• 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.
• 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

![Graph showing the detectability of asteroids by WISE](chart.png)
Simulated WISE Detections of Asteroids

- Color encodes time of obs., early to late.
- 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 \( \mu \text{m} \).
- Most main belt asteroids \( \geq 4 \text{ km} \) in diameter.
- ~10-20 detections of NEOs per day.
- Net hundreds of NEOs w/ diams. \( \geq 300 \text{ m} \).
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

- Yarkovsky force is induced by asymmetric thermal reradiation from rotating asteroids.
- Collision 160 Myr ago $\rightarrow$ 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 $\rightarrow$ decent preliminary orbits.
- Search $\sim 3 \text{ deg}^2$ to $V \sim 23$ 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

![Debris Trail of 22P/Kopff](image)
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.
• 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.