The case of APOPHIS

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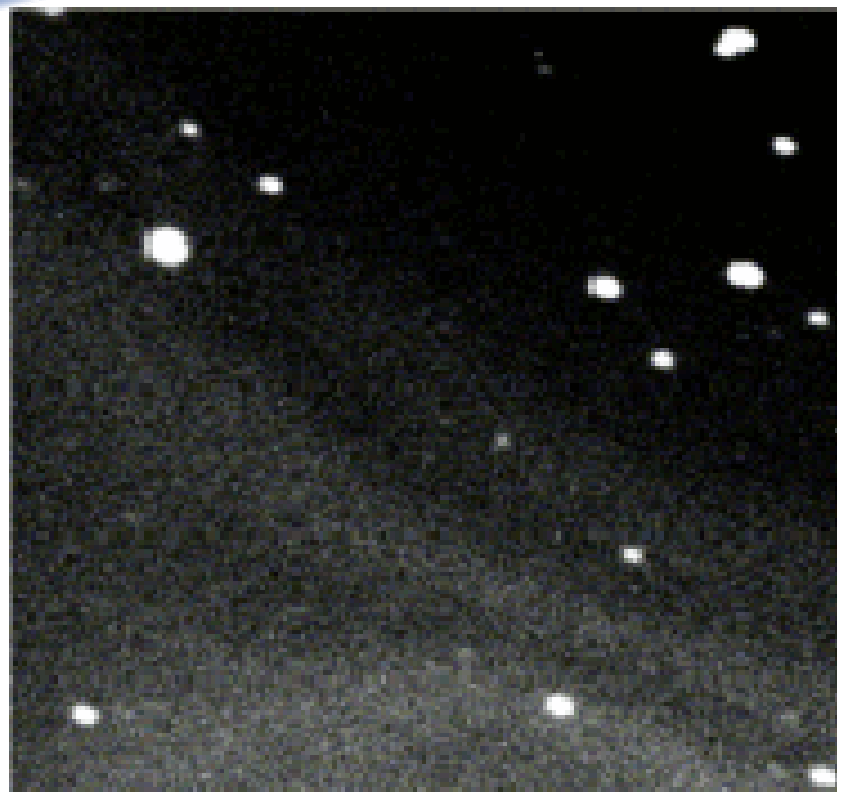
APOPHIS

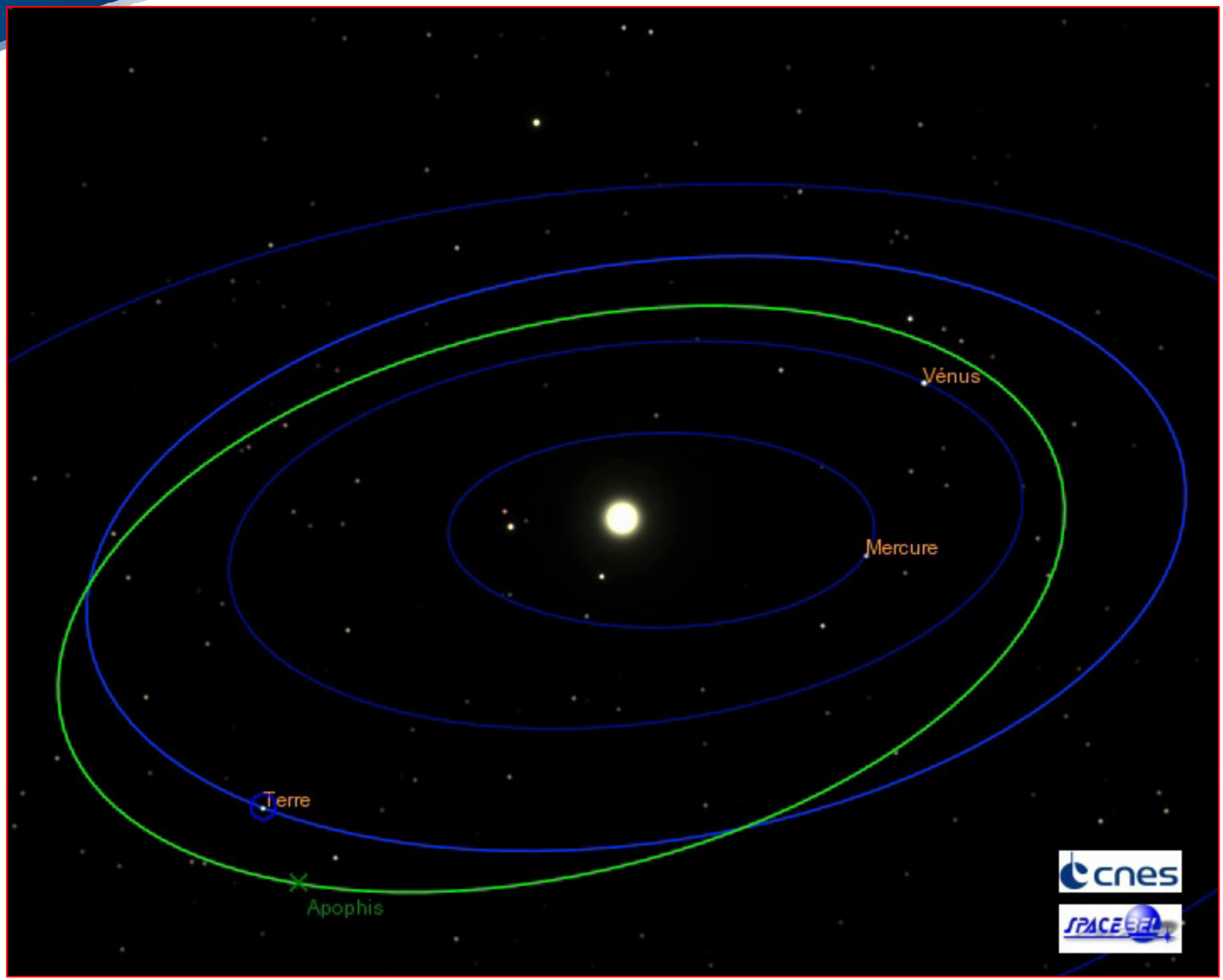


Discovery	
Discovered by:	Roy A. Tucker, David J. Tholen, Fabrizio Bernardi
Discovery date:	June 19, 2004
Orbital characteristics	
Aphelion distance:	1.099 AU
Perihelion distance:	0.746 AU
Orbital period:	323.6 d (0.89 year)
Inclination:	3.331°
Physical characteristics	
Dimensions:	~250 m (estimated)
Mass:	2×10^{10} kg (estimated)
Rotation period ~30h	

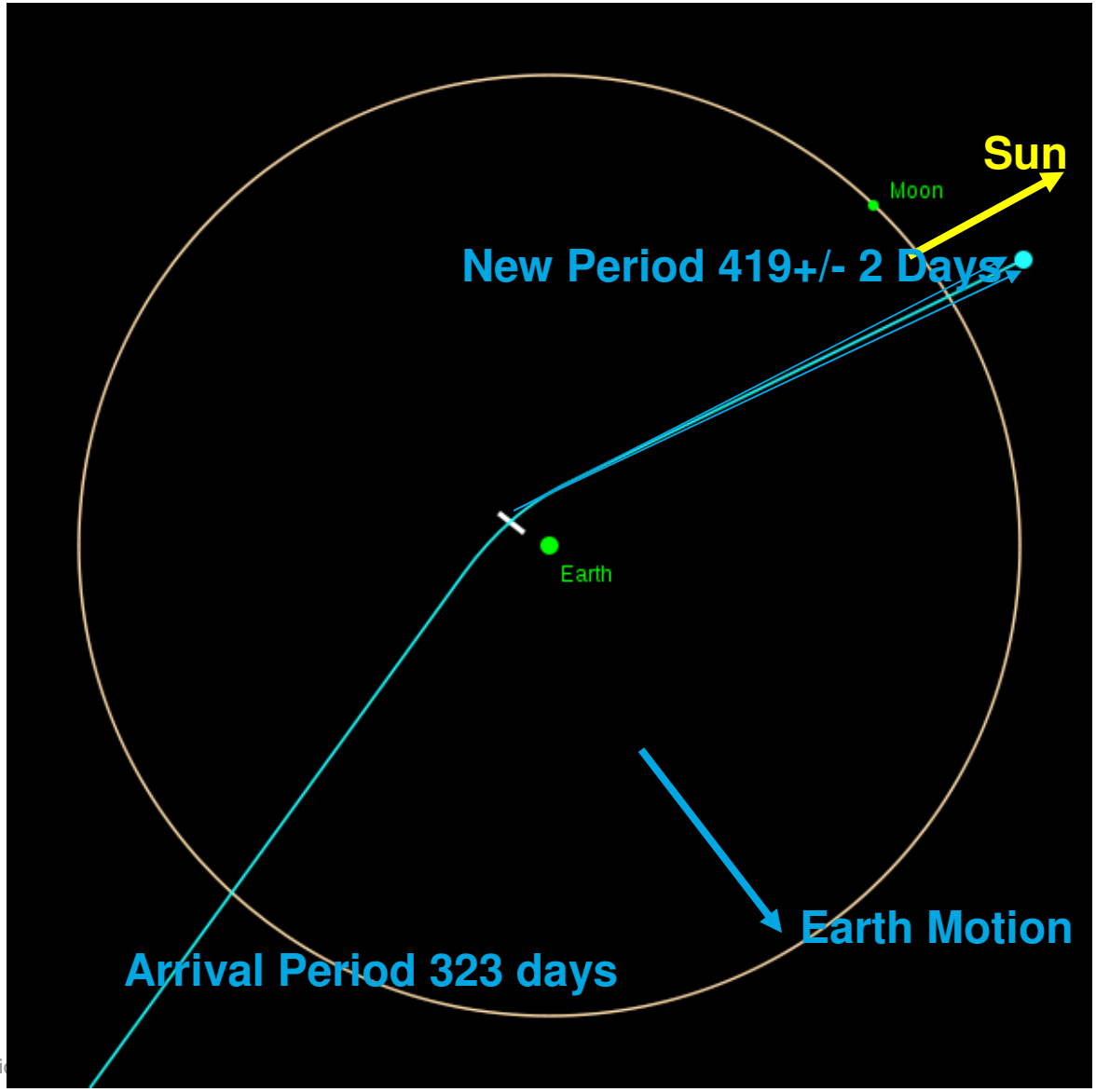
Mass of APOPHIS ~ 200 x

@V=44,000 km/h

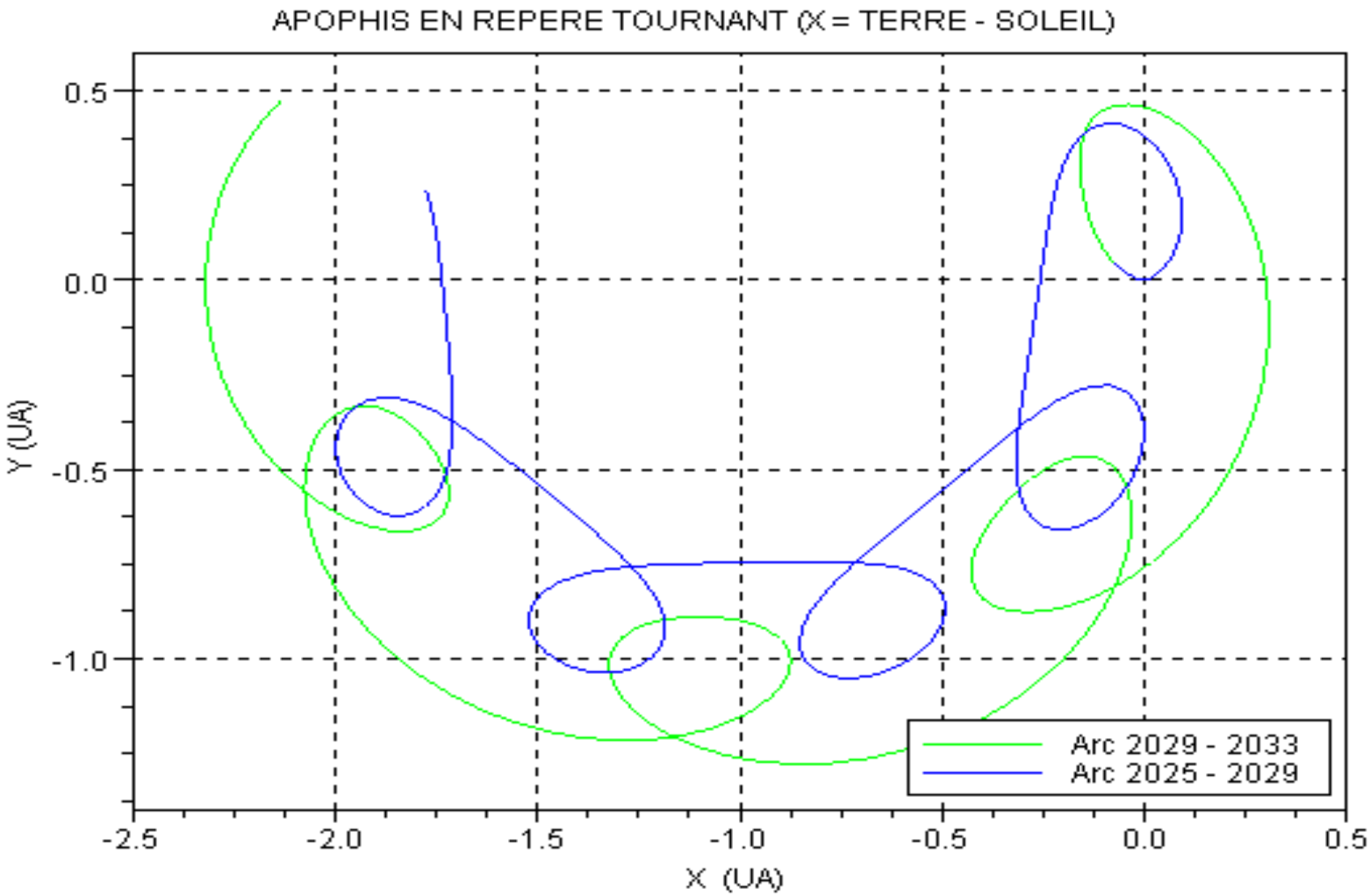
APOPHIS trajectory around the Sun



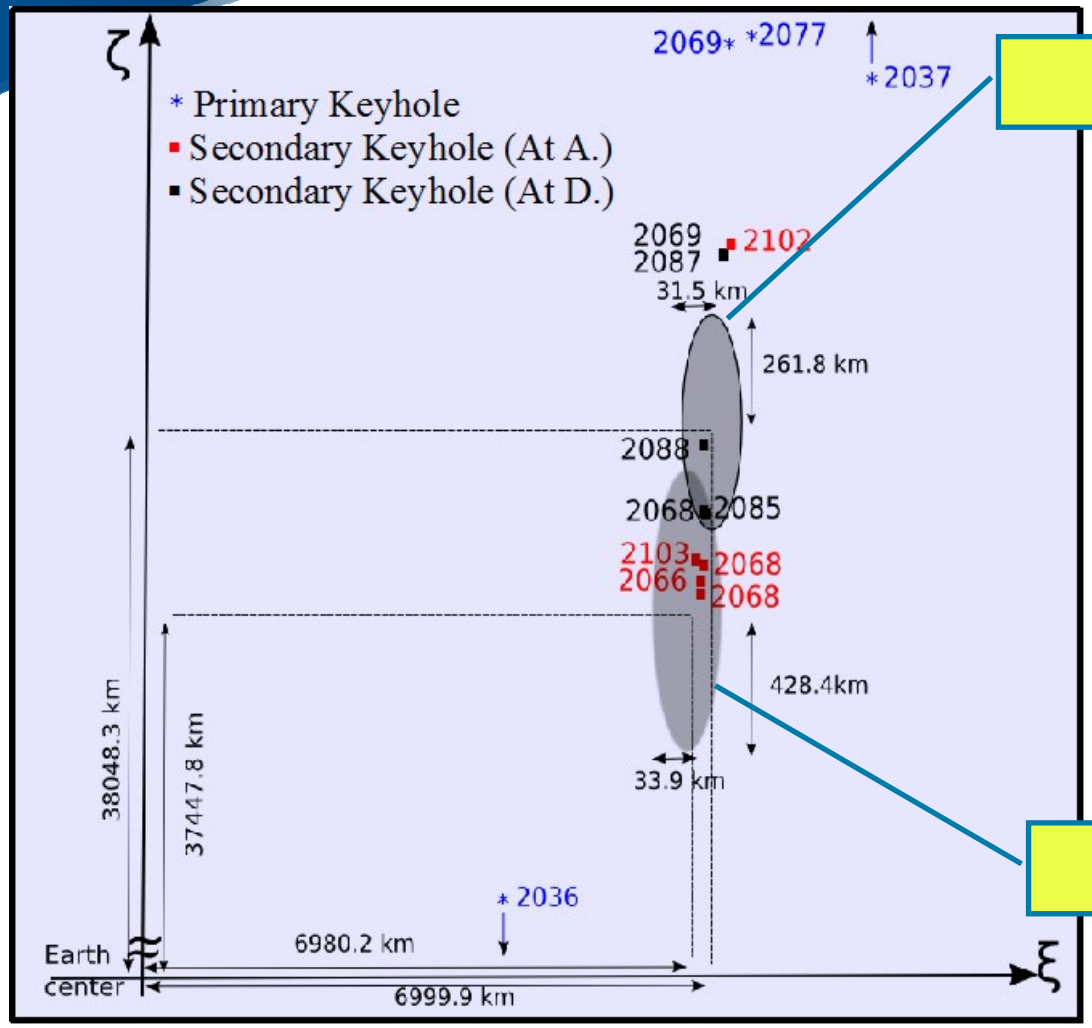
APOPHIS Flyby of the Earth on April 13, 2029



APOPHIS trajectory seen from the Earth



Update of the 2029 approach



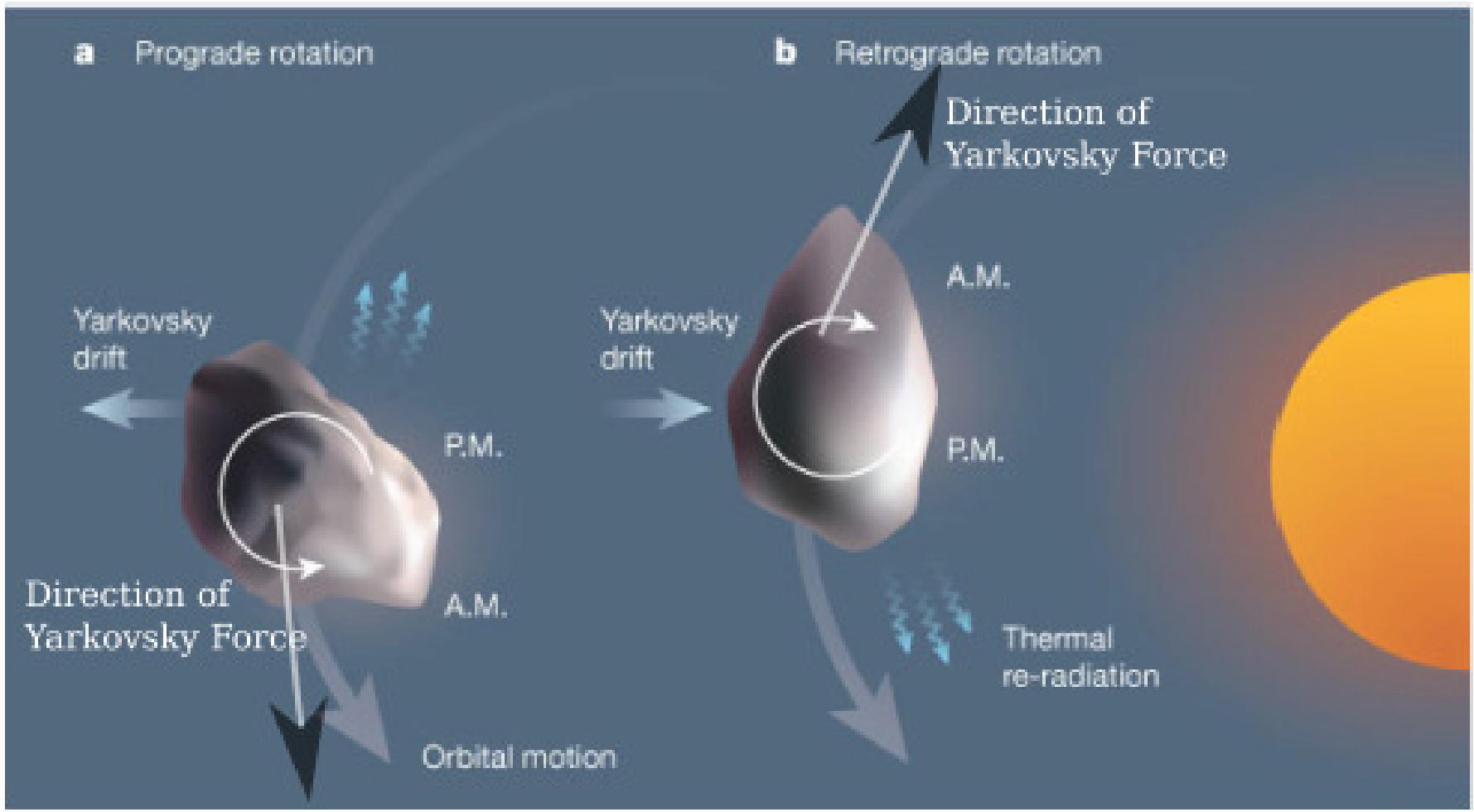
With the 2011 observations

Without the 2011 observations

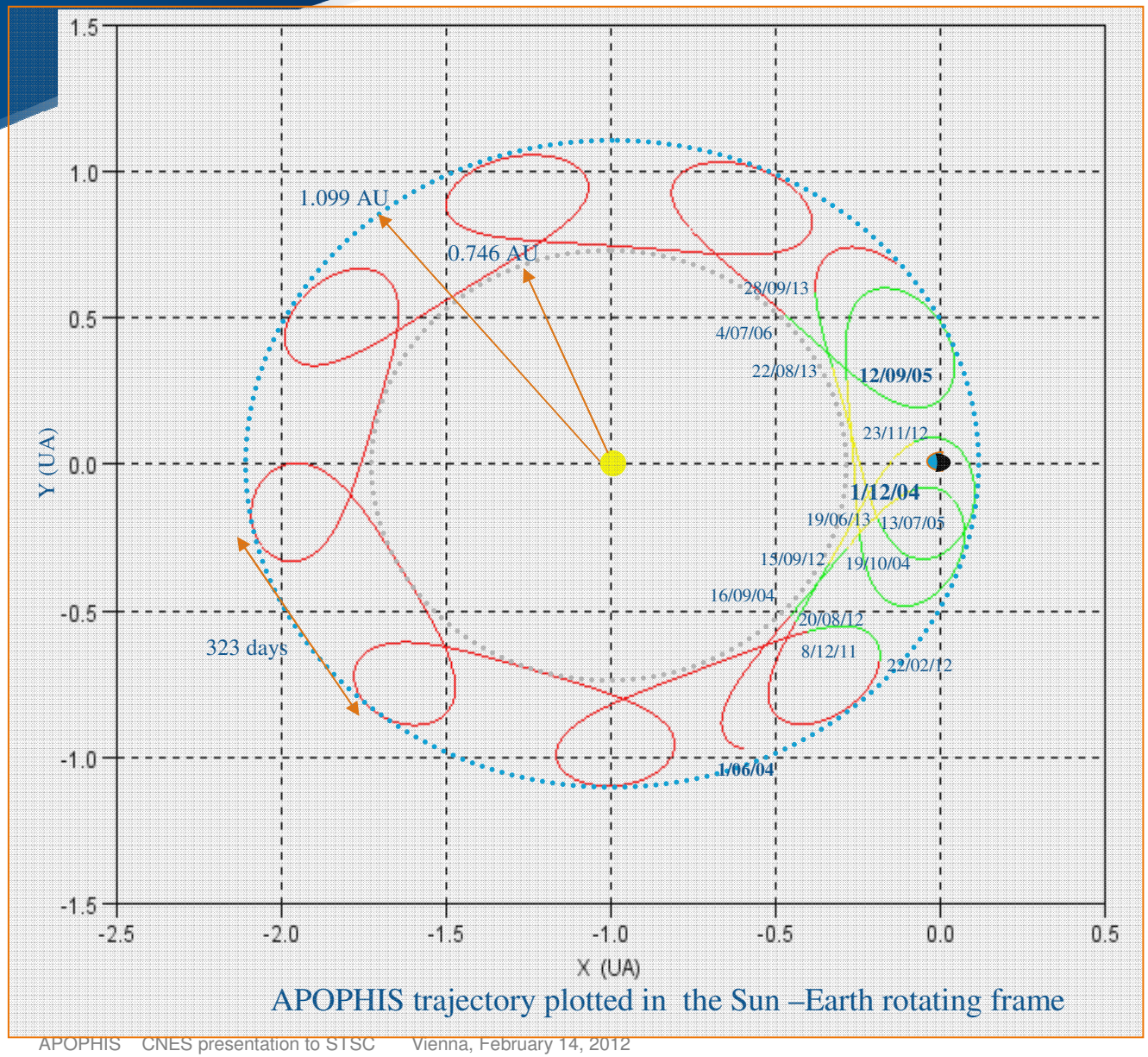
- Zoom on the closest primary and secondary keyholes in the 2029 b-plane
- 3σ uncertainty ellipses in ξ and ζ on the 2029 b-plane.

From David Bancelin PhD thesis

The Yarkovsky Effect



Observation possibilities for the 2004-2013 time frame



APOPHIS trajectory plotted in the Sun –Earth rotating frame

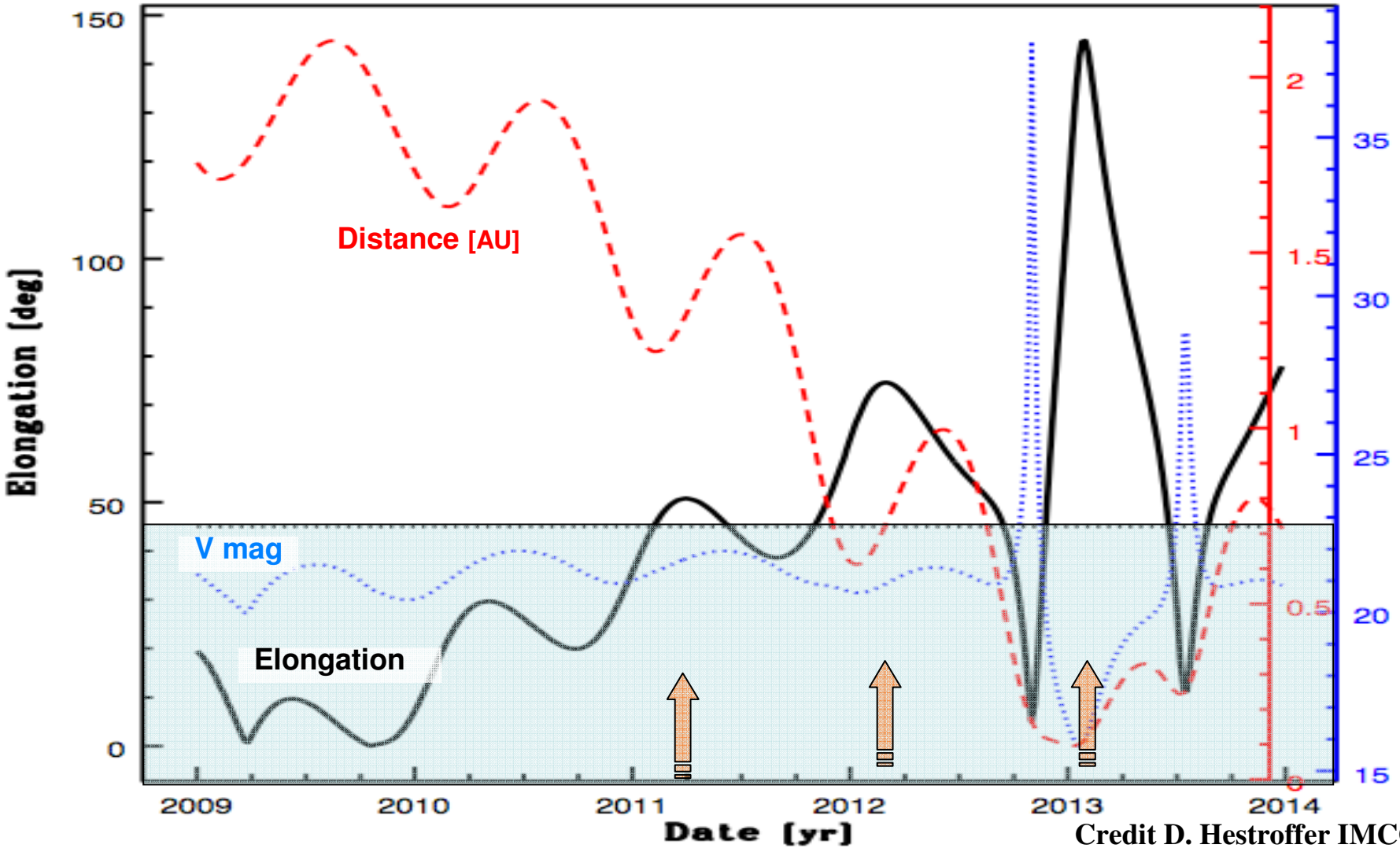
Not visible from the Earth

Distance < 0.7 AU
but solar elongation <45°

Visible from the Earth

Dates format day/month/year

APOPHIS visibility



Credit D. Hestroffer IMCCE

Needs for a tracking campaign in the 2012-2013 time frame

- There will be many ground-based observations of Apophis in the 2012-2013 time frame
- The assessment of impact risk for the future will change with time,
  - new observations coming,
  - better estimates of non-gravitational forces (Yarkovsky Effect) being calculated
- The medias and the general public can be disoriented and skeptical towards official announcements

if conflicting previsions are released

- Needs to harmonize for releasing informations towards the public
  - reference frames
  - graphic presentation of the results in an easy to understand manner
  - cross-checking of the previsions for the 2029 fly-by and the possible subsequent close returns

Mission objectives

- characterization of the internal structure of the asteroid for
  - scientific objectives: formation mechanisms of small bodies
  - mitigation objectives : porosity, structural homogeneity

- take benefit from the external sollicitations by the Earth gravitational field in the perigee area
  - tide phenomena
  - internal response to the gravitational gradient

- strawman payload under investigation
  - a network of seismometers/gravimeters
  - radio tomography (inherited from ROSETTA/CONSERT)
  - IR and visible remote sensing

Conclusions

- Coordinated ephemerides improvement is of paramount importance to release publicly coherent estimations concerning Apophis swingby for 2029
- Also mandatory for assessing the impact risk for the future
- Apophis is an affordable target for space missions
- One or more missions to Apophis, dedicated to science and mitigation investigations, could be planned in a collaborative and complementary way under an Interagency Group similarly to what has been done for the Halley comet in the 80's