Utilizing the NASA IRTF for Planetary Defense



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What is planetary defense?



Planetary defense is the term used to encompass all the capabilities needed to detect the possibility and warn of potential asteroid or comet impacts with Earth, and then either prevent them or mitigate their possible effects.

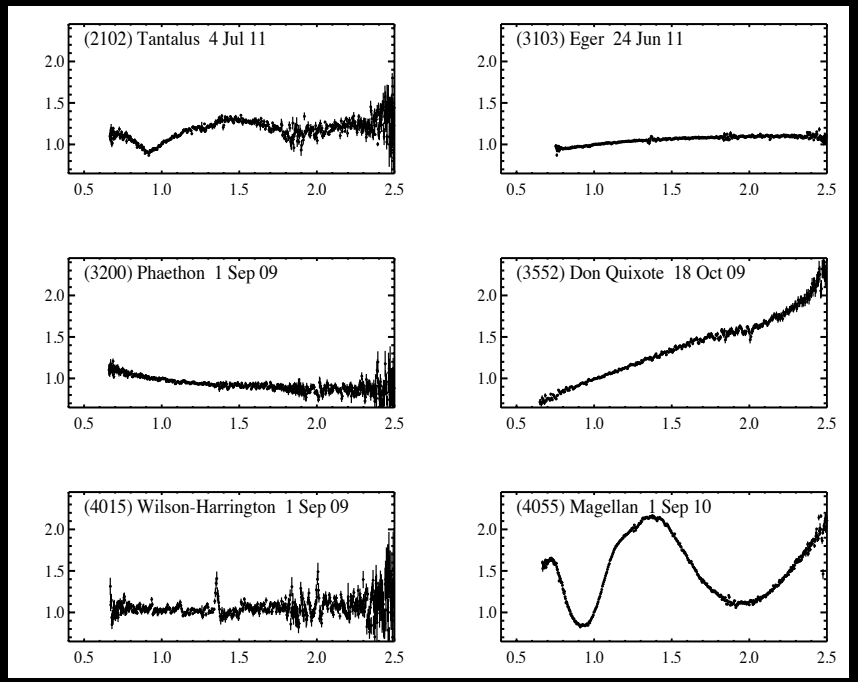
Planetary defense involves:

- Finding and tracking near-Earth objects that pose of hazard of impacting Earth;
- Characterizing those objects to determine their orbit trajectory, size, shape, mass, composition, rotational dynamics and other parameters, so that experts can determine the severity of the potential impact event, warn of its timing and potential effects, and determine the means to mitigate the impact; and
- Planning and implementation of measures to deflect or disrupt an object on an impact course with Earth, or to mitigate the effects of an impact that cannot be prevented. Mitigation measures that can be taken on Earth to protect lives and property include evacuation of the impact area and movement of critical infrastructure.

www.nasa.gov/planetarydefense/faq



SpeX on the NASA IRTF has produced near-infrared spectra for > 1000 different near-Earth asteroids.



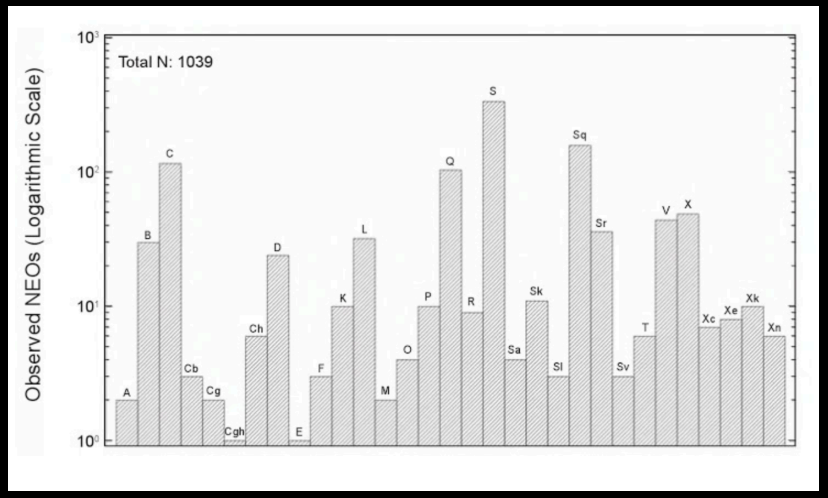
- MIT-Hawaii Near Earth Object Spectroscopic Survey
- DeMeo et al. (2014)
- Reddy et al. (2010, 2012)
- Sanchez et al. (2012)
- Thomas et al. (2011, 2014)
- Binzel et al. (in prep)

*Selected sample, *many* other papers exist

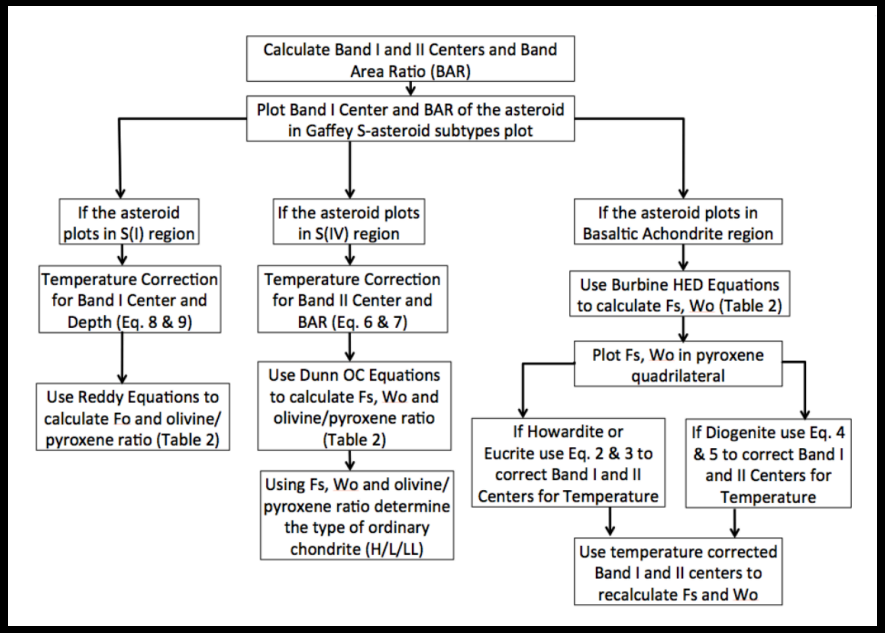
We Have Learned About NEO Compositions…

NEO population studies have investigated the distribution of taxonomic classes, performed spectral analyses to calculate mineralogy, and determined meteorite analogs.

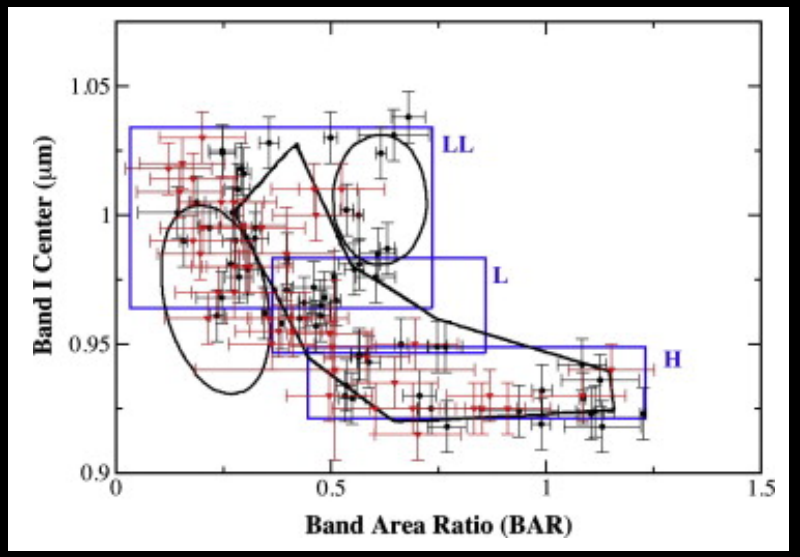
SpeX low-res prism mode is great at this!



Binzel et al. (2015)

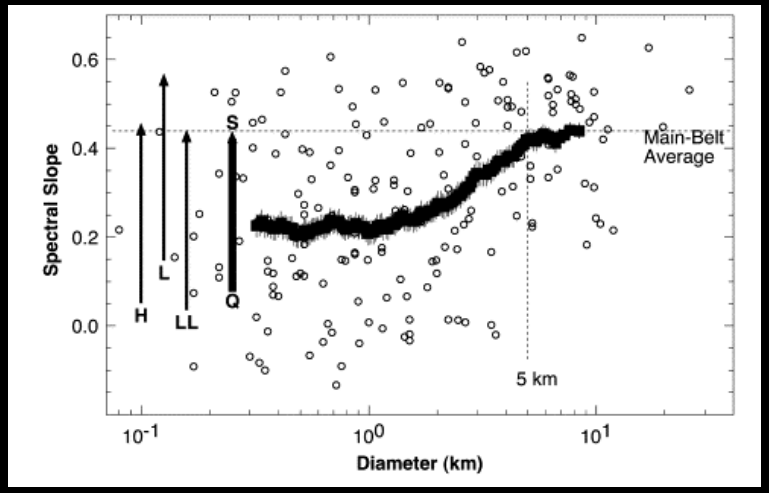


Reddy et al. (2015)



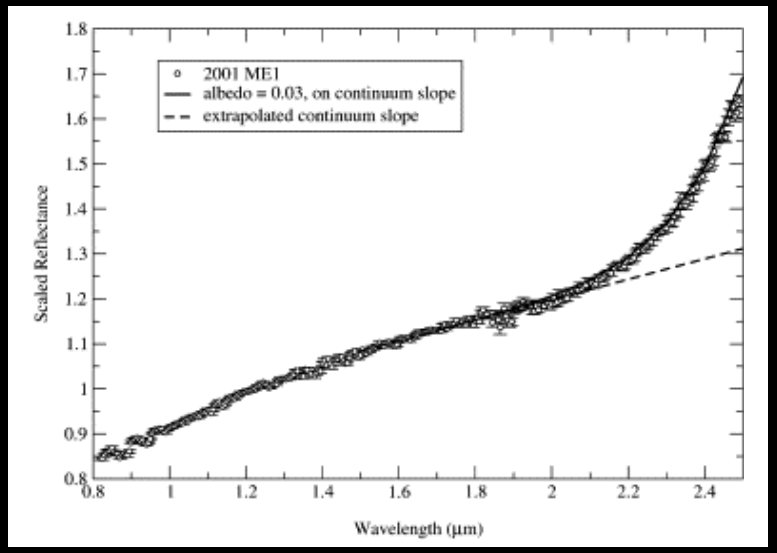
Thomas et al. (2014)

...And Various Other Physical Properties

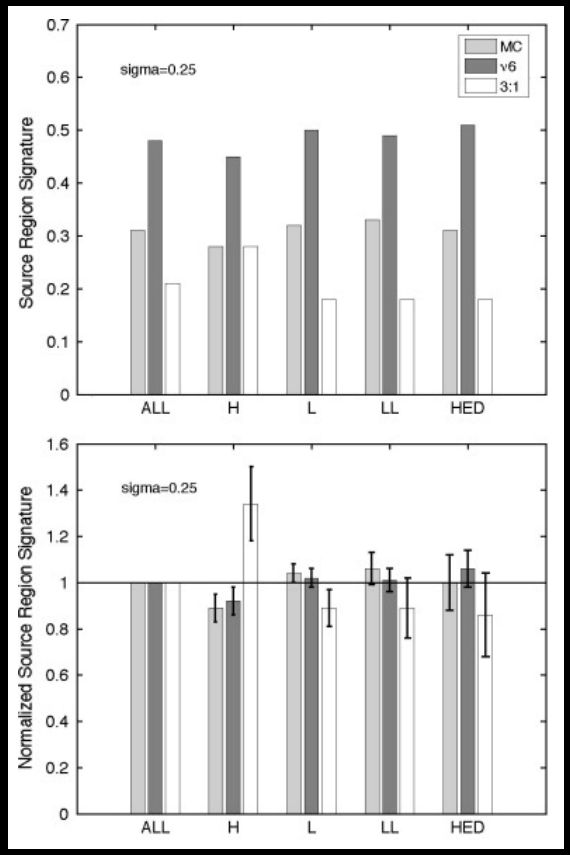


Binzel et al. (2004)*

We have also investigated space weathering, surface albedos, and Main Belt source regions.



Rivkin et al. (2005)

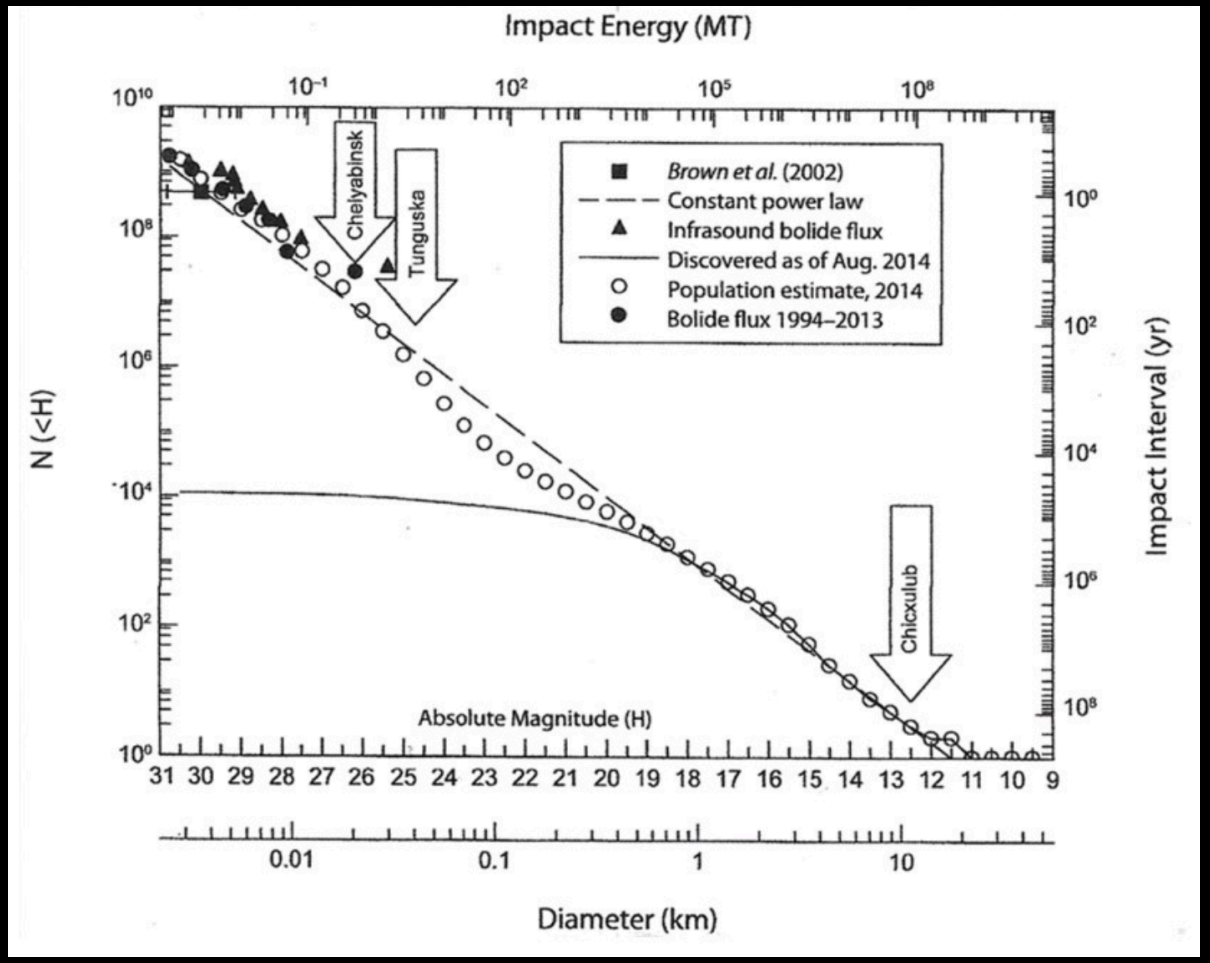


Thomas & Binzel (2010)

Which objects pose a threat and need additional study?

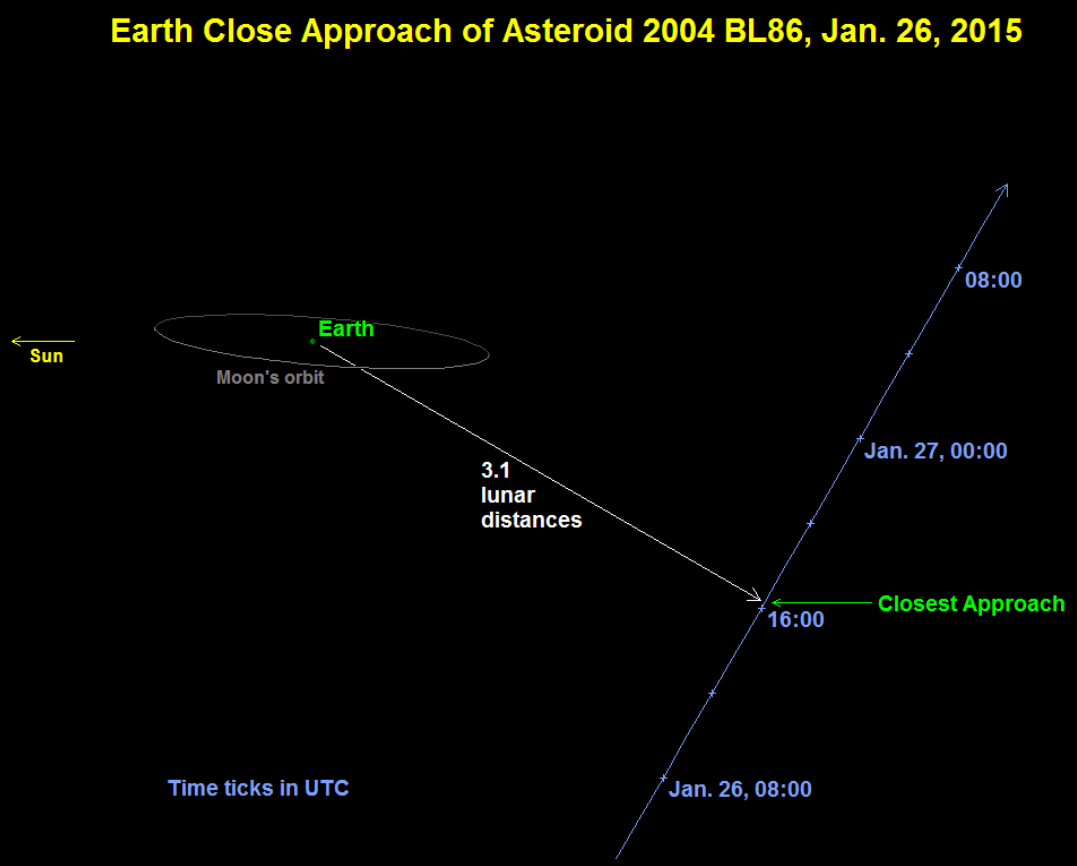
We focus on small NEOs with orbits similar to Earth.

Most large PHAs have been studied and there are orders of magnitude more smaller objects. These small NEOs are the immediate precursors to meteorites. The NEO that caused the Chelyabinsk meteor was ~20m in diameter.



Harris et al. (2015)

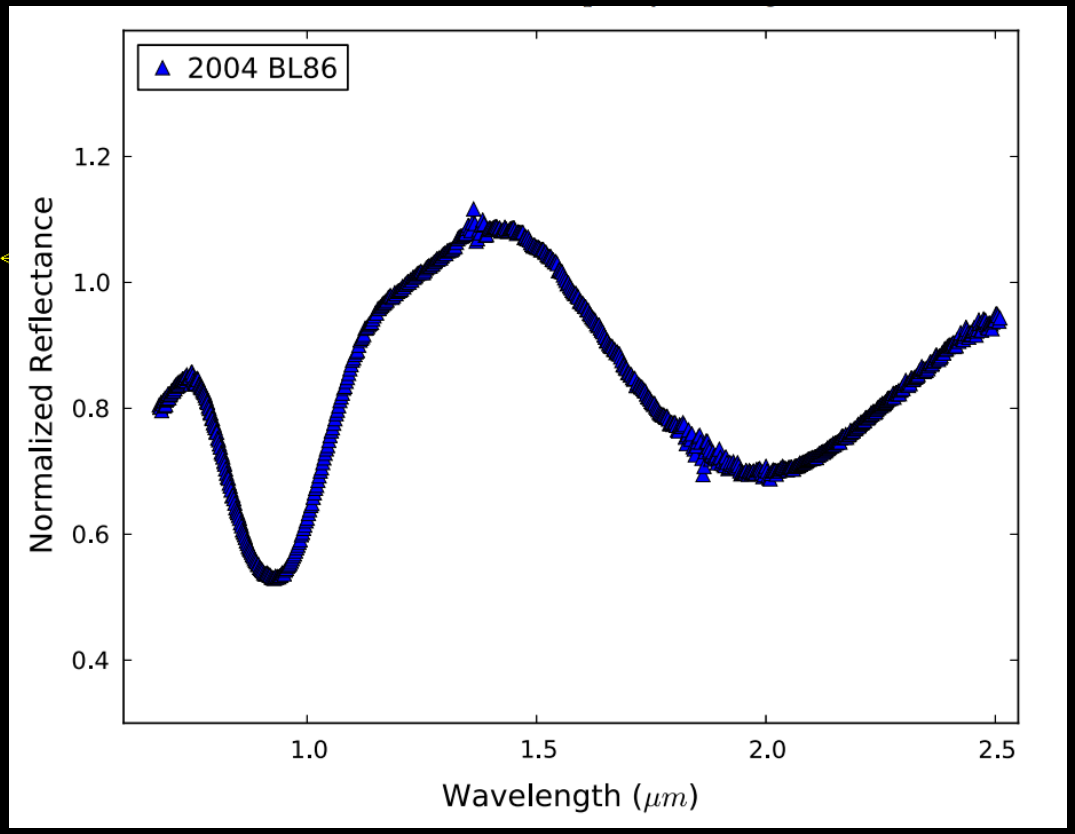
To study small NEOs with orbits similar to Earth, we wait for them to come to us



2004 BL86 flew by Earth at a distance of 1.2 million km (0.008 AU). Lightcurve observations showed that the object is binary and the primary has diameter ~300m.

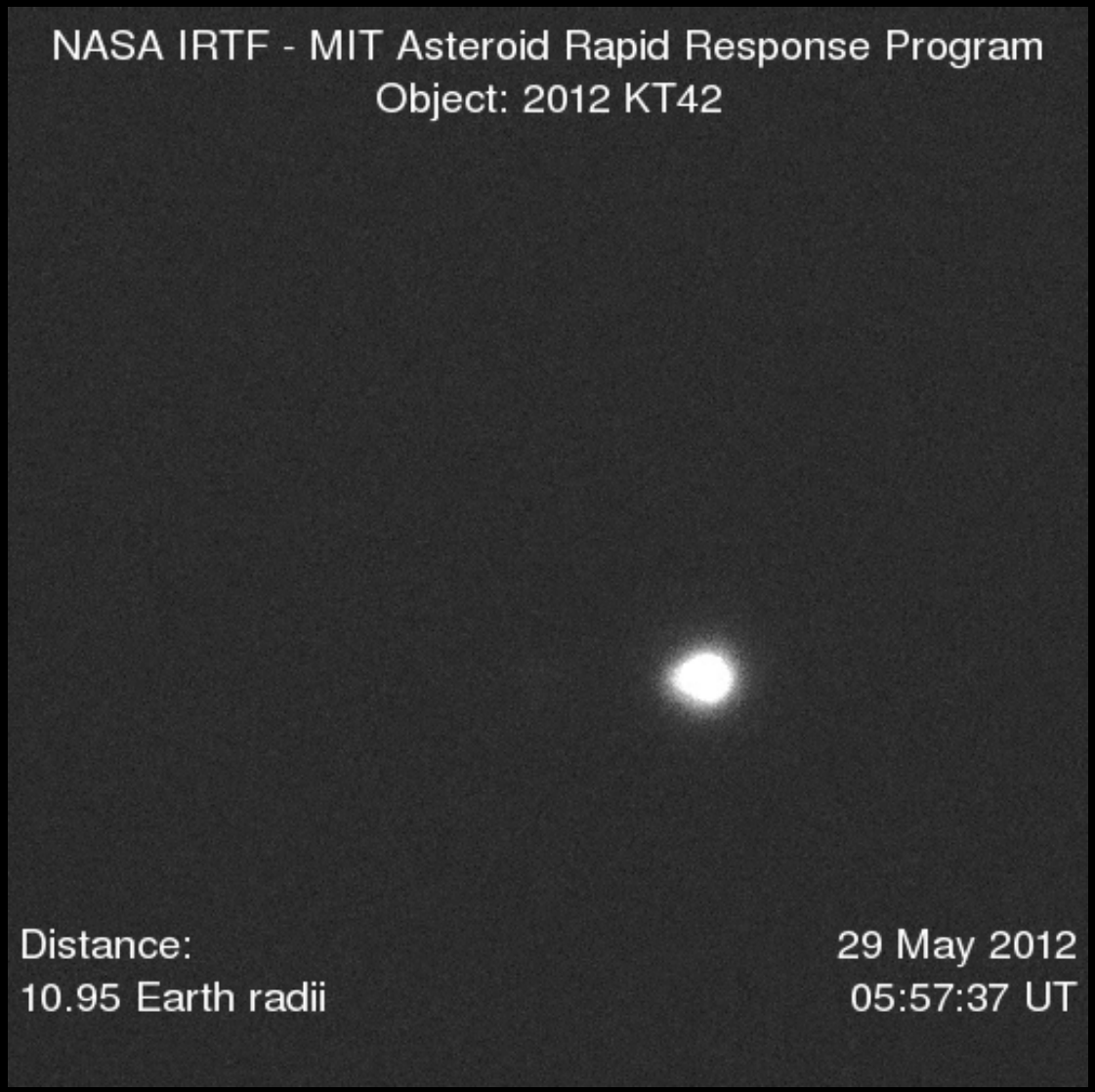
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Earth Close Approach of Asteroid 2004 BL86, Jan. 26, 2015



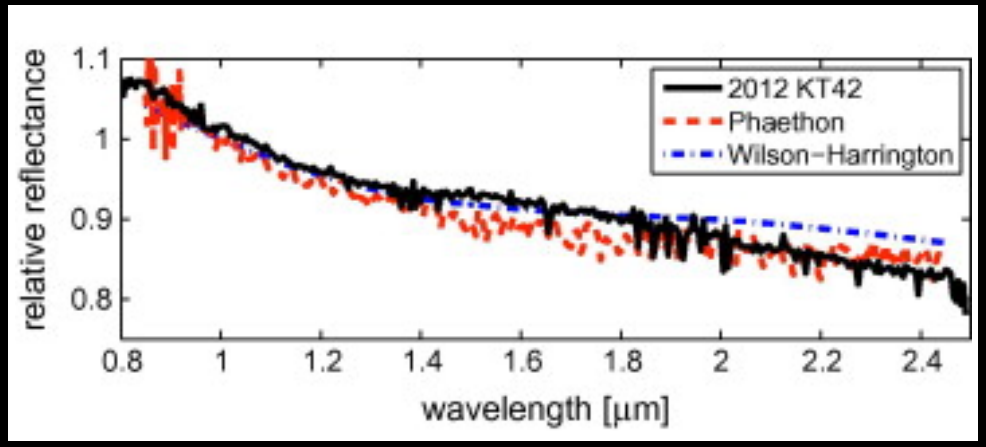
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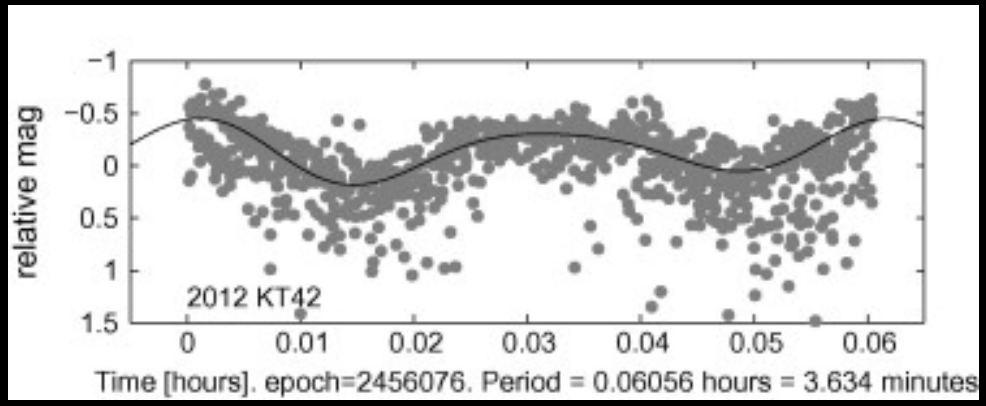
Reddy et al. (2015) determined that the spectrum of 2004 BL86 is consistent with non-cumulate eucrite meteorites.



Polishook et al. (2012)

The IRTF's robust non-sidereal tracking enables observations of NEAs as they make close approaches to Earth



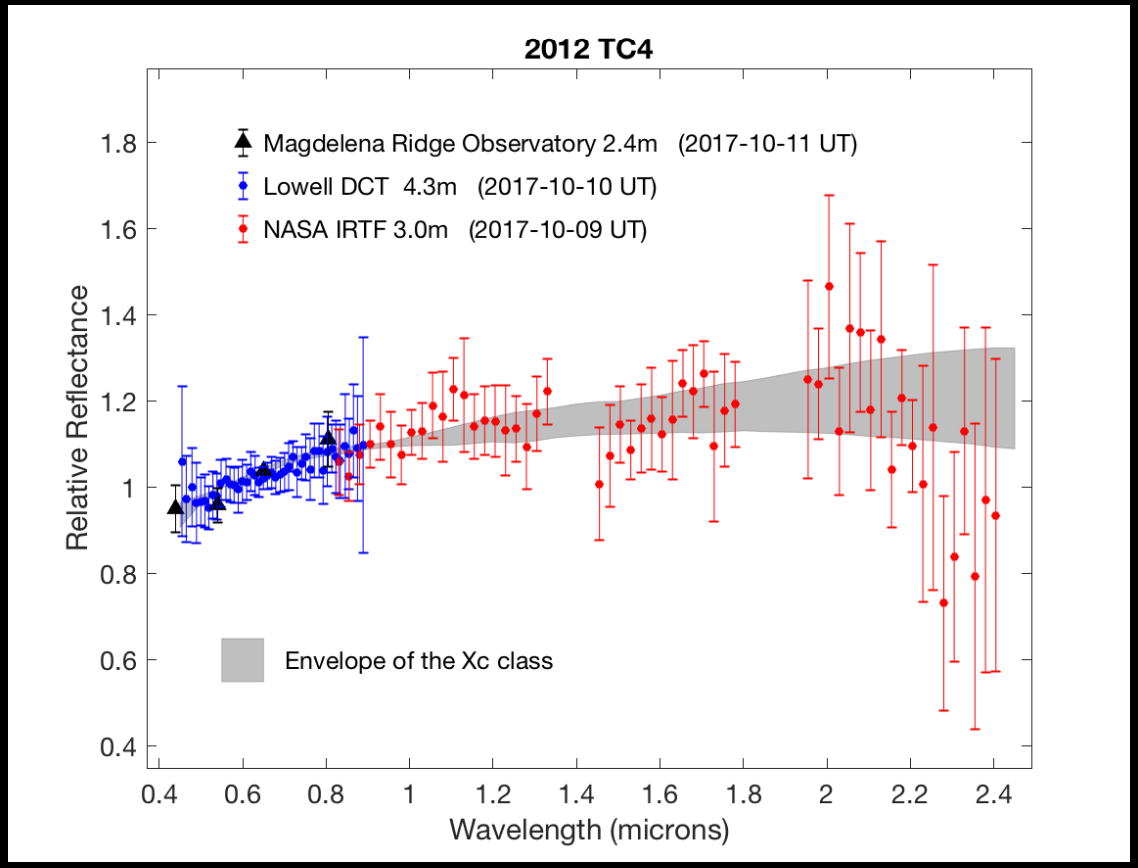


Using the combination of SpeX and MORIS Polishook et al. (2012) determined:
B-type spectrum
D~6 m
P~3.6 min

Asteroid flybys will be discussed in more detail by Nick Moskovitz

The IRTF was a critical component of the 2012 TC4 campaign

The SpeX prism data contain diagnostic features that can constrain the spectral type and/or mineralogy.



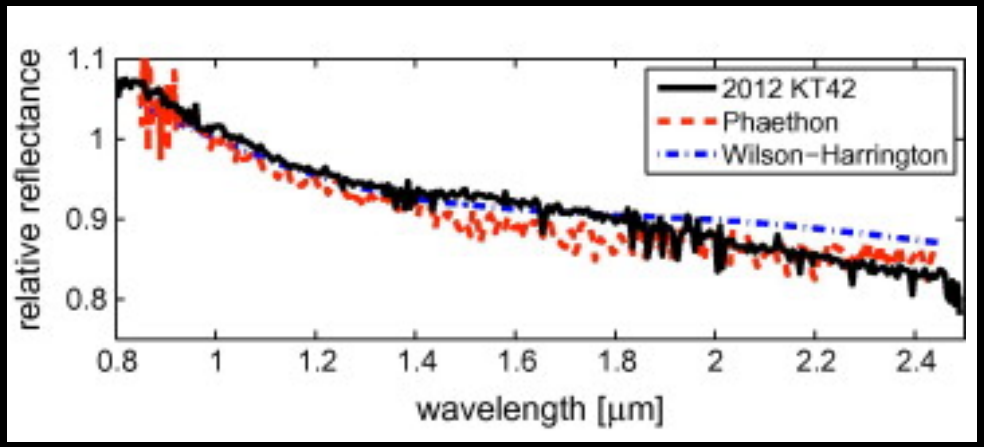
Planetary Defense: Future Directions

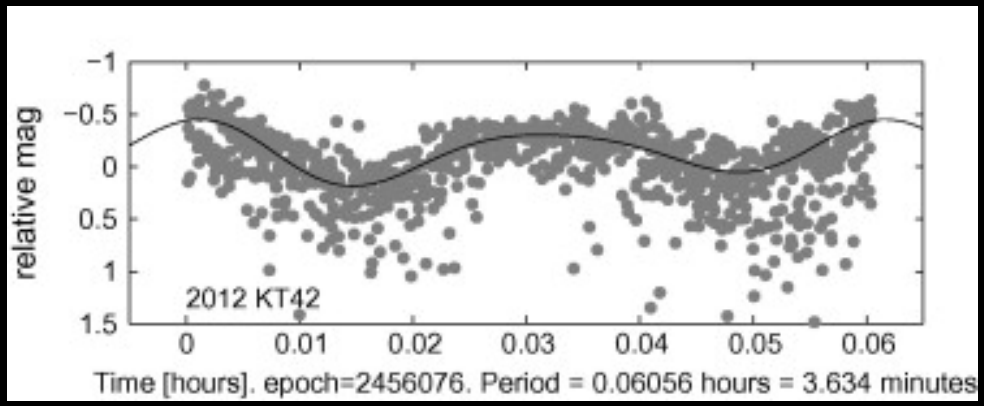


LSST is expected to discover 40,000 near-Earth objects with H=22.4 (D~ 60-200 m)

Larger telescopes will yield more objects and additional assets for physical characterization.

The IRTF should remain a leader of planetary defense studies





Continue to support simultaneous visible and near-infrared wavelength observations. The combination of SpeX and MORIS enables additional science. The SpeX upgrade allows fainter targets and longer observing windows.

The IRTF should remain a leader of planetary defense studies

Continue to support high non-sidereal tracking rates with ability to update rates.

The IRTF successfully observed up to 60 ”/sec, equivalent to ~5 Earth radii.

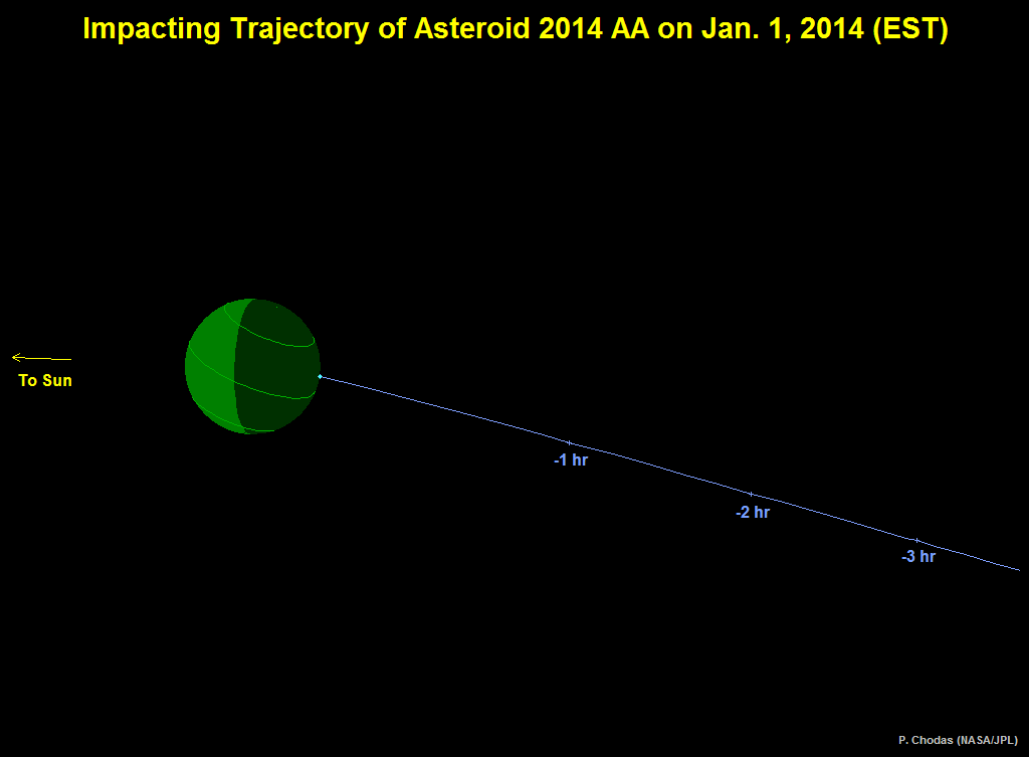
=216,000”/hr



SOAR 4m

Max SOAR rates:
2,700”/hr (dec) and
180 sec time/hr (RA)

The IRTF should remain a leader of planetary defense studies



Continue to support Target of Opportunity observations. Involve the wider NEO community in planning, guarantee time for these observations. More often than not, we cannot plan far ahead!

What more can the IRTF do?

A wide field visible camera could obtain recovery astrometry while spectra are being taken and lightcurve photometry would have additional calibration stars



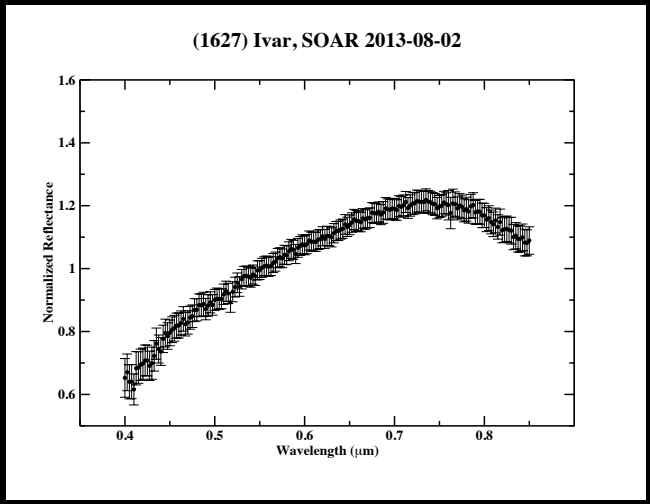
MORIS FOV is 60” x 60”

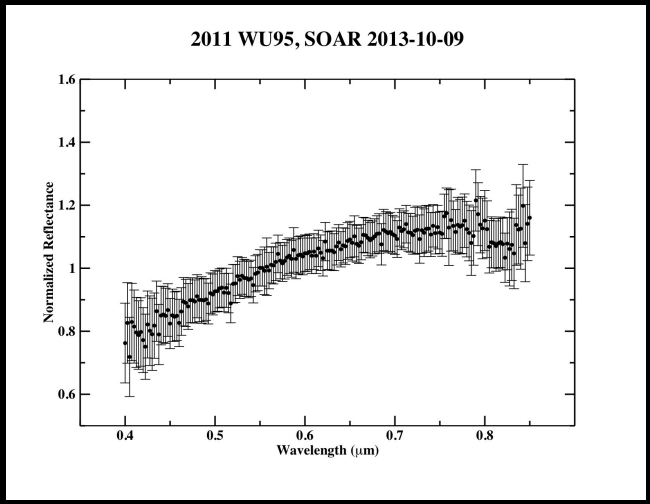


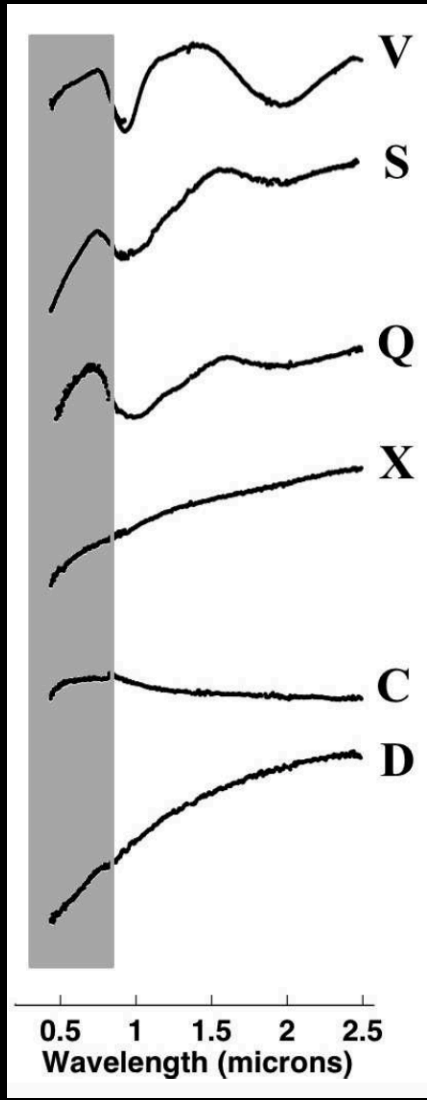
Asteroid 2012 TC4
Date: October 11/2017 (U.T)
By: Alberto Quijano Vodniza and
Mario Rojas Pereira - (Colombia)
University of Narino Observatory
Interval of time = 1hour: 34´: 38´´
Red filter Binning 2X2
Exposure of each picture = 25 sec
CGE Pro1400 Celestrontelescope
& STL-1001E SBIG camera

What more can the IRTF do?

A visible spectrograph could obtain data concurrently with SpeX.

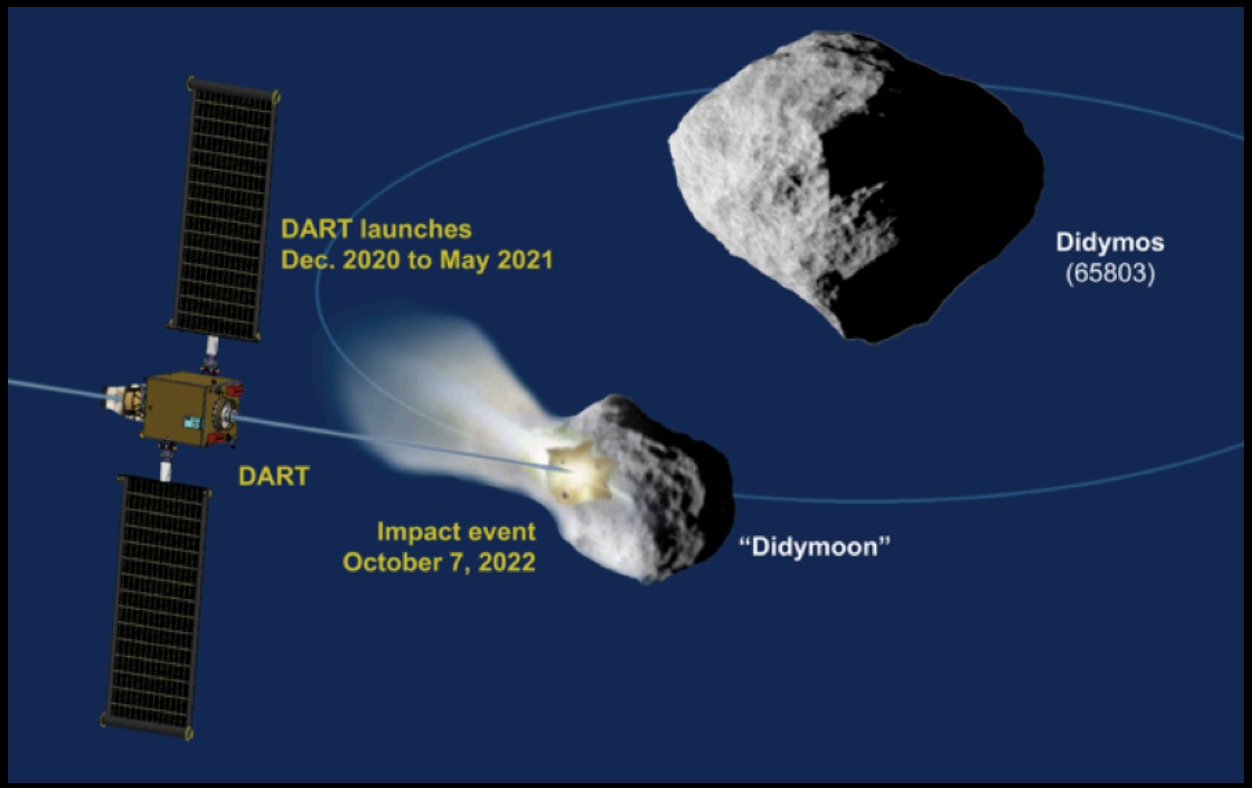






Future Opportunity: DART

AIDA/DART Observing Working Group is characterizing the system pre-impact and will assess the effects of the impact on the system and on “Didymoon”.



The IRTF is not the only piece in the planetary defense puzzle, but it is a very important one. It has a great record of NEO observations. We want to keep it that way!

