0.5 km diameter

- IR flux approximates bolometric luminosity @ these temperatures.
- Range in IR emission due to absorbed and reradiated sunlight << range in visible brightness for most albedos.
- With both IR & visible data the diameter *and* albedo are well determined.

Thermal IR Fluxes from Known Asteroids

- Accuracies of diameters *via* thermal models:
  ±3-5% with detections @ 12 & 22 μm;
  – ±10% with single-band detections;
  – Neglecting unknown rotation axis, etc.
- Vmags from ground-based obs. → albedos.
- IR lightcurves → shapes.

Diameters & Albedos

- ~100,000 MBAs & ~300 NEOs.
- Albedo *vs.* family; albedo *vs.* dist.
- Dark →Inactive comets? main belt comets? Look for trails and/or tails?
- Bright → Rotational modulation? Family origin?
- Yarkovsky force.

Yarkovsky Effect & Dinosaurs

- Bottke *et al.* (2007, Nature, 449, 48)
- Yarkovsky force is induced by asymmetric thermal reradiation from rotating asteroids.
- Collision 160 Myr ago → Baptistina family; Yark. pushed orbits into resonant zones, scattered into Earth crossing orbit, then BOOM! 65 Myr ago.
- Revisits during mission on AM & PM sides can measure Yark. force for hundreds of Baptistina members.

NEOWISE: *Ab initio* Survey of Asteroid Populations

- Uniform detection of knowns & unknowns.
- Documented & verified …
  - Flux sensitivity
  - Motion sensitivity
  - Sky coverage
- Quantifiable efficiencies & biases → debiased description of asteroid populations.

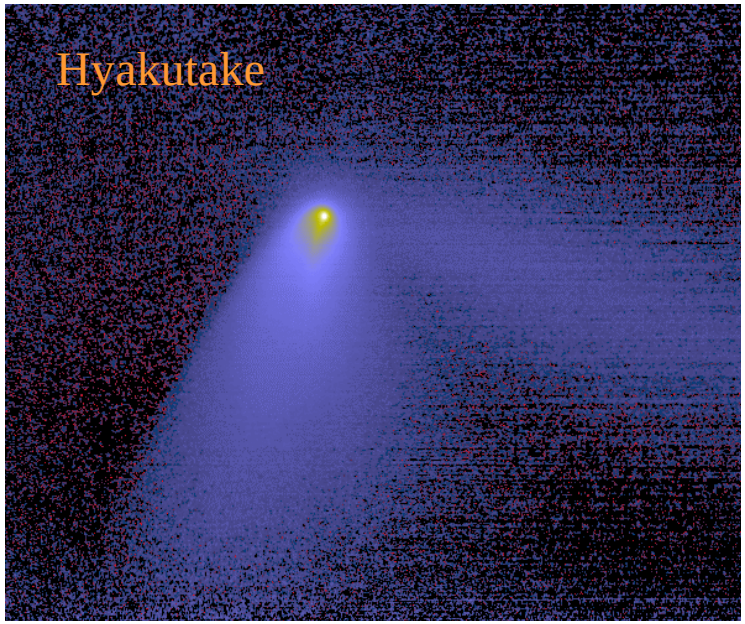
NEOWISE Survey Expectations

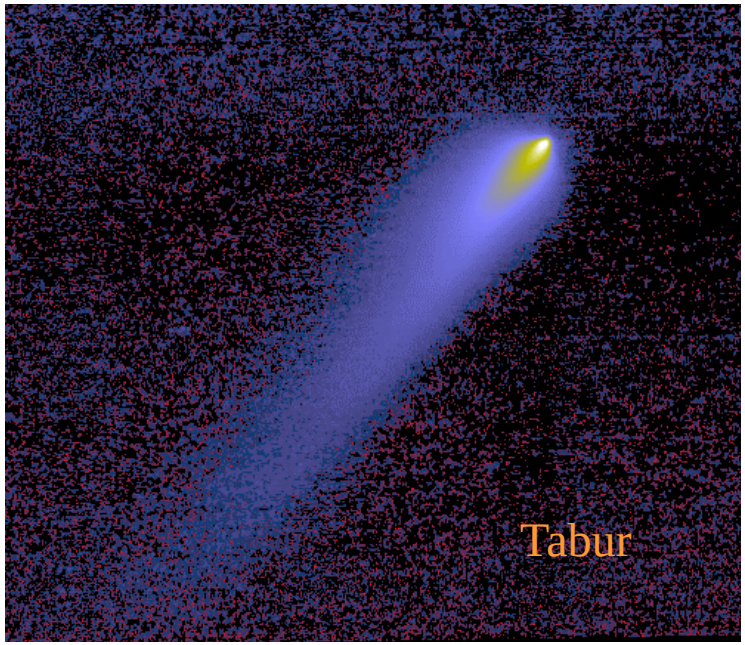
- Good diameters for ~100,000 asteroids.
  - Including 100's of NEOs.
- Avoid bias *vs.* dark asteroids.
- Estimate numbers & size dist'ns of:
  - MBAs/Families.
  - NEOs.
  - PHAs…any dark impactors?

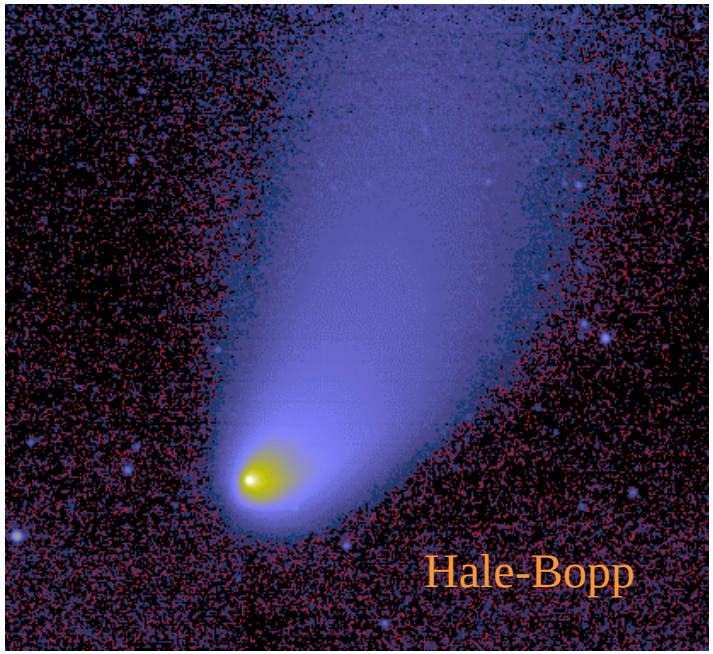
Ground-Based NEO Followup

- NEOWISE proposes to detect & report 100's of previously unknown NEOs.
- Process & post to MPC in $\leq 10^{d}$.
- Detection tracklets long & dense → decent preliminary orbits.
- Search ~3 deg^2 to V~23 to recover.

Mid Infrared Observations of Comets







Diameters and Albedos of Comet Nuclei

- 12 & 22 micron bands → thermal size estimates.
- 3.4 & 4.6 micron bands → albedos or upper limits.

- Sizes and albedos of …
  - Comet nuclei in general.
  - Nuclei of Jupiter-family comets beyond 4.25 AU.
  - Oort Cloud (OC) comet nuclei?
- Get JFC size distribution.
  - Compare OC nuclei dist'n w/ JFC nuclei dist'n.

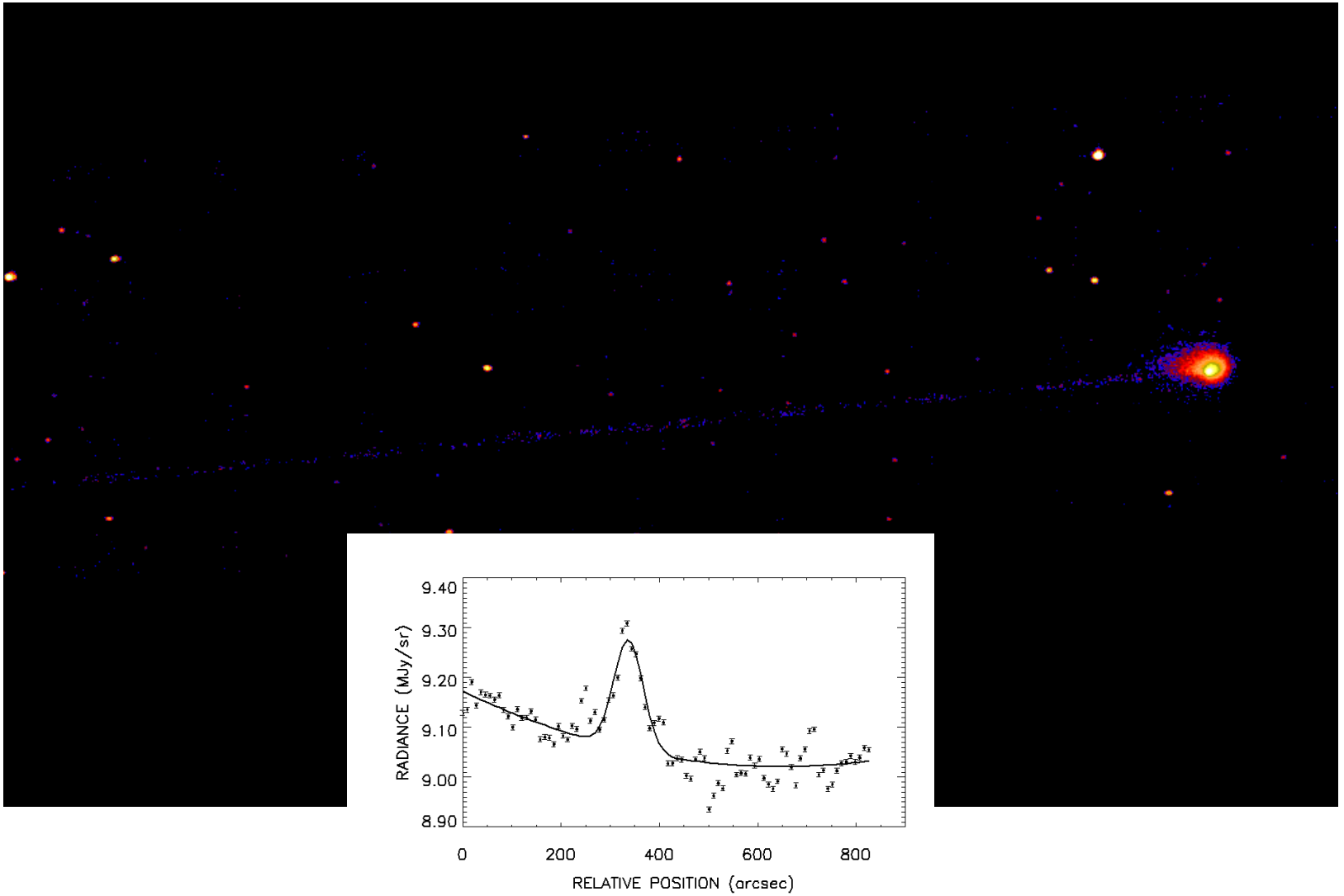
Zodiacal Dust Bands

Should see a few forming dust bands due to the disruption of asteroids.

Determine source(s) and age(s).

Relative contributions of dust to the cloud from asteroids and from comets.

Debris Trail of 22P/Kopff



Comet Debris Trails

- 29 comets w/ debris trails and/or meteor streams.
  - Additional ~35-52 comets whose trails have not yet been detected.
- Fainter trails than Spitzer through single frame coaddition in wider FOV and number of revisits.
- Model & compare with prior detections.
- Estimate mass loss *via* trails & replenishment of zodiacal dust cloud.

Precedent and Anticipations

- In 1983 IRAS discovered:
  - Comets are snowy dirtballs, not dirty snowballs.
  - The solar system is dustier than was thought.
- WISE will have > 6 mag greater sensitivity.
- Exploration doesn't get any better than this, folks.