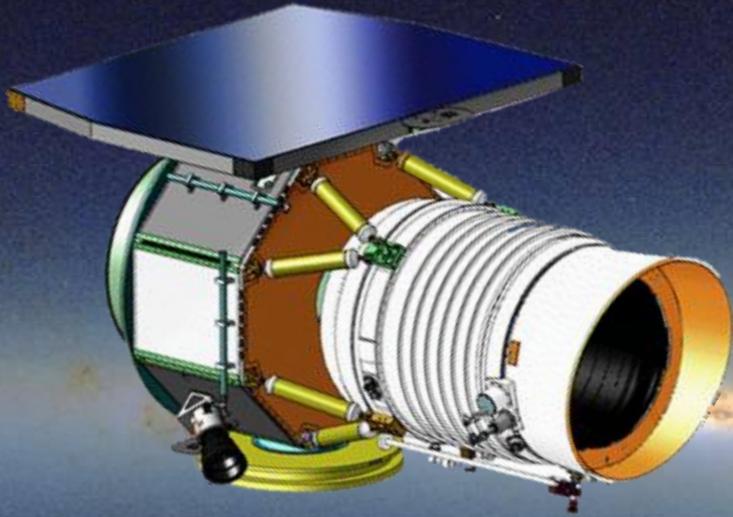


WISE

Wide-field Infrared Survey Explorer



WISE will map the sky in infrared light, searching for the nearest and coolest stars, the origins of stellar and planetary systems, and the most luminous galaxies in the Universe.



WISE will deliver to the scientific community:

Over 1 million images covering the whole sky in 4 infrared wavelengths

Catalogs of \approx 500 million objects seen in these 4 wavelengths



asteroids



brown dwarfs



Galaxy



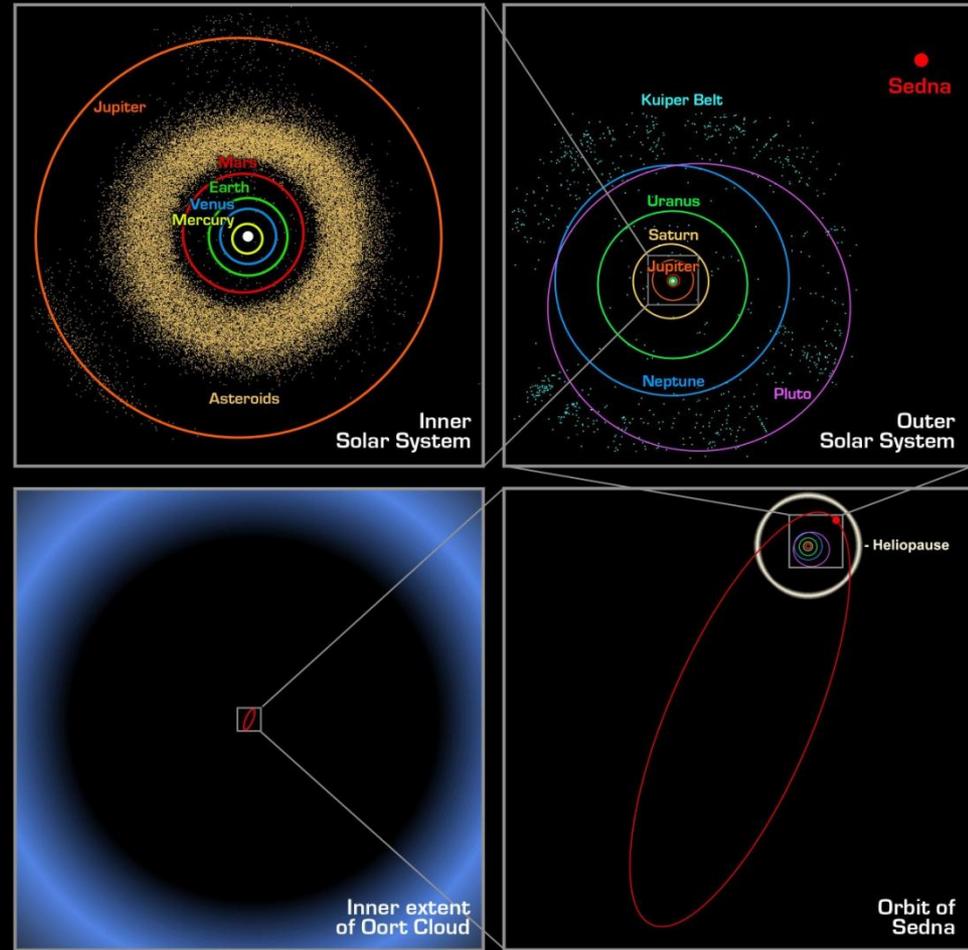
ULIRGs

wise.astro.ucla.edu

WISE Solar System Science



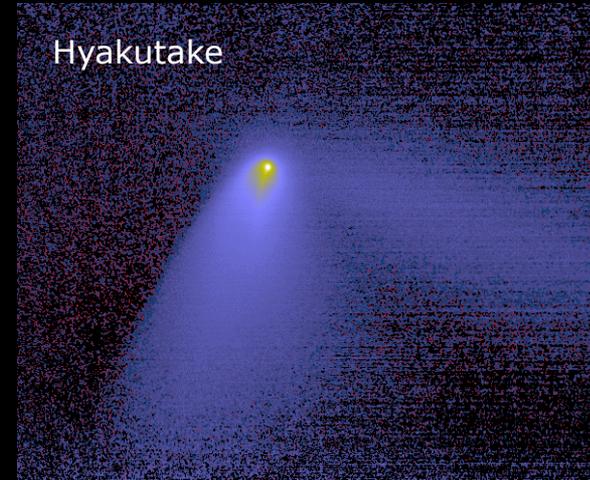
- Solar System bodies glow brightly in Mid-IR wavelengths.
- WISE will detect both known and previously unknown...
 - Asteroids.
 - Comets.
 - Comet nuclei.
 - Zodiacal dust bands.
 - Cometary debris trails.
- With these data we can draw inferences about physical properties, history, and processes.



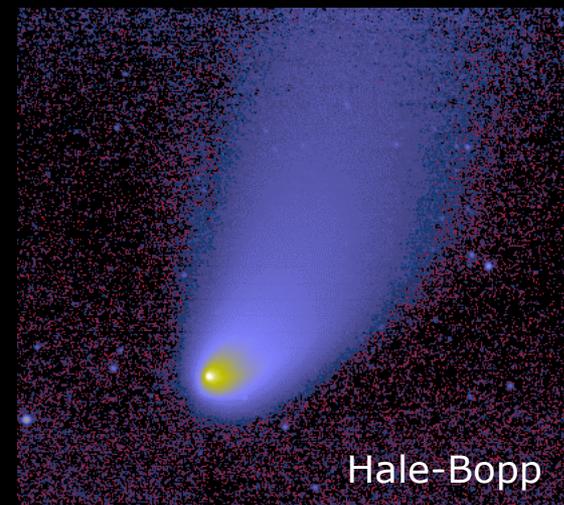
WISE Solar System Science



- In 1983, IRAS discovered:
 - Comets are snowy dirtballs, not dirty snowballs.
 - The Solar System is dustier than was thought.
- WISE will have 100s times greater sensitivity.



Mid Infrared Observations
of Comets



WISE and Comets



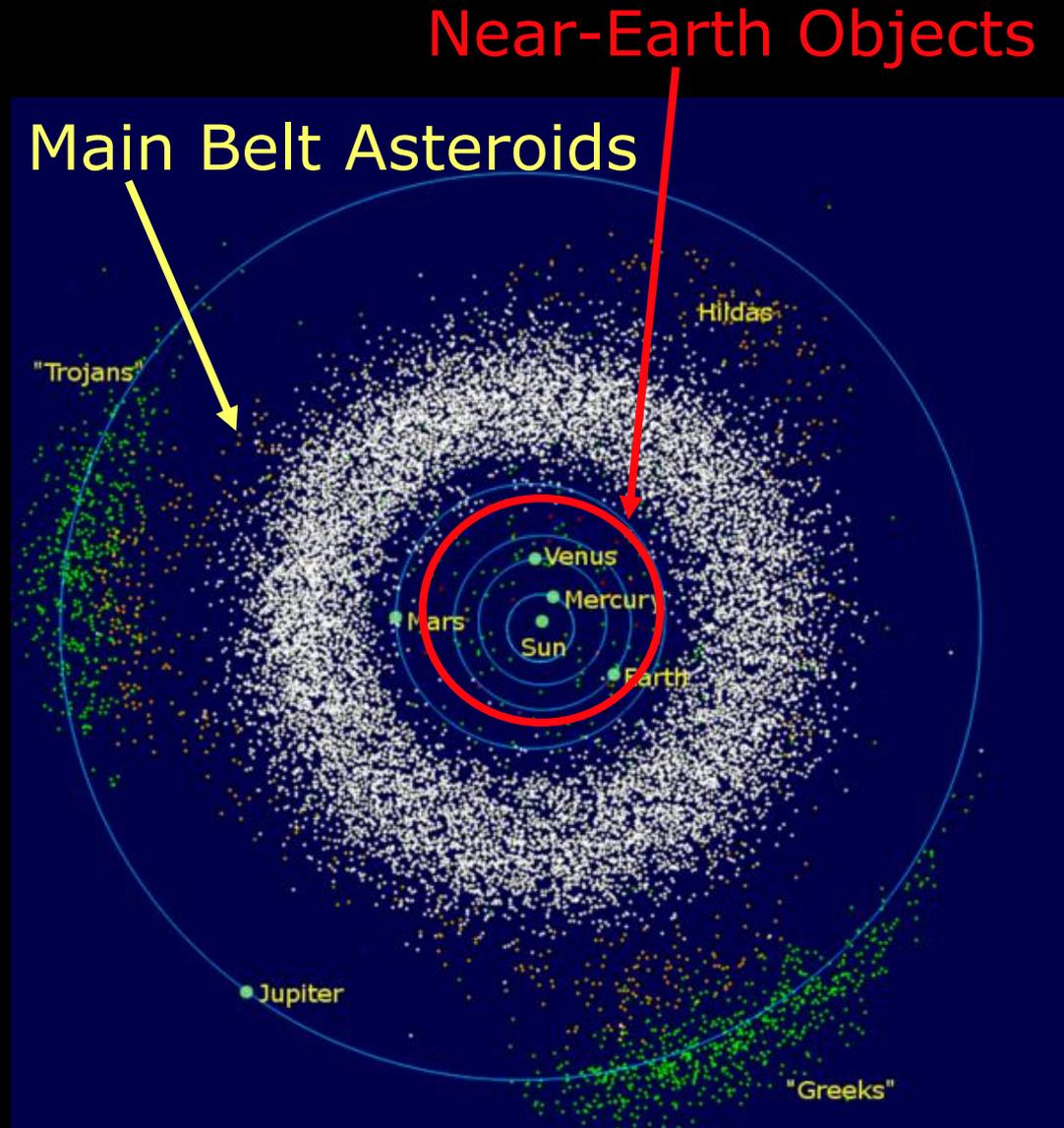
- Observations in 12 & 22 micron bands will yield size estimates.
- Combined with observations in visible light will yield albedos.
- Sizes and albedos of ...
 - Comet nuclei in general.
 - Nuclei of Jupiter-family comets beyond 4.25 AU.
 - Oort Cloud (OC) comet nuclei?
- Get Jupiter-family Comet size distribution.
 - Compare Oort Cloud nuclei distribution with Jupiter-family comet nuclei distribution.



WISE and Asteroids



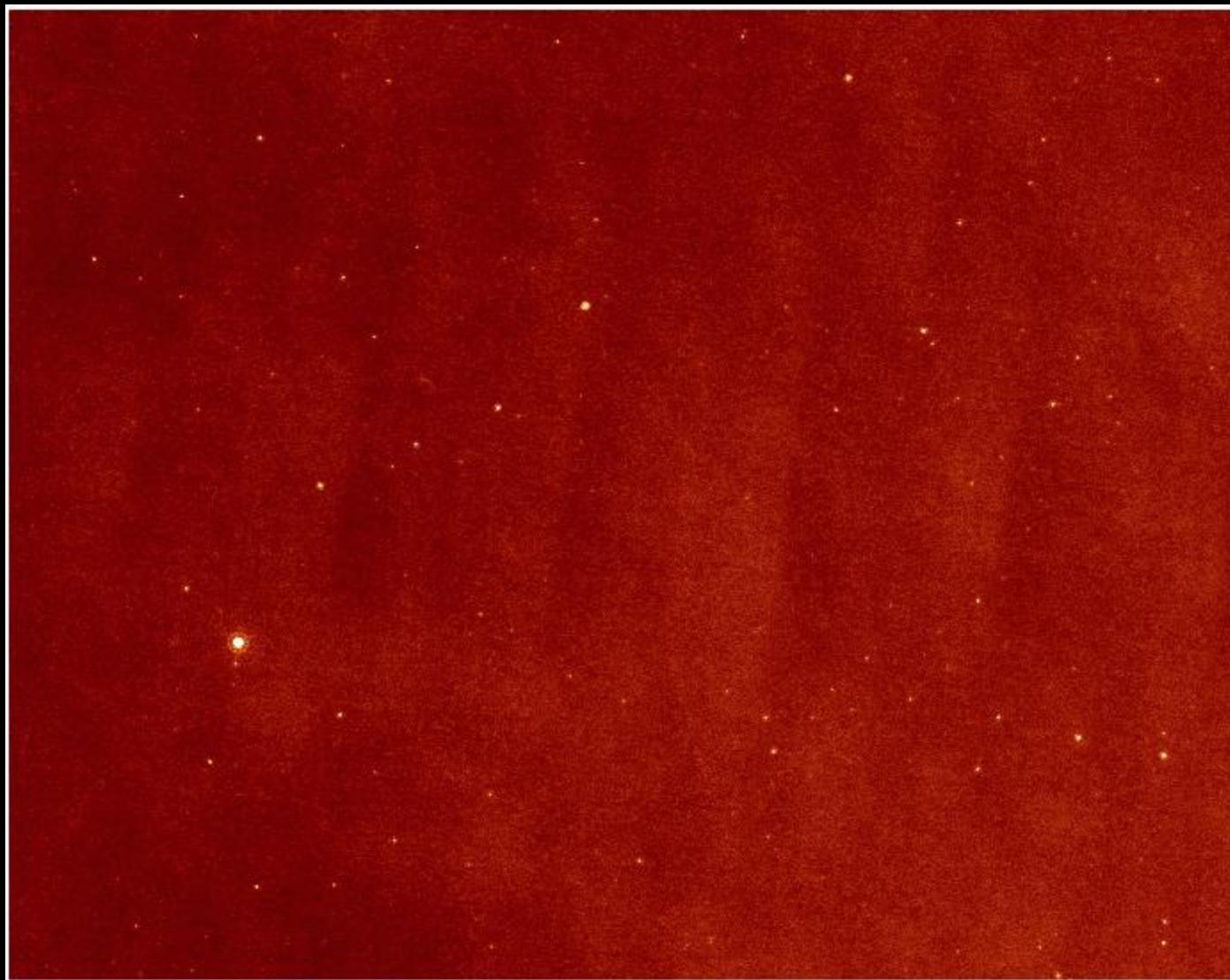
- WISE will find many asteroids — many never seen before
 - 100,000s of Main Belt Asteroids
 - 100s of Near-Earth Objects (NEOs)
- This will help us understand the size distribution of asteroids, as well as their compositions
- This will help us understand the probability of impacts on Earth



WISE Will See Many Asteroids



- Spitzer Space Telescope 24 micron data in Taurus
- Most of the bright objects are asteroids!
- Size $0.7^\circ \approx$ WISE field of view



WISE and Asteroids

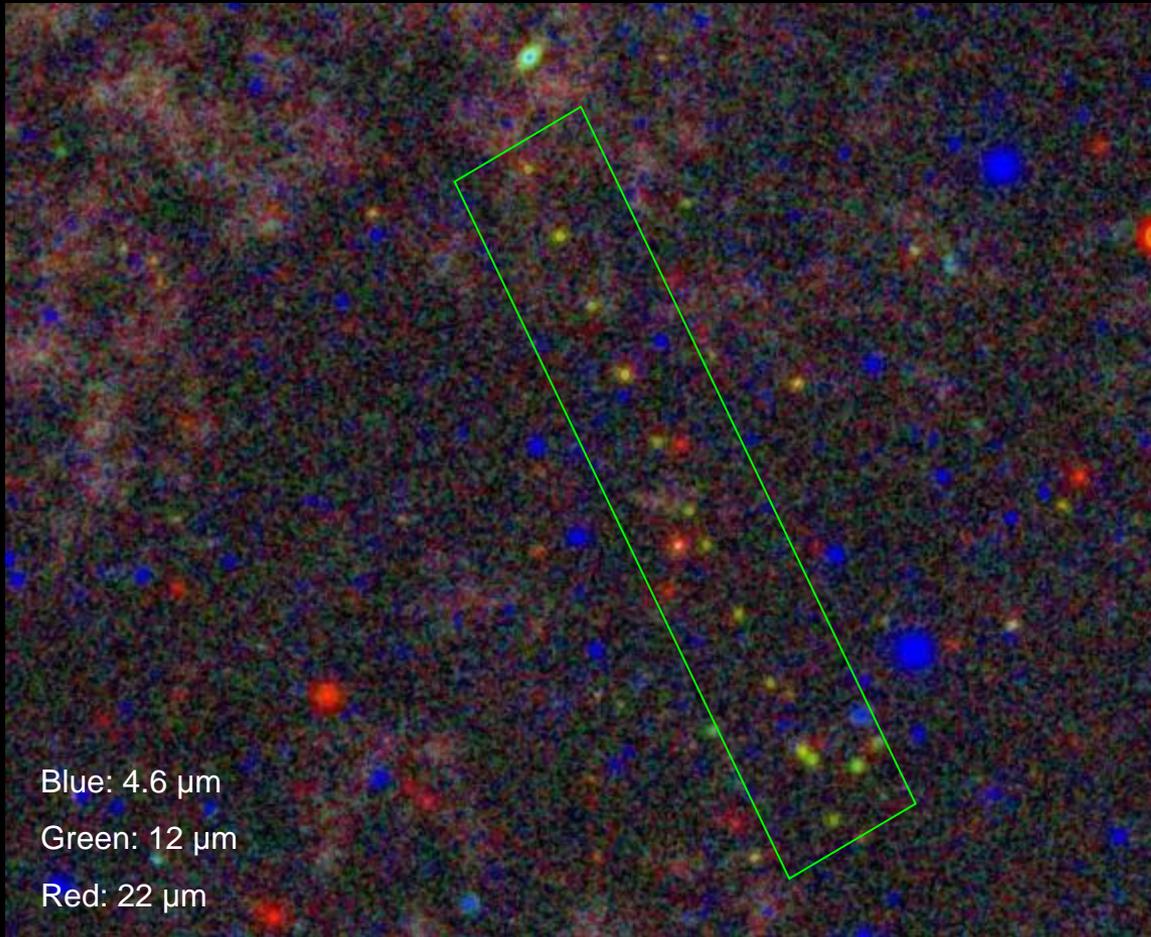


Asteroids are much brighter in infrared than in visible light.



Comet in Visible and Infrared (artist's rendition)

WISE and Asteroids



Blue: 4.6 μm

Green: 12 μm

Red: 22 μm

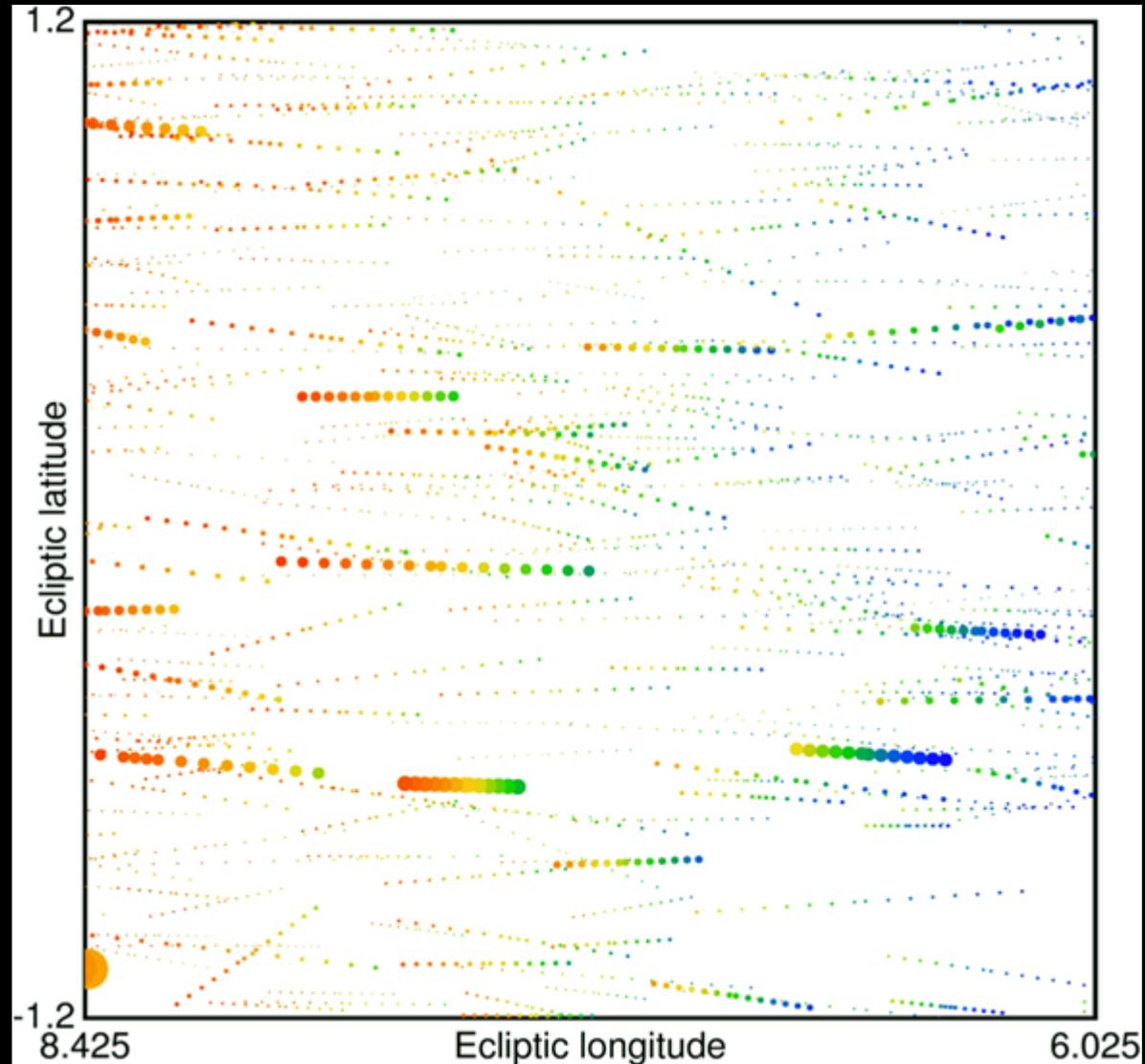
They move in the hours between WISE frames.

A simulated composite WISE image demonstrates how the motion of an asteroid will be easily detected

WISE and Asteroids



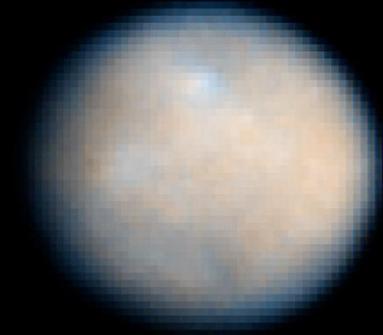
- Simulated WISE Detections of Asteroids on the Ecliptic
- Note the color code shows the time of observations, from early to late.
- Every dot is a detectable single frame observation by WISE at 12 microns of a known asteroid.



Asteroid Numbers



- WISE will make $\sim 20,000$ observations of $\sim 3,000$ different asteroids per day.
 - Several hundred thousand at 12 & 22 microns throughout the mission.
- WISE will see most main belt asteroids larger than 4 km in diameter.
- WISE will also detect $\sim 10-20$ of Near Earth Objects (NEOs) per day.
- Over the mission WISE will net hundreds of NEOs with diameters larger than 300 m.



WISE will find PHAs

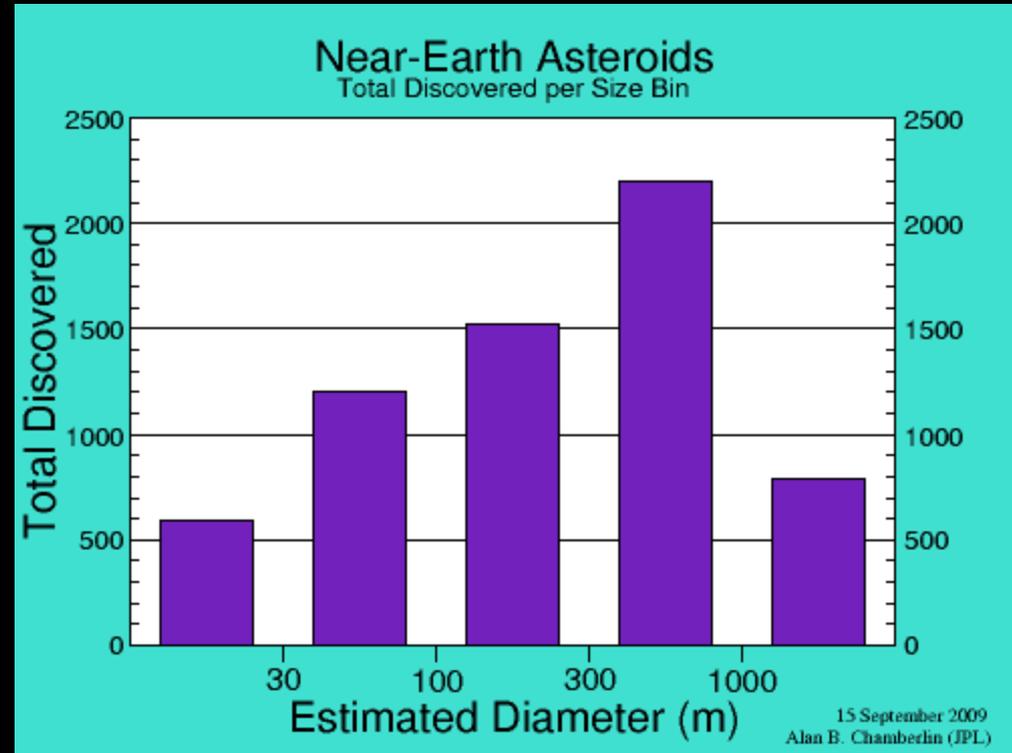


- Near Earth Objects pass within 0.3 AU of Earth.
 - WISE observations at 90° from the Sun will detect known asteroids with diameters larger than 1 km up to 2.8 AU from the Earth (3 AU from the Sun).
- **Potentially Hazardous Asteroids** (PHAs) are larger than 150 m in diameter and have orbits that approach within 0.05 AU of Earth's orbit.
 - WISE will detect known 150 m PHAs up to 0.7 AU from Earth.

Size Frequency Distribution



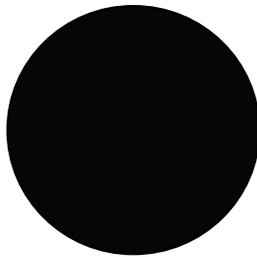
- Since we haven't found all the NEOs, we need to know how many there are of what size
- Visible surveys are biased against dark objects
 - Recent results suggest there are fewer smaller ones than previously thought, but this could be due to bias
- WISE will find hundreds of new NEOs, and a hundred thousand new Main Belt Asteroids.
 - Will get size frequency distribution for NEOs as small as ~ 300 m
 - Infrared-discovered sample is not biased against dark objects



Value of IR Asteroid Data



- Asteroid sizes are hard to determine in visible light because something can be shiny and small or big and dark - but will have the same apparent brightness.



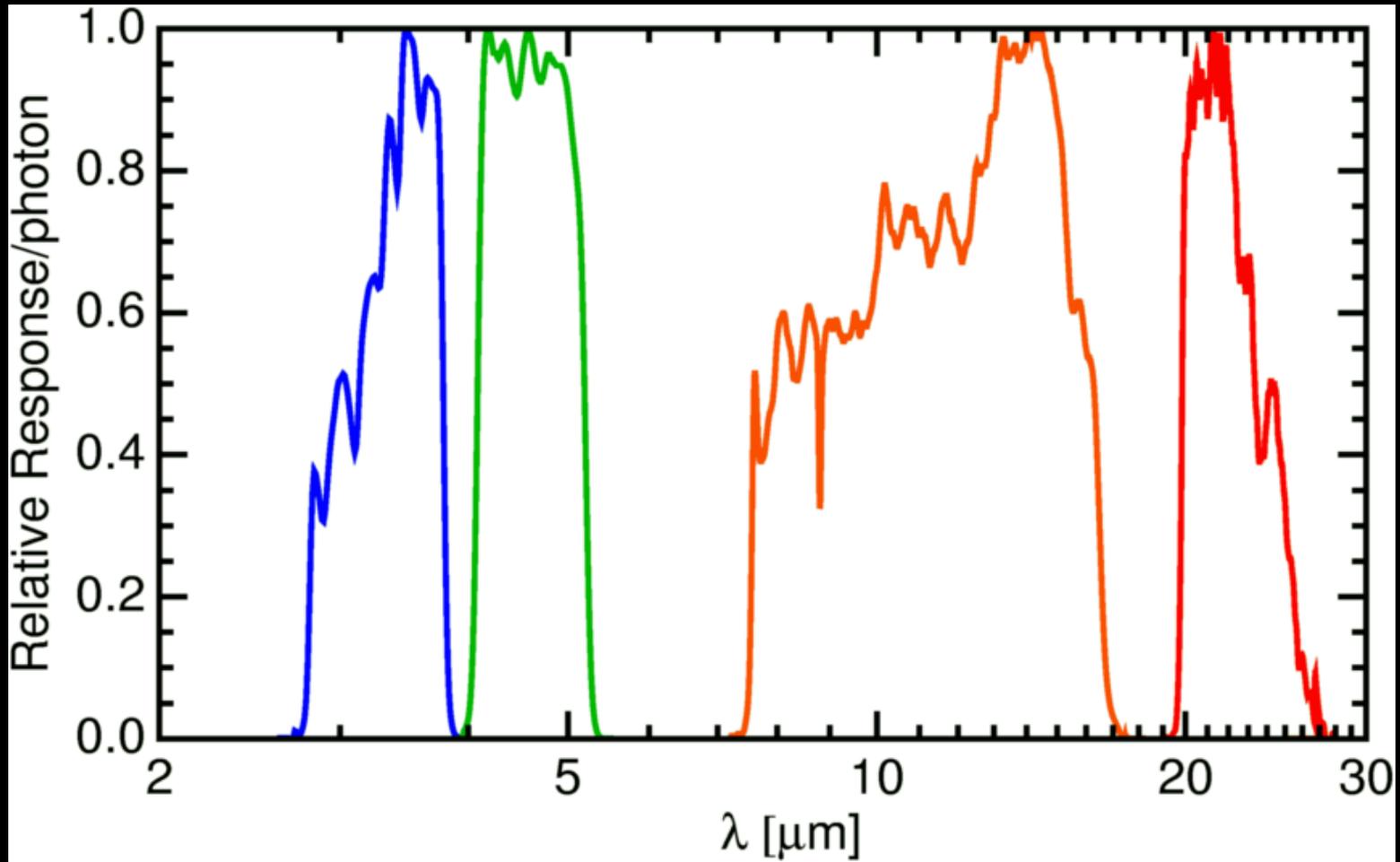
2.3% albedo,
2.6 km diameter



63% albedo,
0.5 km diameter

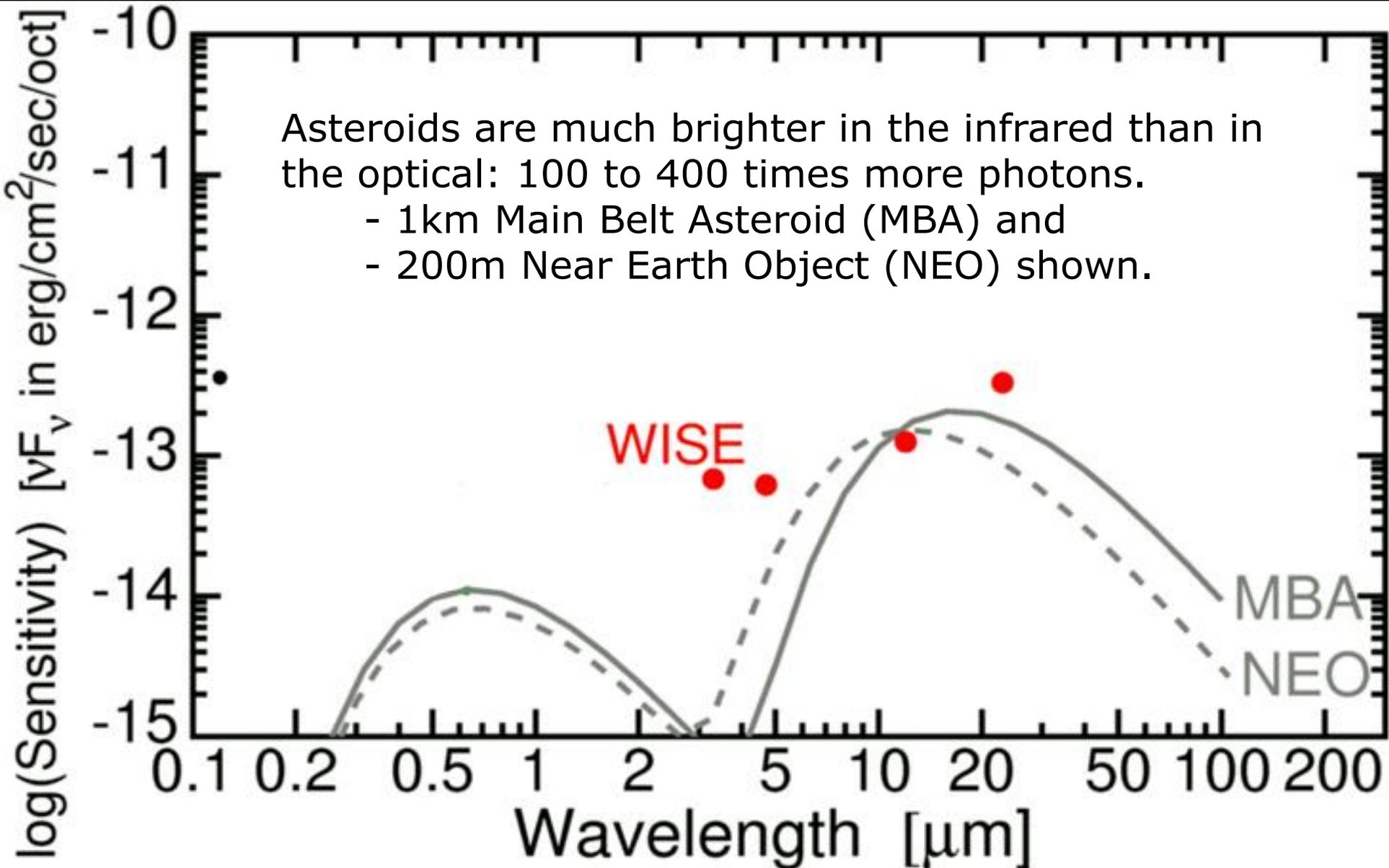
- Surveys in visible light don't give us good size measurements.
- Infrared diameter measurements are $\sim 10x$ more accurate than visibly derived sizes.
- If you have both infrared & visible data, the diameter and albedo are well determined
 - From albedo, can infer composition --> estimate of bulk density --> mass.
 - Asteroid mass is essential for hazard assessment.

WISE Passbands



These are the 4 wavelength filter responses for the WISE mission. The effective band centers are 3.4, 4.6, 12, and 22 microns.

Detectability of Asteroids by WISE



WISE and NEOs



- By doing an infrared-selected survey of asteroids, we can learn the true size frequency distribution of sub-km NEOs down to ~ 300 m
- We can determine accurate diameters
- We can determine albedos for most WISE-discovered NEOs
 - Currently, only a few dozen objects have well-measured albedos
 - This leads to an idea of composition
 - When combined with diameter, get impact energy





Use of IR Data on Known Asteroids

- We can determine diameters using thermal models of asteroids:
 - ❑ $\pm 3\text{-}5\%$ errors with detections @ 12 & 22 μm ;
 - ❑ $\pm 10\%$ errors with single-band detections;
 - ❑ Neglecting unknown rotation axis, etc.
- Visible observations from ground-based telescopes will yield albedos.
- IR lightcurves help determine shapes.

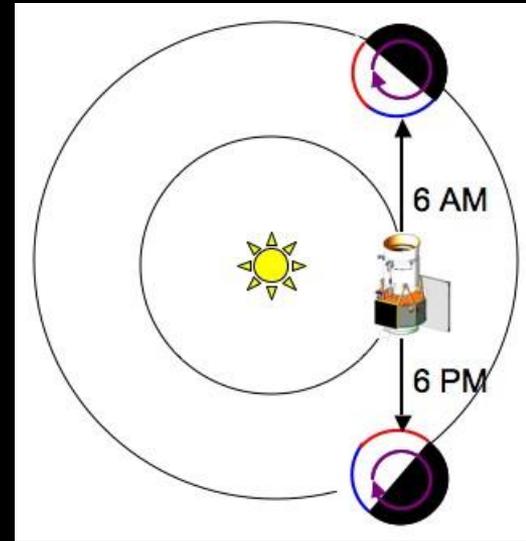
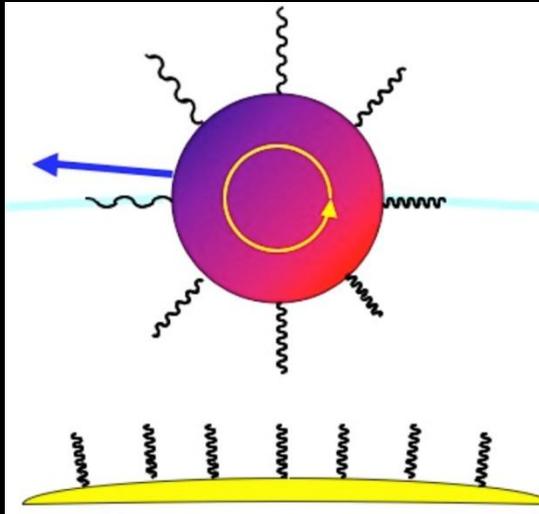


WISE Studies of Previously Known Asteroids



- Diameters & albedos for $\sim 100,000$ MBAs & ~ 300 NEOs.
- Compare these determinations with info from IRAS, occultations, radar, Spitzer, etc.
- Follow up unusually hi or low albedos or discrepancies:
 - Ground-based spectroscopy, lightcurves, &/or polarimetry.
 - Inactive comet nuclei?
 - Unusual surface properties?
 - Spin vectors?
 - Yarkovsky force?
- Albedos of MBA families & NEOs; origins of same.

Yarkovsky Effect



- Due to thermal inertia, afternoon is hotter than morning - on Earth and on asteroids.
- More afternoon thermal radiation leads to net radiation force, changing the asteroid's orbit.
- Yarkovsky effect can dominate uncertainty in whether a NEO will impact Earth.
- WISE can measure the temperature difference between morning and afternoon.

Yarkovsky Effect & Dinosaurs



- Collision in the asteroid belt 160 Million years ago created the Baptistina family of asteroids
- Yarkovsky effect pushed orbits into resonant zones, where asteroids scattered into Earth crossing orbits

Then BOOM! 65 Million years ago.



WISE data will:



- Eliminate the factor of 5 diameter uncertainty due to uncertainty in the optical albedo, which ranges from 0.023 to 0.63 for NEOs.
 - Give good diameters for more than 100,000 asteroids, including hundreds of NEOs.
- Eliminate the bias against dark asteroids in current optical searches.
 - Determine whether dark asteroids significantly enhance the threat.
- Reduce the bias against asteroids most likely to impact the Earth, which have elongations from 60 to 90 degrees.
 - Current NEO searches are centered at opposition.
- Estimate the size of the population and characterize the distribution of diameters of NEOs in the potentially hazardous 0.14 to 1 km diameter range.
 - WISE will observe approximately 100s of NEOs during its 6 month baseline mission survey, and possibly 100s more with operations extended until the cryogen runs out.
 - A more complete inventory would require a longer mission lifetime.