Wide-field Infrared Survey Explorer

# 459.06: NEOWISE: Discovery of Near-Earth Objects in the Infrared by the WISE Mission

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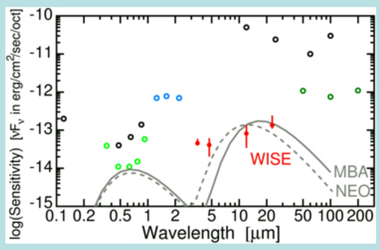
## WISE and Asteroids





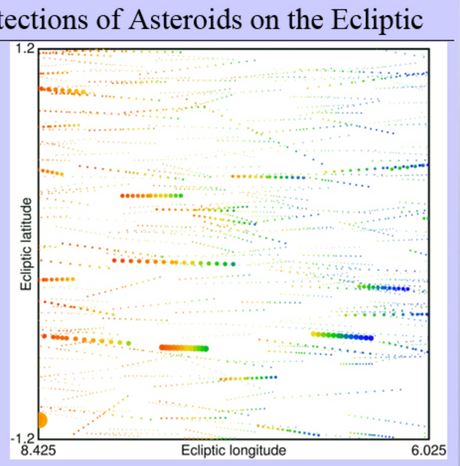
Gaspra


Asteroids move

- Asteroids are much brighter in the IR than in the optical.
- They move in the hours between WISE frames.
- For asteroids with known orbits, WISE sensitivity will be slightly better than for fixed celestial objects:
  - –Asteroids generally move in the same direction that WISE scans and thus get more repeated observations than stars.
  - –Asteroids' movement across the sky greatly reduces the confusion noise from unresolved celestial sources.

## Simulated WISE Detections of Asteroids on the Ecliptic

- Color code shows the time of observations, from early to late.
- The time period simulated is from 2004 Dec 27 to 2005 Jan 7.
- Each dot is a detectable single frame observation by WISE at 12 microns of an asteroid in Bowell's list.




## Incidental Detections of Asteroids in All-sky IR Survey

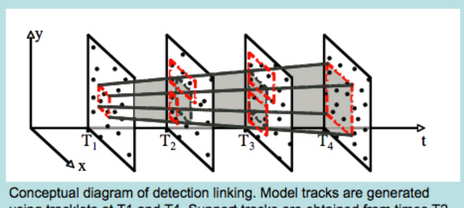
- Several ×10$^5$ detections @ 12 & 23 μm.
- Main belt asteroids ≥ 3 km in diameter.
- 100's of NEOs ≥ few× 100 m in diameter.
- IR fluxes & astrometry of known objects.

## Discover New Asteroids in WISE Survey Imagery.

- Report new asteroids w/ 8-12 detections spanning ~36 hours, within days of obs. epoch.
- Surveying 90° from Sun yields PHAs.
- Prompt reports for ground-based followup.
- Rely on NEO followup community via MPC.
- NEOs recoverable ~2 wks after discovery by searching <3 square degrees to V=21-23.

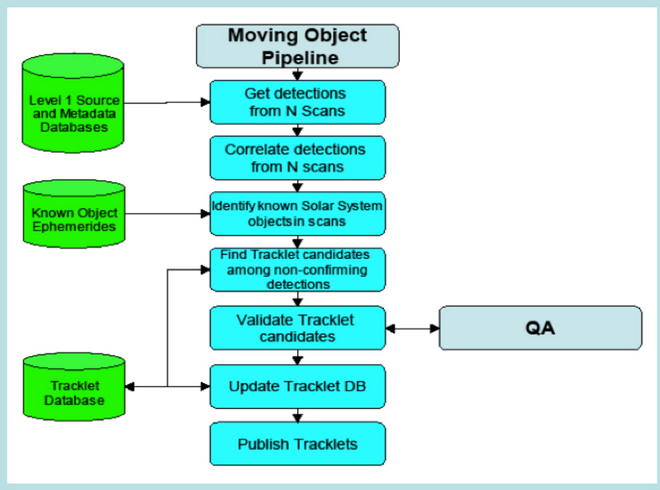
## Detection of Moving Objects

- Detection by motion between WISE orbital passes.
- Id candidates in source-space, not via image subtraction.
- Select sources that are not stationary from WISE orbit-to-WISE orbit.
- "Find Tracklet" routine adapted from the Moving Object Pipeline of Pan-STARRS and LSST.
- KD-tree and variable-tree spatial searching links detections into tracks.



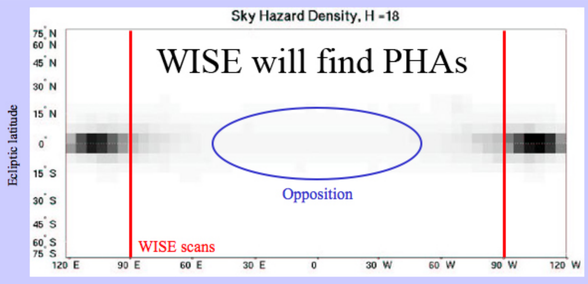

Conceptual diagram of detection linking. Model tracks are generated using tracklets at T1 and T4. Support tracks are obtained from times T2 and T3. When sufficient number of support tracks are obtained, the linkage is returned for quality checks.

- Cadence & QA → low false positive rate.
- Validated tracklets to MPC ≤7$^d$ of the mid-point of tracklet.
- Visual-band followup will be the role for the community.



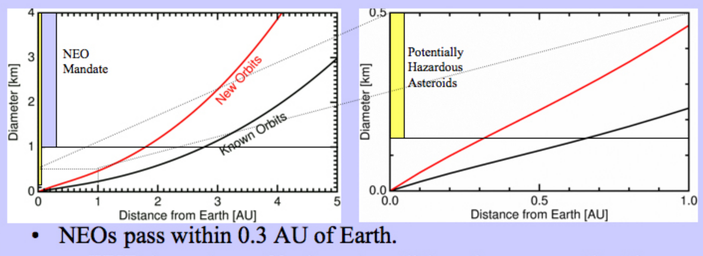

## NEOWISE:

- Uniform Detection of NEOs, Known & Unknown
- Documented & verified …
  - – Flux sensitivity
  - – Motion sensitivity
  - – Sky coverage
- "Characterizable" efficiencies & biases of NEOWISE →debiased description of NEO populations.




- Chesley and Spahr (2003) showed that the asteroids most likely to impact the Earth are better found by observing close to the Sun. WISE observes at 90° from the Sun, while current surveys are centered at opposition, 180° from the Sun.

## Detectability of Asteroids by WISE



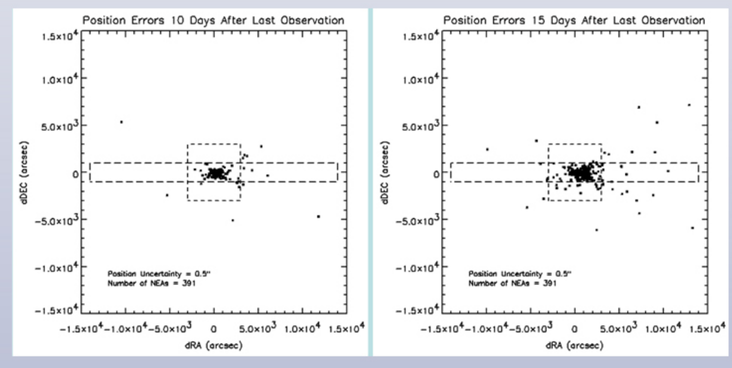

- NEOs pass within 0.3 AU of Earth.
  - – WISE observations at 90° elongation will detect known asteroids with diameters > 1 km up to 2.8 AU from the Earth (3 AU from the Sun).
- Potentially Hazardous Asteroids (PHAs) are larger than 140 m in diameter and have orbits that approach within 0.05 AU of Earth's orbit.
  - – WISE will detect known 140 m PHAs up to 0.7 AU from Earth.

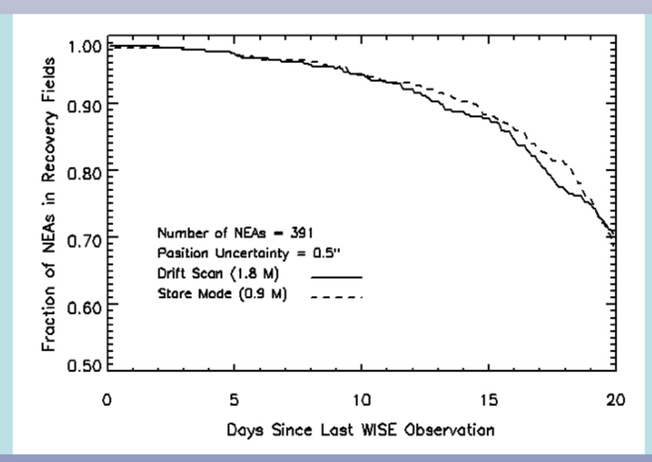
## What Can WISE Detect?

- Assume SNR 7 in a single frame is needed for confident detection of previously unknown objects.
  - – Corresponds to 2.6 mJy at 12 μm.
  - – 5% albedo → V=22, below most current search sensitivities.
- WISE detections will be much less biased by the albedo.
- WISE will find relatively more dark asteroids than optical surveys do.
- NEOWISE will be essentially diameter-limited.

## NEO Recovery Fields of View Used by Spacewatch, University of Arizona

- General Requirements for Recovery
  - Solar elongation > 60°
  - Fields must be observed 3 times/night
- 0.9 Meter Telescope
  - $V_{lim}$ = 21.2$^m$ in stare mode
  - Field Covered = 6000" x 6000"
- 1.8 Meter Telescope
  - $V_{lim}$ = 23$^m$ in RA drift scan mode
  - Field Covered = 2048" x 28000"




## Thermal IR Fluxes

- IR lightcurves from WISE's 36$^{hr}$ coverage.
- Get diameters via thermal models.
  - – ±3-5% with detections @ 12 & 23 μm;
  - – ±10% with single-band detections;
  - – Neglecting effects of unknown rotation axis, etc.
- Dist'n of numbers vs. size; free of albedo bias.
- Vmags from ground-based obs. ➔ albedos.

## Recruiting Co-Authors

- Unique & voluminous IR fluxes & astrometry.
- Experience needed:
  - – Modeling populations of asteroids
  - – Debiasing of survey results
  - – Handling databases
  - – Use of asteroid thermal models
- Contact Bob McMillan: bob@lpl.arizona.edu

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http://wise.ssl.berkeley.edu