

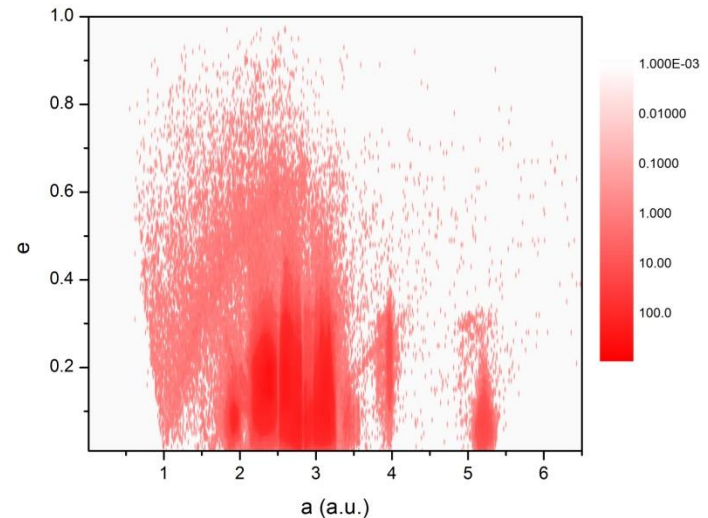
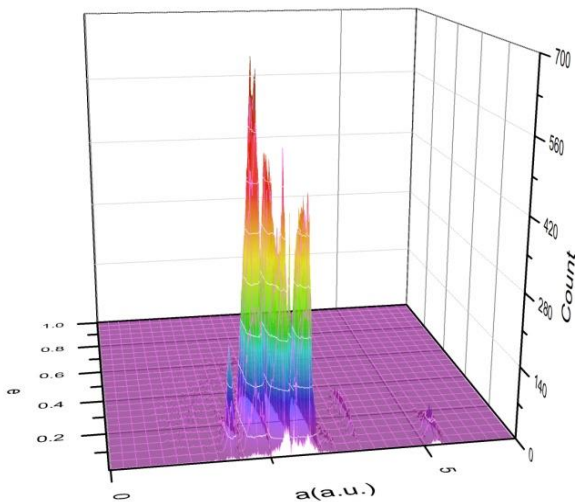
Surveillance and opportunities for observing Near-Earth Objects

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- 3) University of Bucharest, Romania
- 4) Laboratoire d'astrophysique de Marseille, France

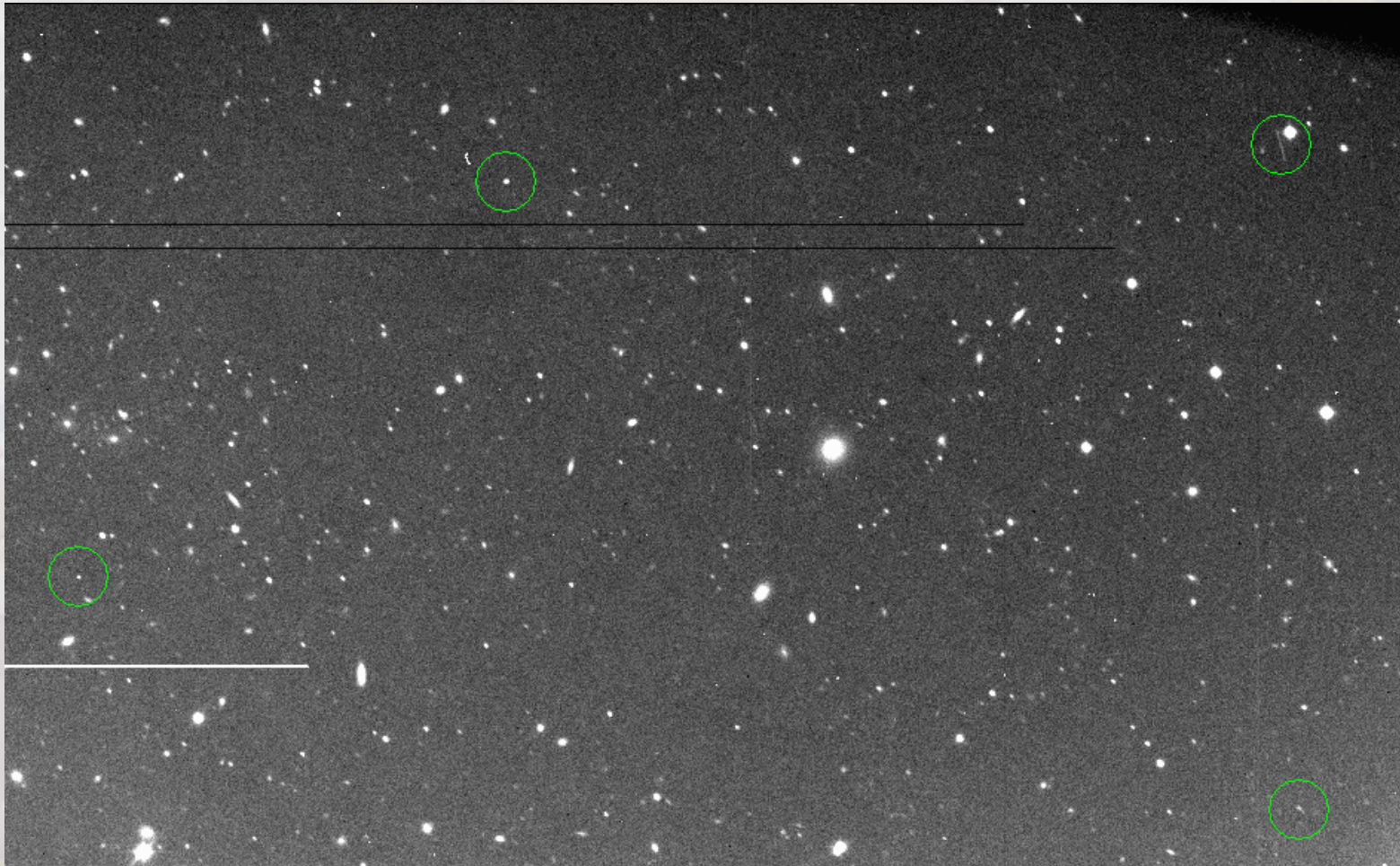
Asteroid population

- More than 790,000 objects (779,833 MB in May 31, 2018)
- 13,800 Near-Earth Asteroids (NEA),
- ~1,200 Potential Hazardous Asteroids (PHA)



~10% of NEA population with known spectral trends (1,400 objects)

Discover an asteroid- short opportunities for NEA



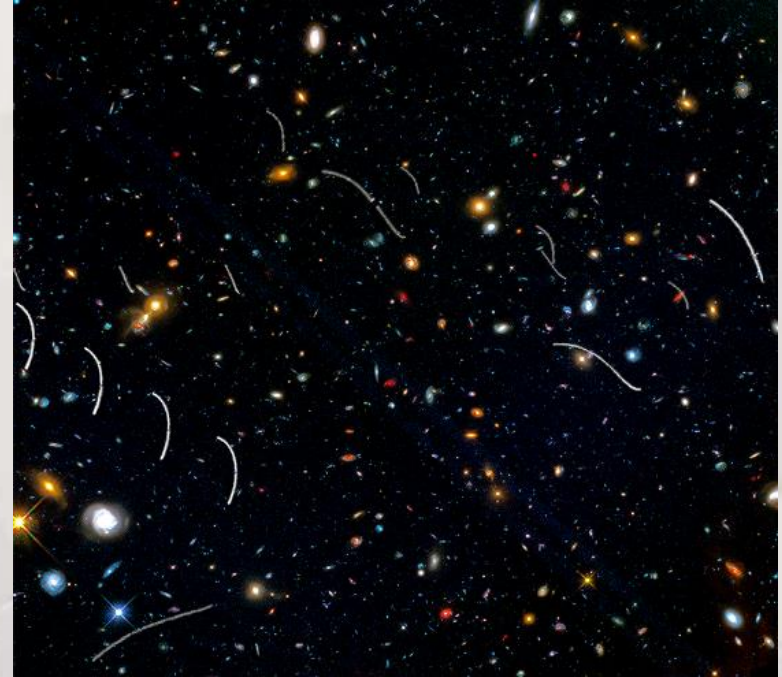
Didymos Observer Workshop 2018

Credit:



Constraints NEAs

- Geometries of observations - only few/century
- Tight windows (hours to few weeks)
- Asteroids – vermin in the sky?
- Need to secure orbit and to maximize data for physical characteristics
- Need coordinated campaigns of observation.



Copyright HST

Initiatives over Europe



- Photometry, spectroscopy of a short list NEAs

- Astrometry, photometry, spectroscopy



- Astrometry, recovery, secure orbits, natural risk evaluation

Campaigns

- How quick is the Quick response for a medium/ large telescope?

Planetary Spectroscopy at MIT

Bus-DeMeo taxonomy

MIT-UH-IRTF Joint Campaign for NEO Reconnaissance

SMASS Small Main-Belt Asteroid Spectroscopic Survey

Browse Catalog of Asteroid Spectra

New Horizons

MIT-NASA IRTF Remote Observing Laboratory

Web resources

Planetary Spectroscopy at MIT

The Planetary Spectroscopy group at MIT primarily study asteroids, both in the asteroid belt and those that approach the Earth (as well as others, where available!). We use reflectance spectroscopy to classify objects based on their spectral properties as well as doing more detailed studies of their composition.

We use a number of telescopes for our studies, including the Infrared Telescope Facility and the Keck Telescopes on Mauna Kea, telescopes on Kitt Peak in Arizona, and the Magellan telescopes in Chile. We have even published results using data from the Wallace Observatory here in Massachusetts!

Principal Investigator

Dr. Richard P. Binzel ([abstracts in ADS](#))

MIT Collaborators

Dr. Francesca DeMeo

Local Collaborators

Dr. Thomas Burbine, U. Mass. Amherst
Dr. Stephen Slivan, Wellesley College

Other U.S. and International Collaborators

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Brian Burt, Lowell Observatory
Dr. Shelte J. (Bobby) Bus, Univ. of Hawaii
Dr. David Polishook, Weizmann Institute Israel
Dr. Andrew S. Rivkin, APL
Dr. Cristina Thomas, PSI
Dr. Alan Tokunaga, Univ. of Hawaii
Dr. Pierre Vernazza, Laboratoire d'Astrophysique de Marseille

[Close Encounter Flyby Movie](#)
Asteroid 2012 KT42

NASA IRTF - MIT Asteroid Rapid Response Program
Object: 2012 KT42

Distance: 6.67 Earth radii
29 May 2012
06:26:32 UT

1998 SF36

Normalized Reflectance

Wavelength (μm)

0.05% nprFe⁰

Ordinary Chondrite

Normalized Reflectance

Wavelength (μm)

• Asteroid Dereddened
- - Average H Chondrite
- - Average L Chondrite
- - Average LL Chondrite

Our campaigns for NEAs

- Pic du Midi, France
1meter telescope

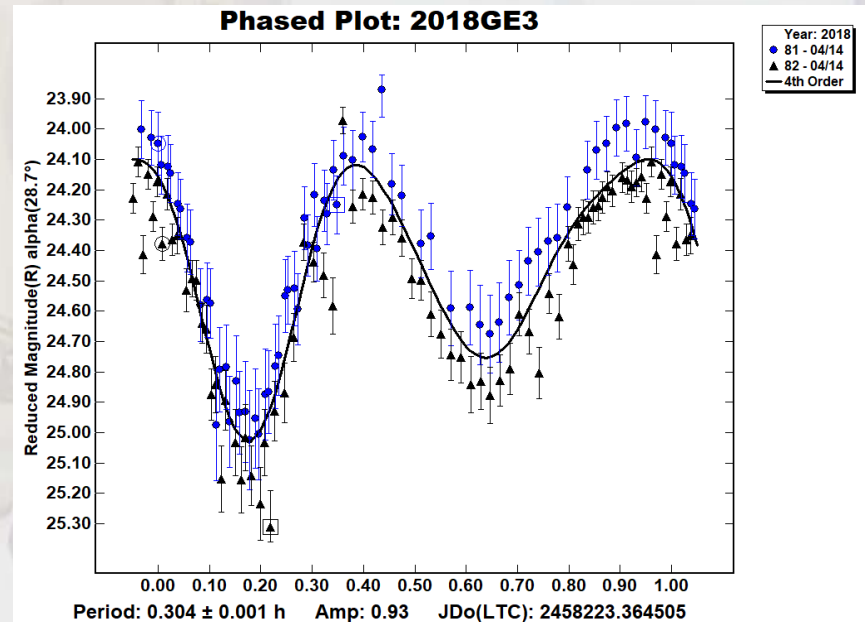
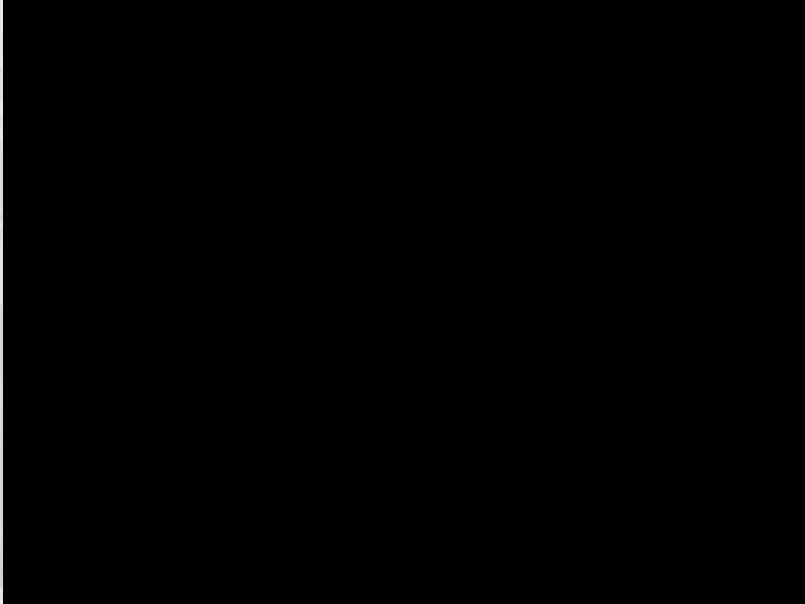


- Bucharest, Romania
0.4meter telescope



2018 GE

- Observed in April 14, 2019 (0.005AU from Earth) from Bucharest (0.38 m f/8 Ritchey-Chretien, SBIG STL-11000M)
- Astrometry reported to MPC
- $P_{\text{syn}} = 18.24 \text{ min}$, $A=0.93 \pm 0.03$



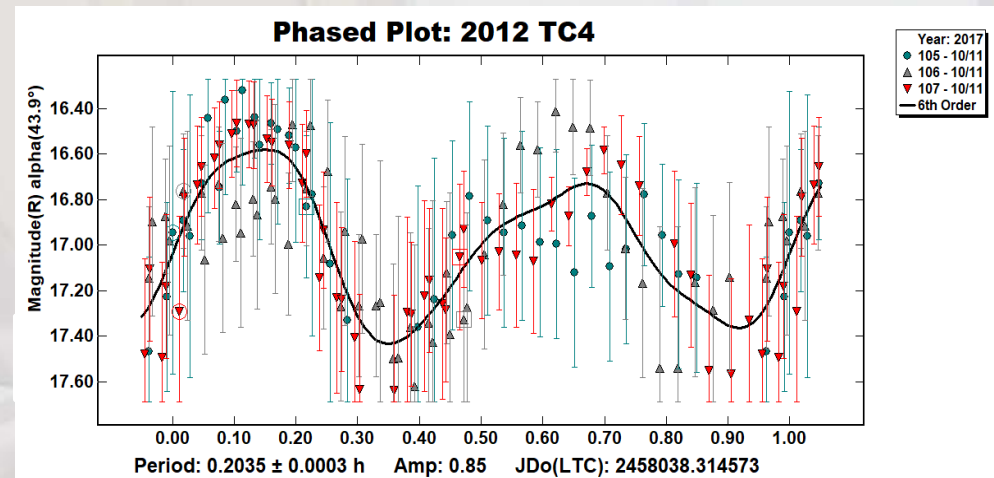
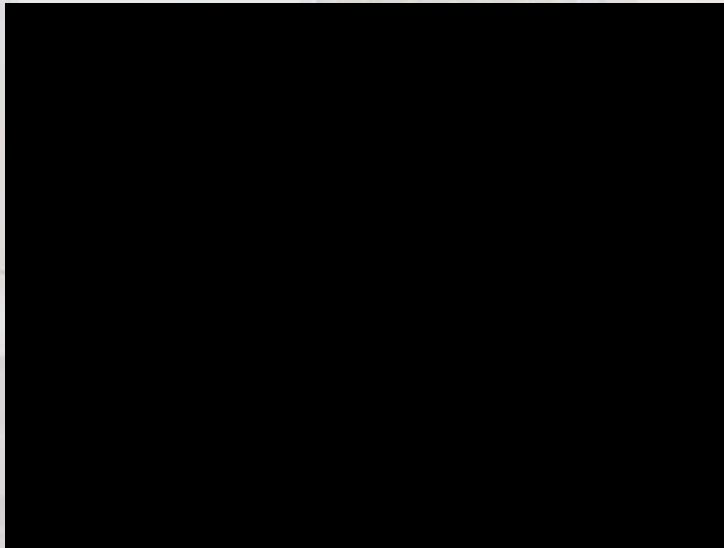
2012 TC4

- Graze the Earth at 50,151km in October 12, 2017
- Recovered in August 2017 by FORS2-VLT « the faintest NEA ever measured » ($m_{\text{app}}=27$)
- Observed in October 10 & 11, 2017 from Bucharest



2012 TC4 – Fast rotator

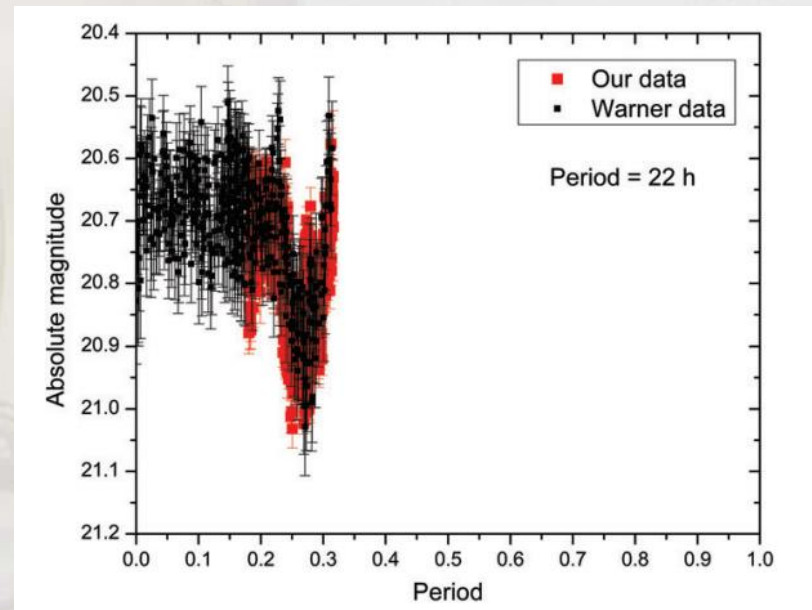
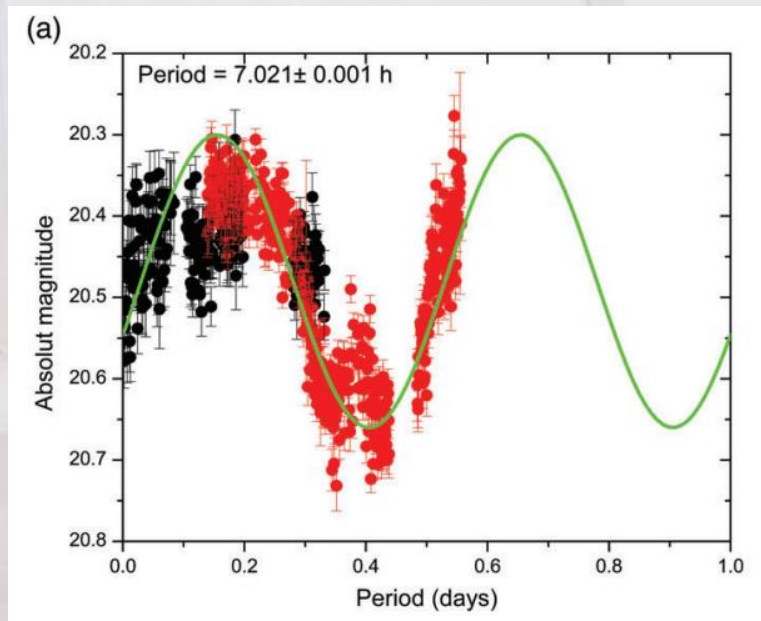
- $P_{\text{syn}} = 12.18 \text{ min}$ (compatible with the literature)
- $D = 17\text{-}26 \text{ meter}$ (albedo = 0.15)



Sonka et al RoAJ, 2017

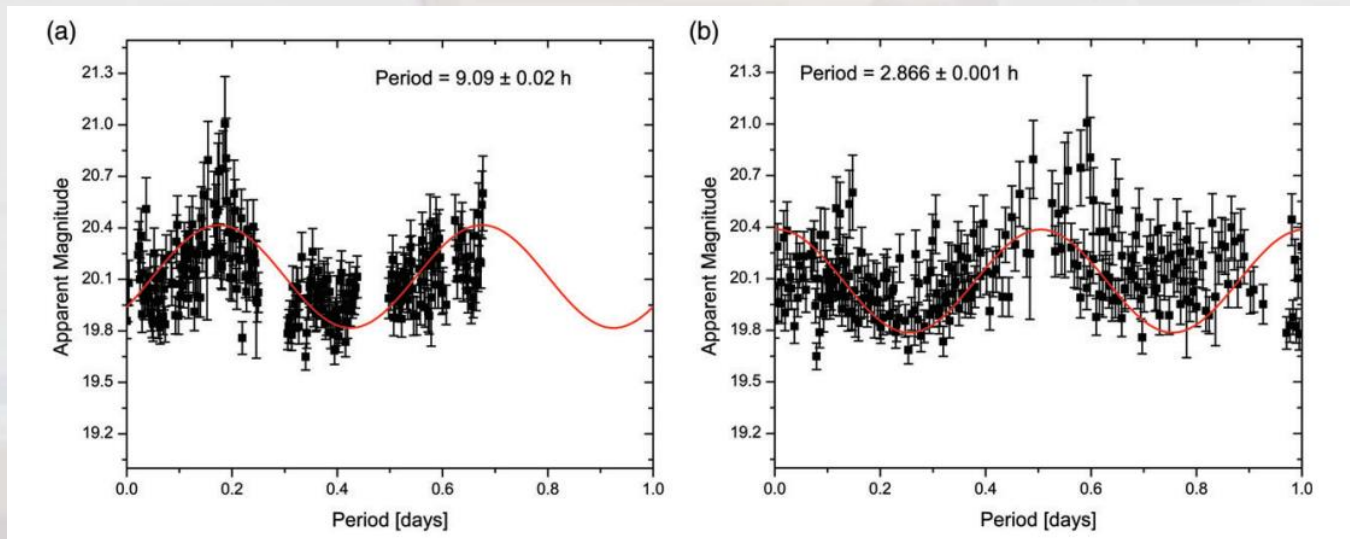
Colors and lightcurves from Pic du Midi

- (363599) 2004 FG₁₁ and the necessity of observations in network over longitudes

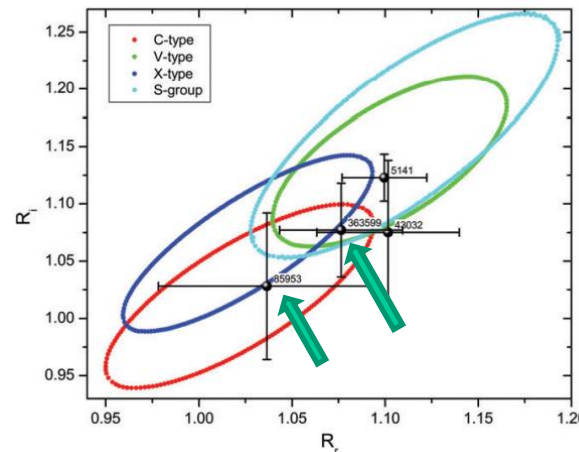


Colors and lightcurves from Pic du Midi

- (259221) 2003 BA₂₁

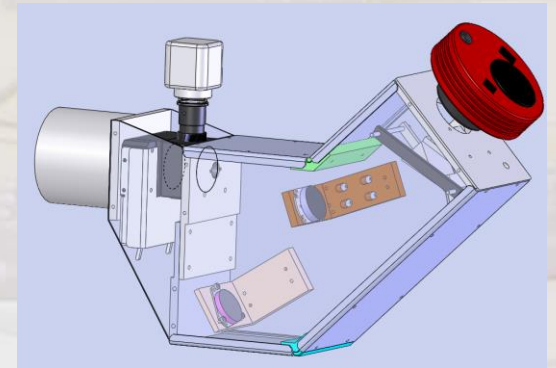
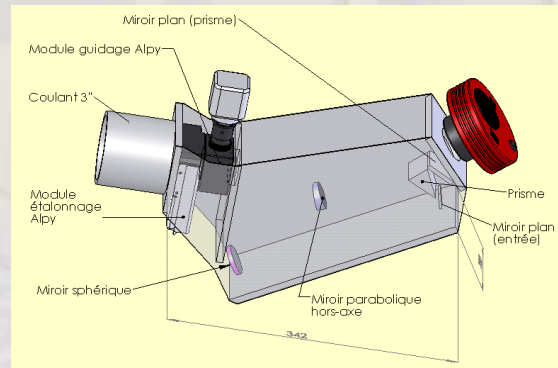
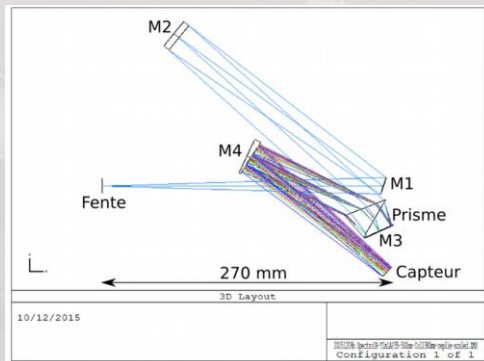


SDSS data
(g-r), (g-i)
plot



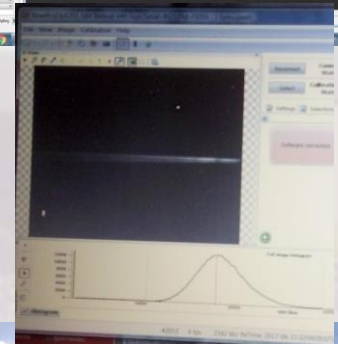
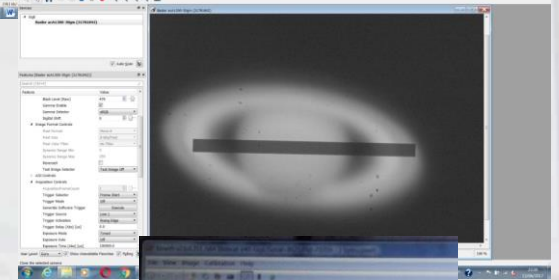
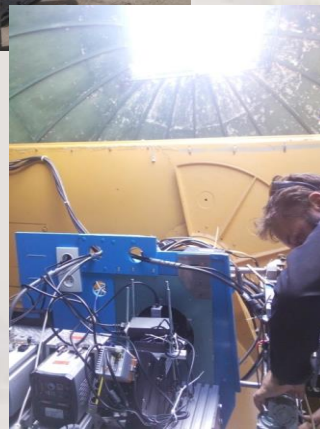
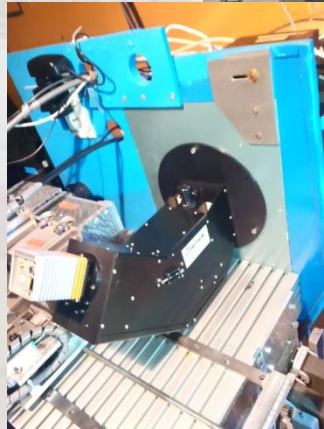
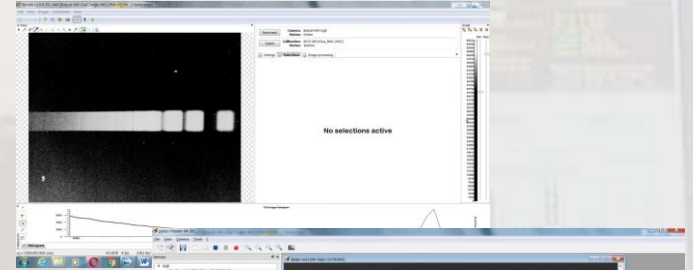
SOVAG- New facility for NEAs in Pic du Midi

- Spectrograph Visible + NIR (0.5-1.6 μm)
- Single order spectrum $R=100-280$
- Take profit of miniaturisation for hyperspectral cameras



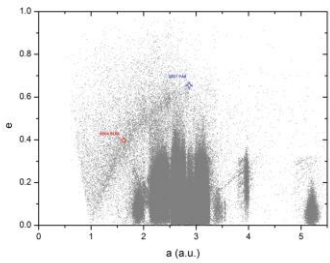
Laboratory and on-site calibration

Ne lamp



- First light - Fall 2018

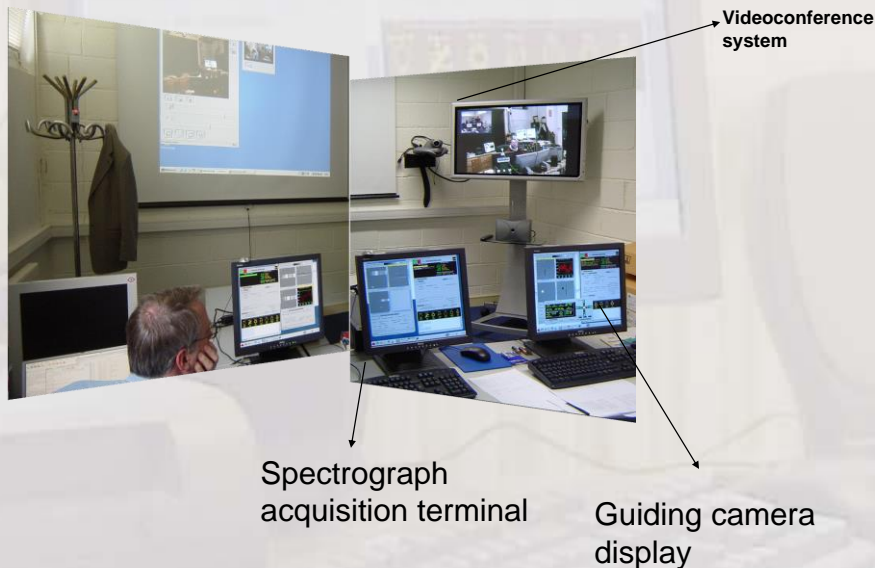
2004 BL86



- Grazed the Earth : Jan 26, 2015
- Distance: 1.2 million km.
- Discovered in 2004 (LINEAR program)
- Estimated diameter: 500m
- Arecibo radar : binary object

Physical properties

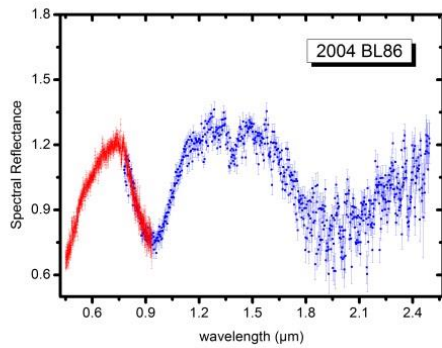
Usually observations using 3m diameter facilities: IRTF (Hawaii) & INT (Canarias Islands) operated remotely from Paris Observatory (CODAM) or Bucharest-Astronomical Institute (ROC).



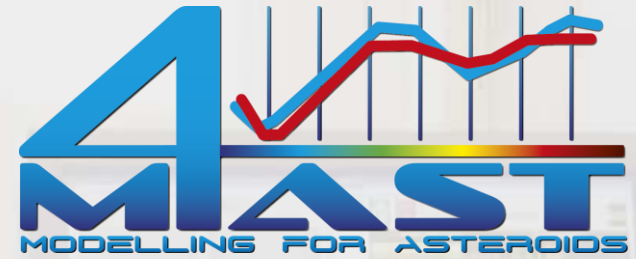
CODAM



ROC



2004 BL86 Analysis

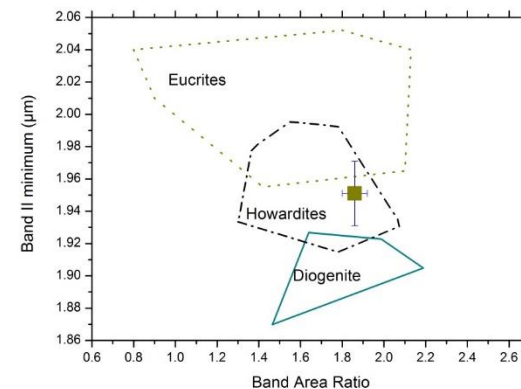
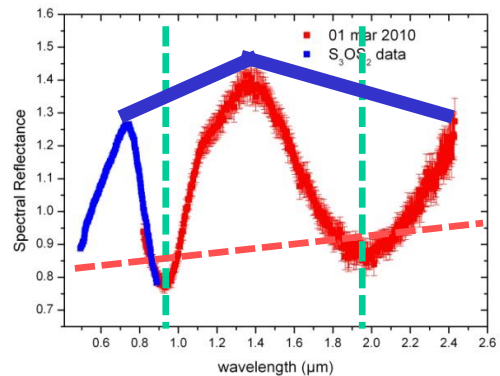


Runs in Feb 6 & 7, 2015, first spectrum of this PHA (INT/Vis + IRTF/Nir)

- BL86 is V-type asteroid

Mineralogical analysis: 2004 BL86 has a basaltic mineralogy

Thermal albedo of BL86 help in deriving a diameter of 290 ± 20 m.



Next favorable observation of 2004 BL86 in 2050!

(Birlan et al, A&A, 2015)

Asteroid Event of the Decade –

A “close shave” 5 times larger than the Tunguska body.
100 times more massive.

Slides From Richard Binzel (MIT)

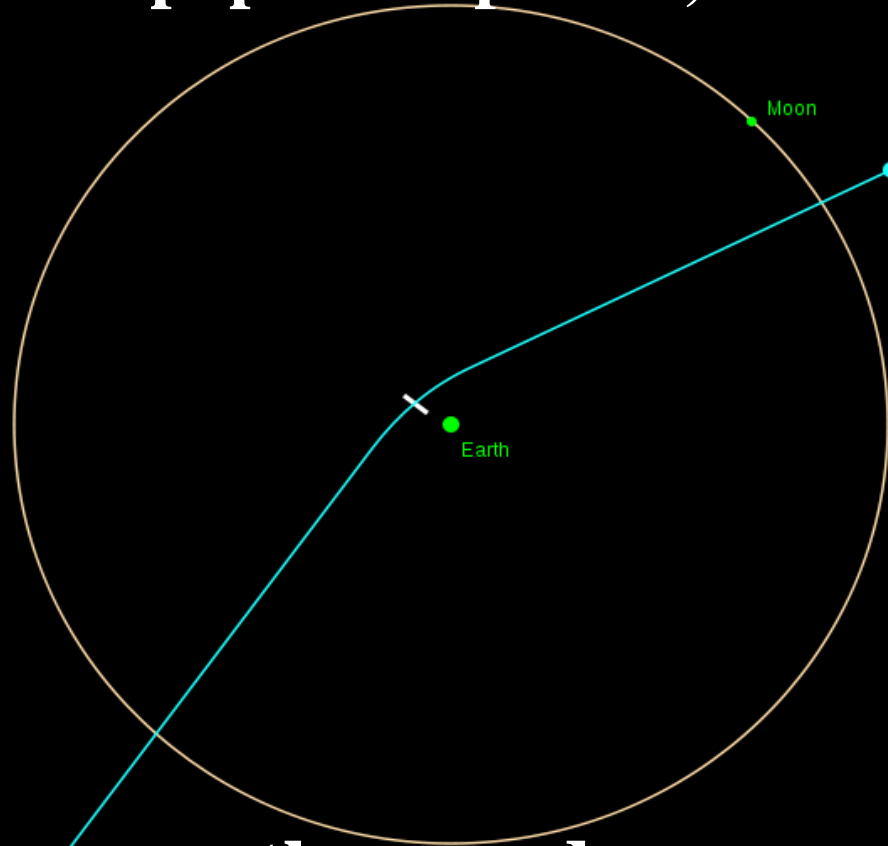


Credit: M. Birlian (IMCCE, Paris)

Asteroid Event of the Decade –

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Apophis: April 13, 2029

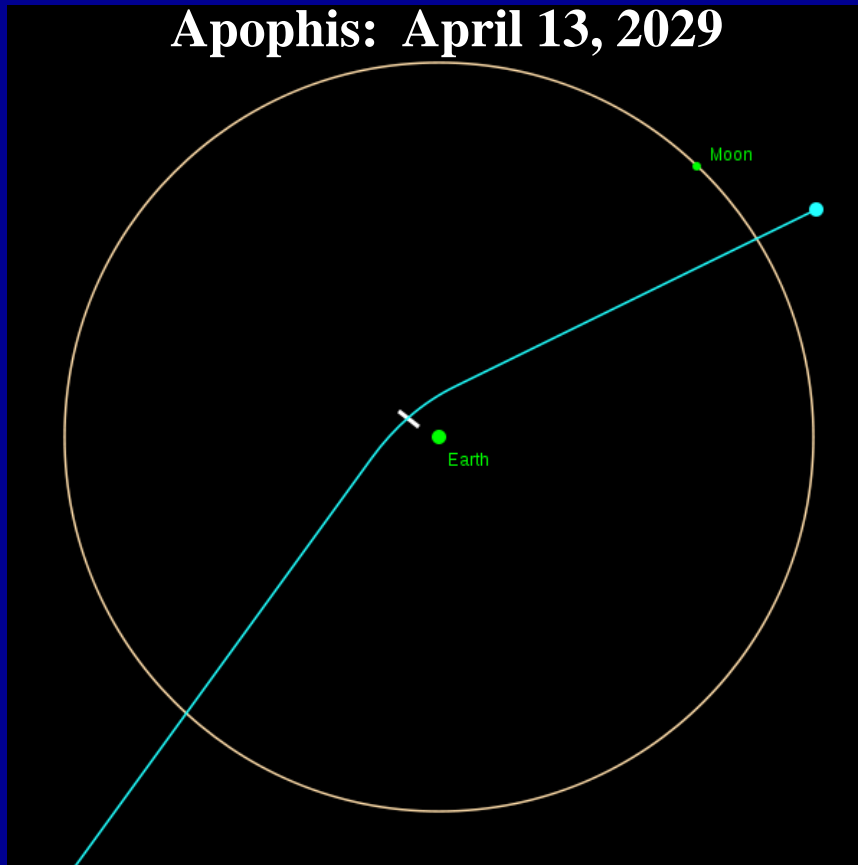


**Once per thousand year event:
350m asteroid within 6 Earth-radii**

Slides From Richard Binzel (MIT)

Credit: P. Chodas (JPL)

Decadal opportunity for science and for informing Planetary Defense.



Encounter will alter Apophis' orbit and spin, but other physical effects are less sure.

Scheeres et al. (2005)



Itokawa landslides

Miyamoto et al. (2007)

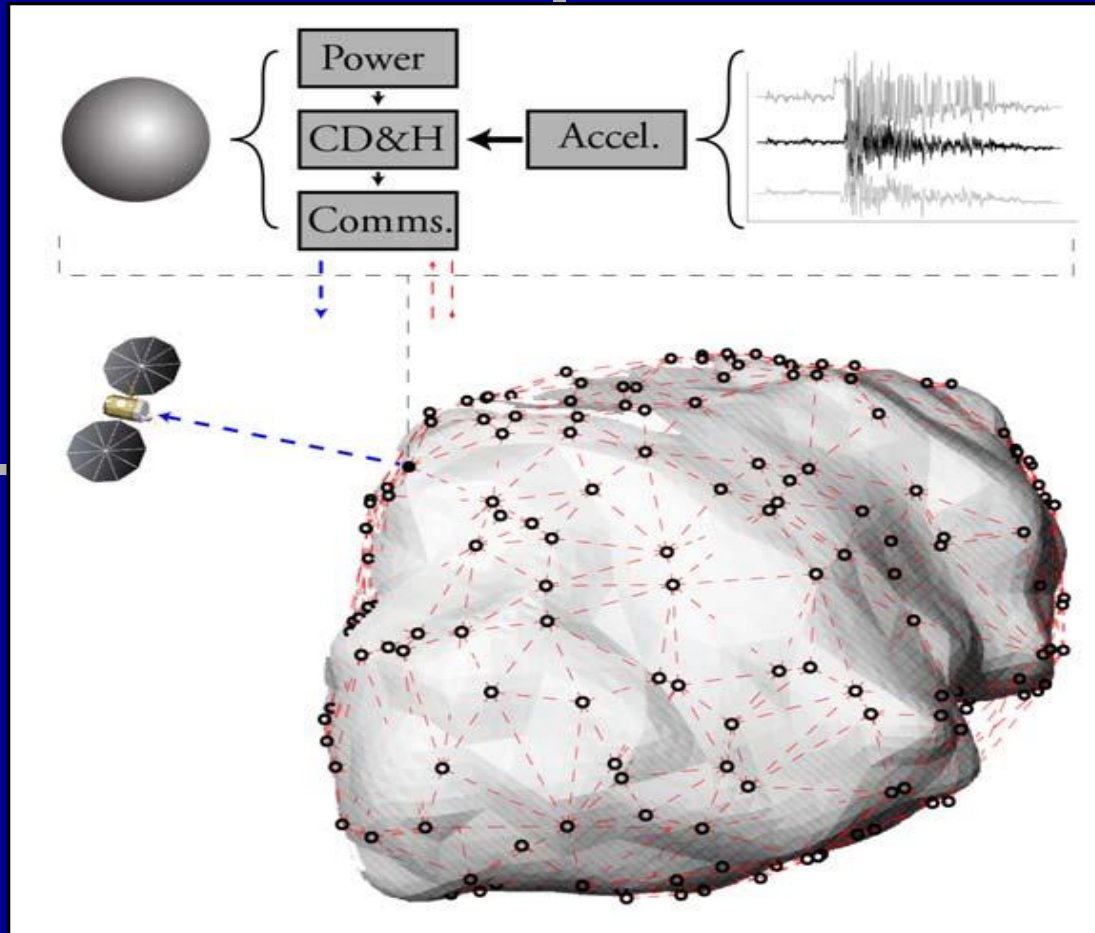


“Fresh” resurfacing?

Binzel et al. (2010);

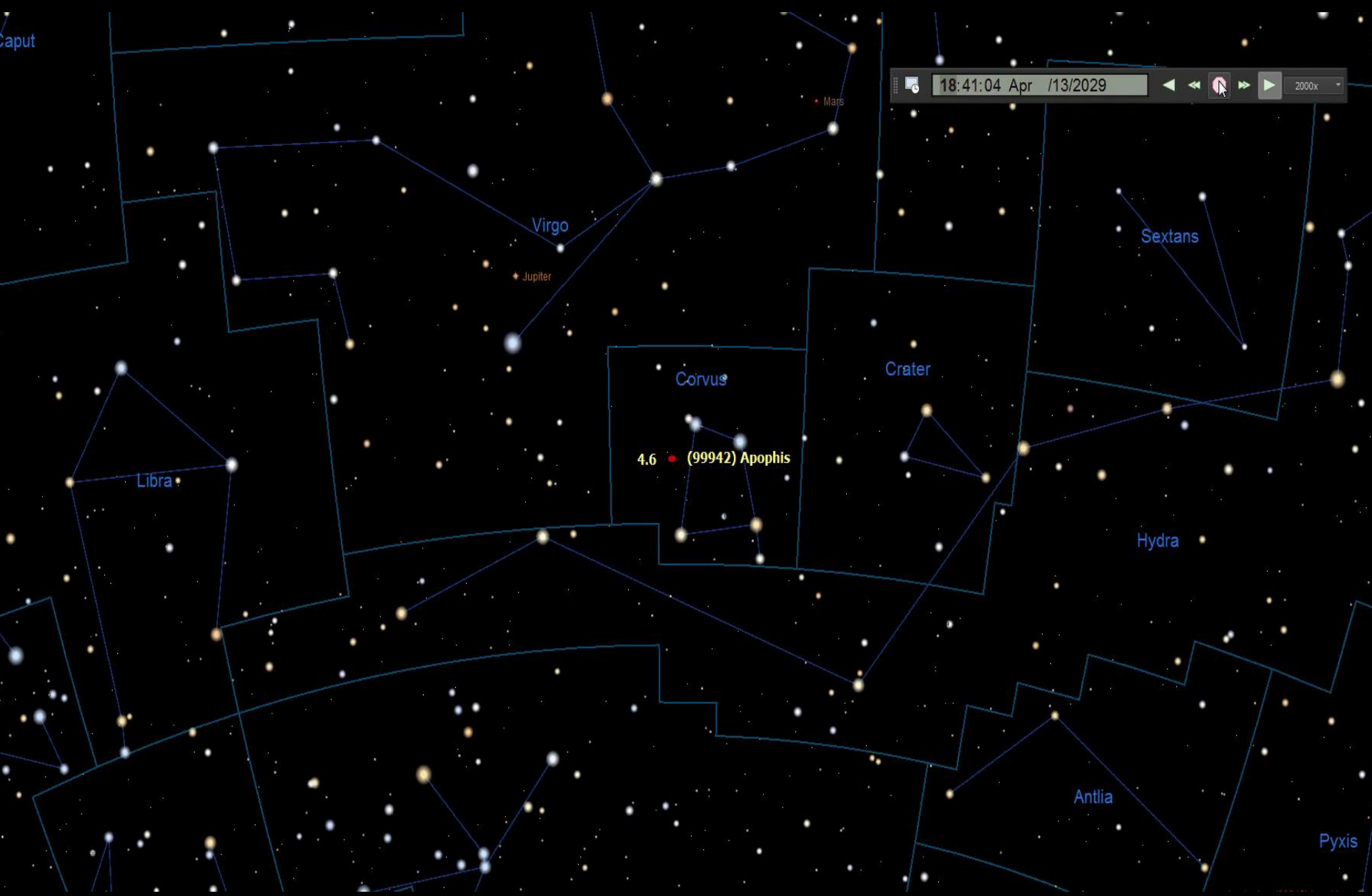
Nesvorny et al. (2005; 2010)

Decadal opportunity for mapping the *interior structure* of a Potentially Hazardous Asteroid.



MIT "Project Apophis" concept study (2017).

The World Will be Watching “What will the science community be doing?”



Apophis over Paris: April 13, 2029 Animation by Brian Warner