Characterization of Near-Earth Asteroid 153814 (2001 WN5) and Prospects for the 2028 Close Encounter with Earth

Patrick A. Taylor[1] (ptaylor@usra.edu)

E.L. Wright[2], J.R. Masiero[3], A.K. Virkki[4], F.C.F. Venditti[4], S.E. Marshall[4], D.C. Hickson[4], L.F. Zambrano-Marin[4], T.M. Becker[5], M.C. Nolan[6], and J.D. Giorgini[7]

[1]Lunar and Planetary Institute, USRA, [2]UCLA, [3]Caltech/IPAC, [4]Arecibo Observatory, UCF, [5]SWRI, [6]U. Arizona, [7]JPL/Caltech

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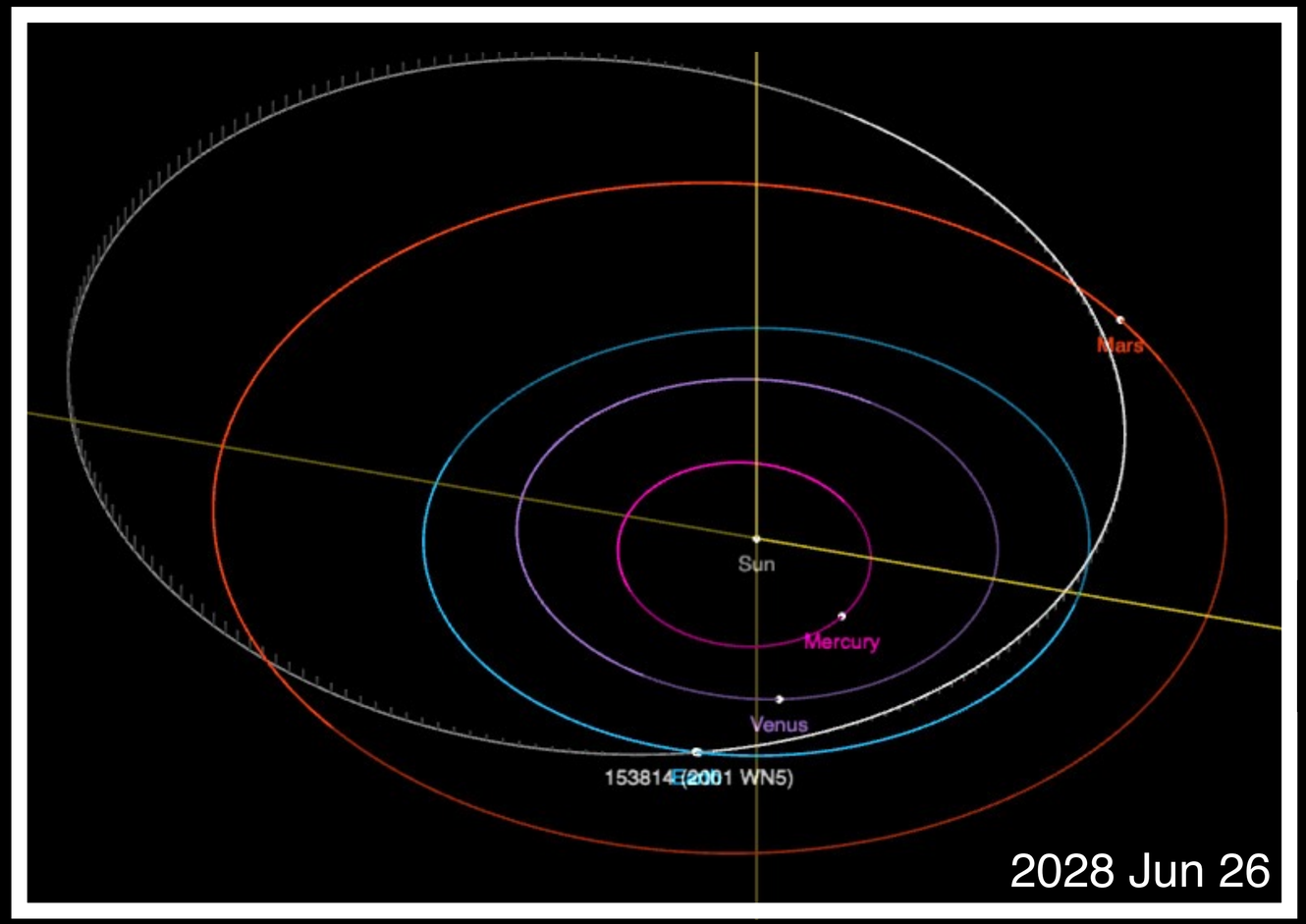
Near-Earth Asteroid 153814 (2001 WN5)

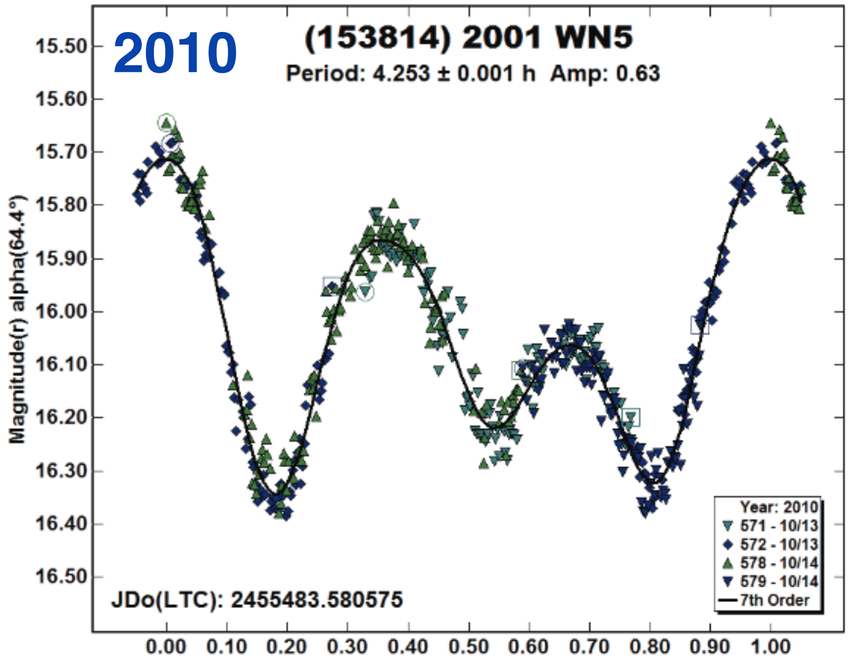
- Discovered by LONEOS on 2001 November 20 with precoveries back to 1996 by Spacewatch
- Designated potentially hazardous to Earth based on H = 18.33 and MOID of <0.002 au (<1 LD)
- Removed from the JPL SENTRY list ~6 weeks after discovery
- Orbit well known, *U* = 0, data arc spans 25 years and 11 solar orbits
- Makes approaches to Earth every ~9 years, <1 LD on 2028 June 26

a = 1.71, *e* = 0.47, *i* = 1.9 deg

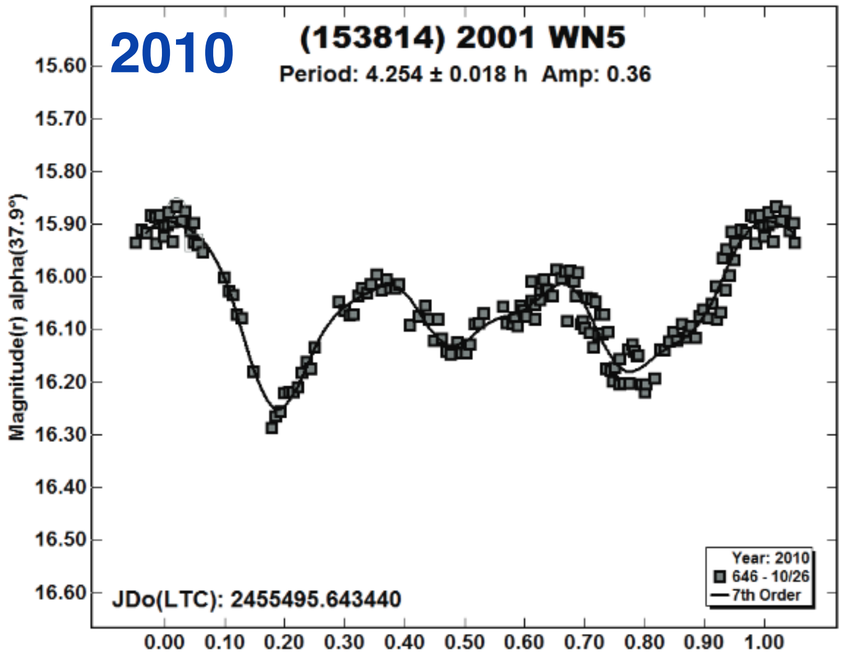


Orbit diagram from the JPL Small Body Database

Previous Optical Observations



Skiff et al. (2019)



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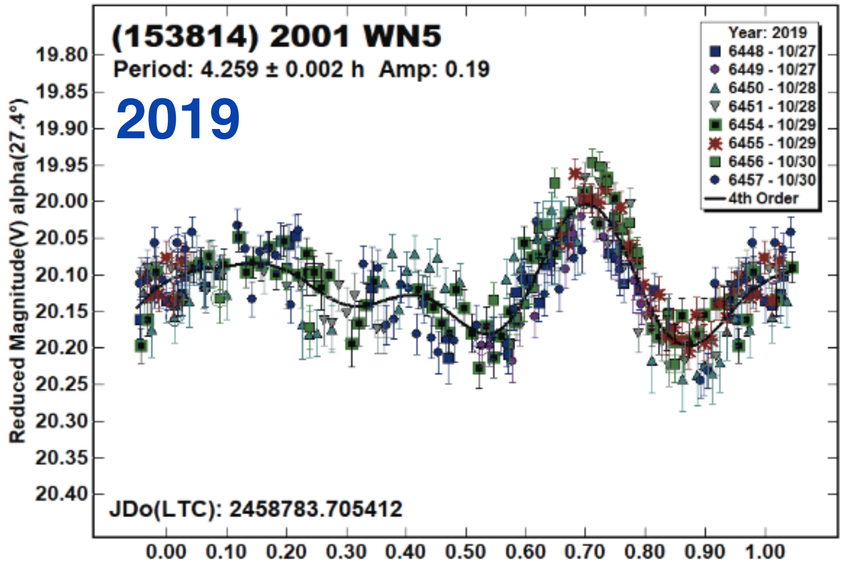

Warner et al. (2020)

Trimodal lightcurve, P = 4.25 h, high amplitude at high phase angle

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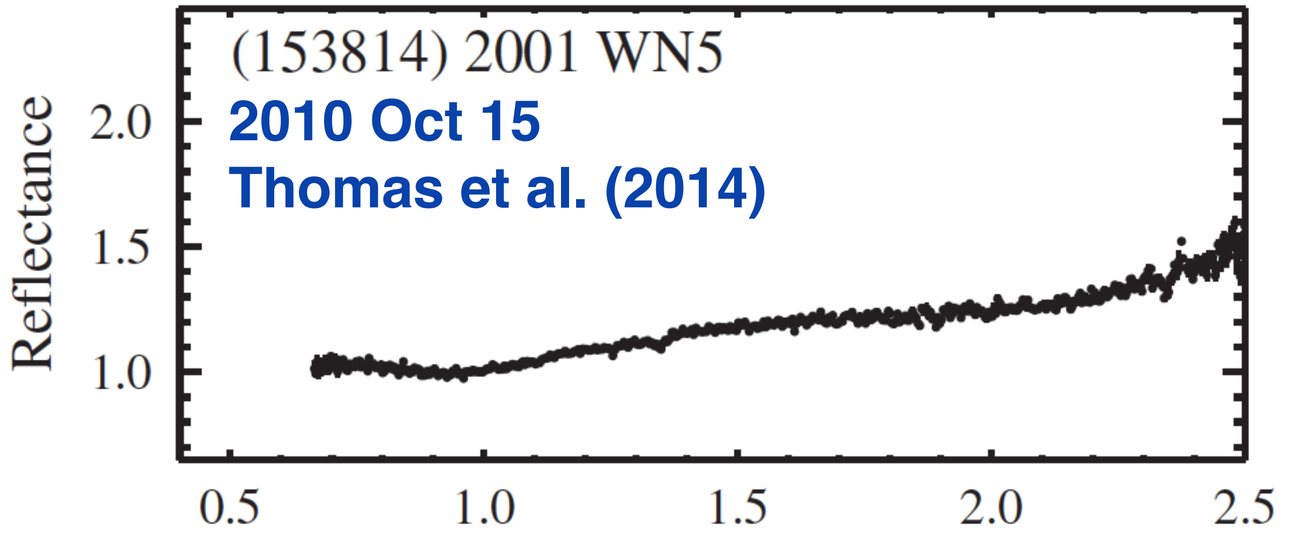
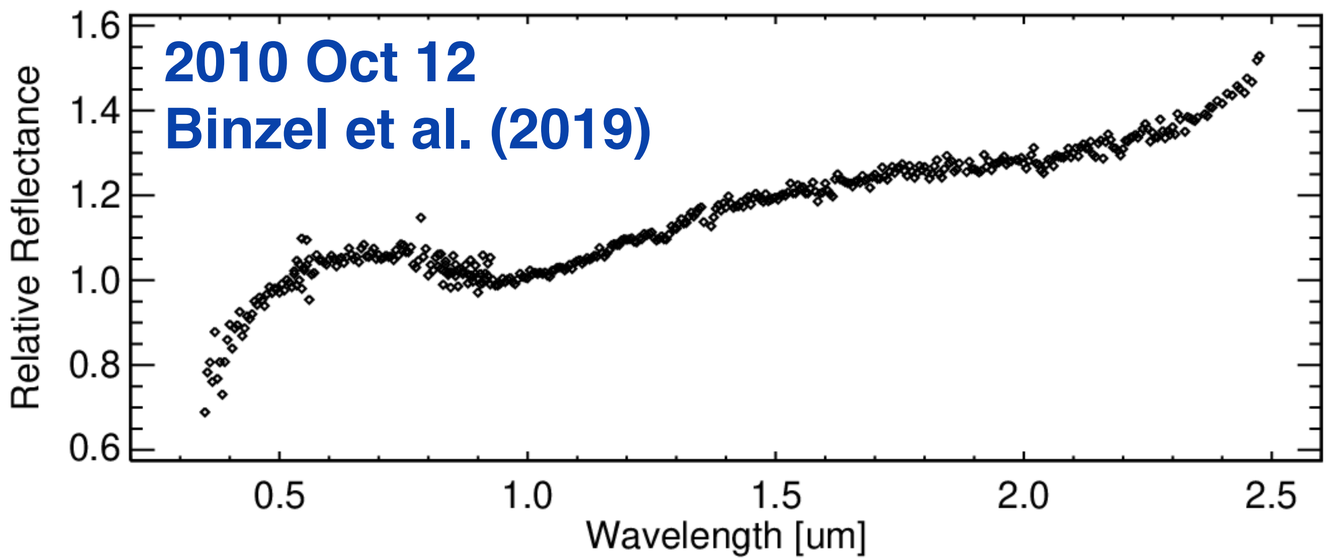
Previous Infrared Observations

- **NASA IRTF:** 3 m, SpeX instrument
- **Thomas et al. (2014):** relatively featureless, red sloped, described as "**K/L/Sq** Indeterminate"
- **Binzel et al. (2019):** sharp increase to 0.7 um, shallow ~1 um feature, red sloped, categorized as an **L-type** asteroid





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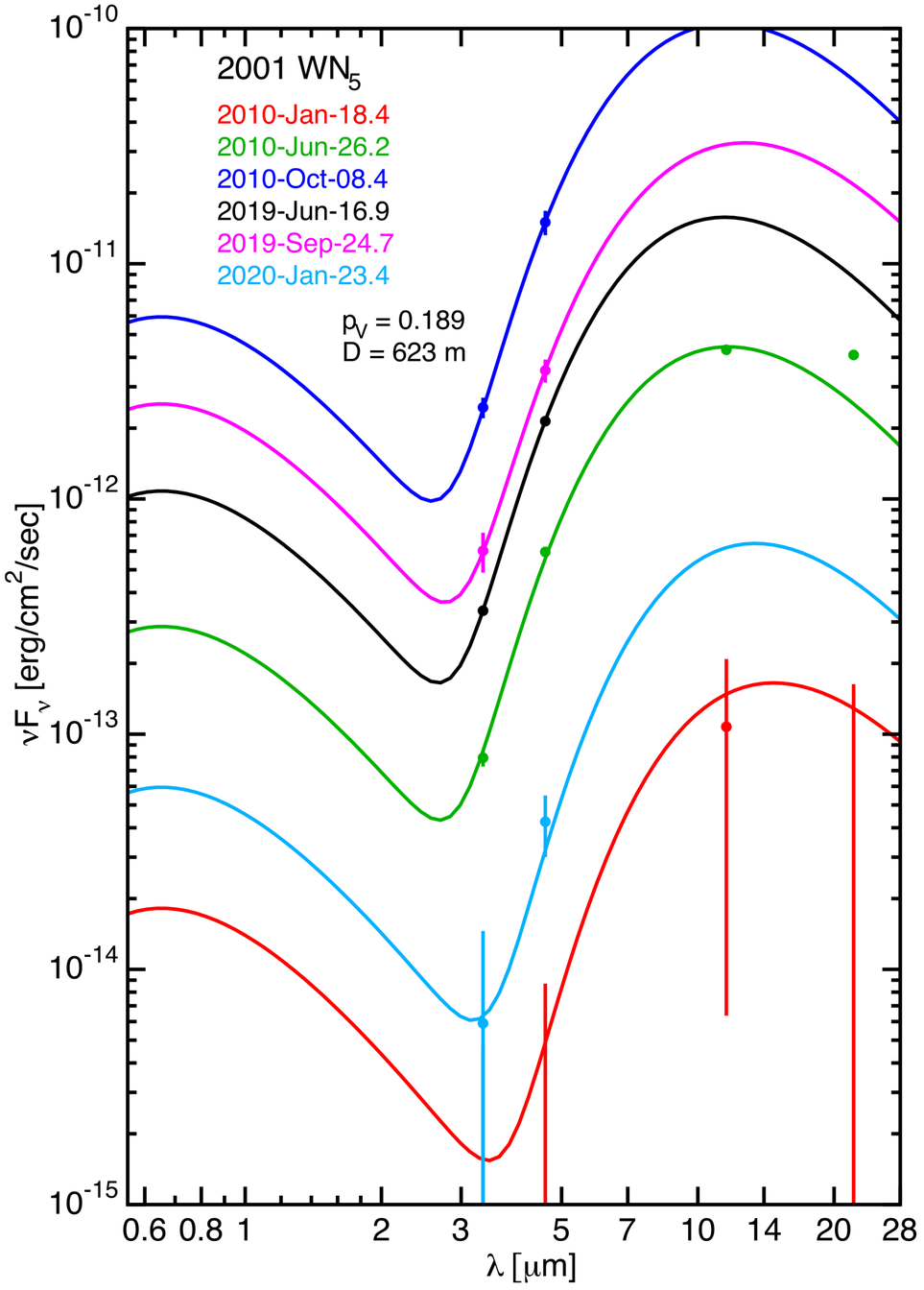
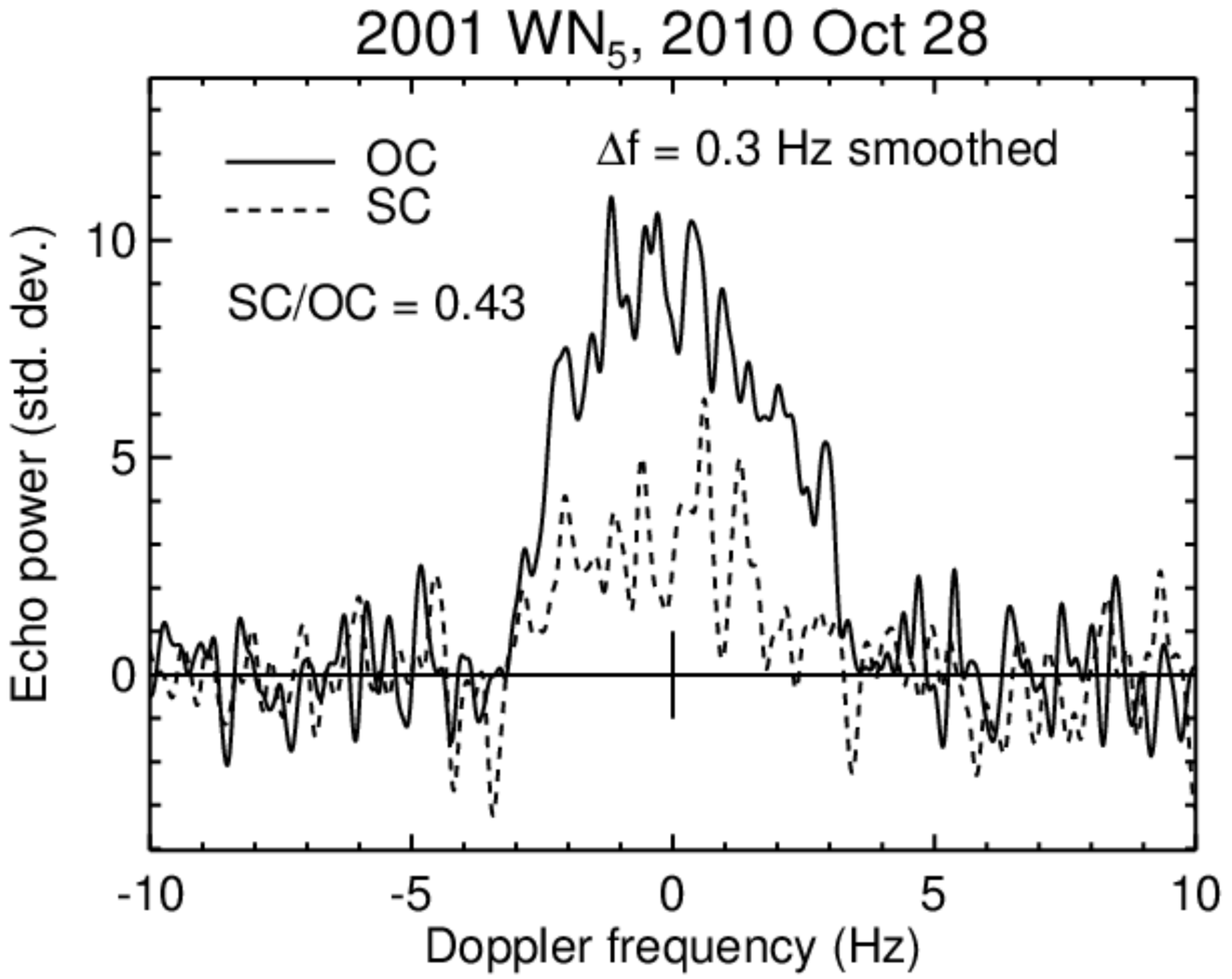
NEOWISE Observations

- **Seven epochs** from 2010 through 2020 covering phase angles from 27 to 112 deg
- **Mainzer et al. (2011):** NEATM fit to the best cryogenic data (**green**) found a **diameter of 932 +/- 11 m** and an **albedo of 9.7 +/- 1.6%**
- **NEATM** fit to the 2019 Sep 24 data (**magenta**) found a **diameter of 940 +/- 340 m** and a similar albedo
- A **thermophysical model** fit to an ensemble of six epochs found a much smaller **diameter of 623 m** and an **albedo of 19%**
- Understanding these discrepancies is under investigation; note that these modeling approaches **assume spherical shapes**



Radar Observations

- Observed by **Arecibo** during the 2010 and 2019 apparitions
- **Bandwidth** ~ 6 to 7 Hz, corresponding to a diameter of **~1 km or larger**
- **Radar albedo** ~ 10%, *i.e.*, not metallic
- **Polarization ratio** ~ 0.4, elevated for S complex, but not unusual
- **No evidence for satellites**
- **Astrometry:** <25 km range corrections
- **Yarkovsky drift:** (38.8 +/- 9.3) x 10^{-4} au/My from Greenberg et al. (2020)



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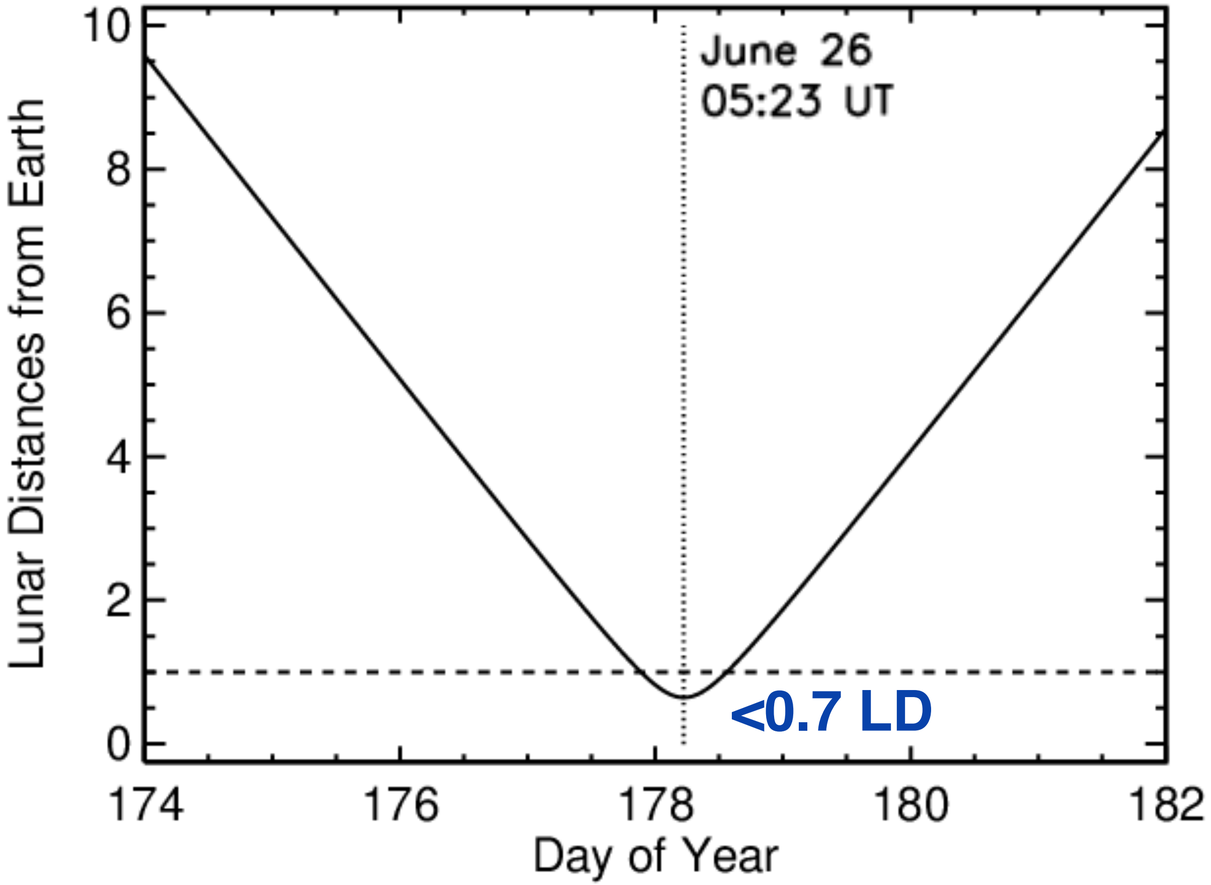
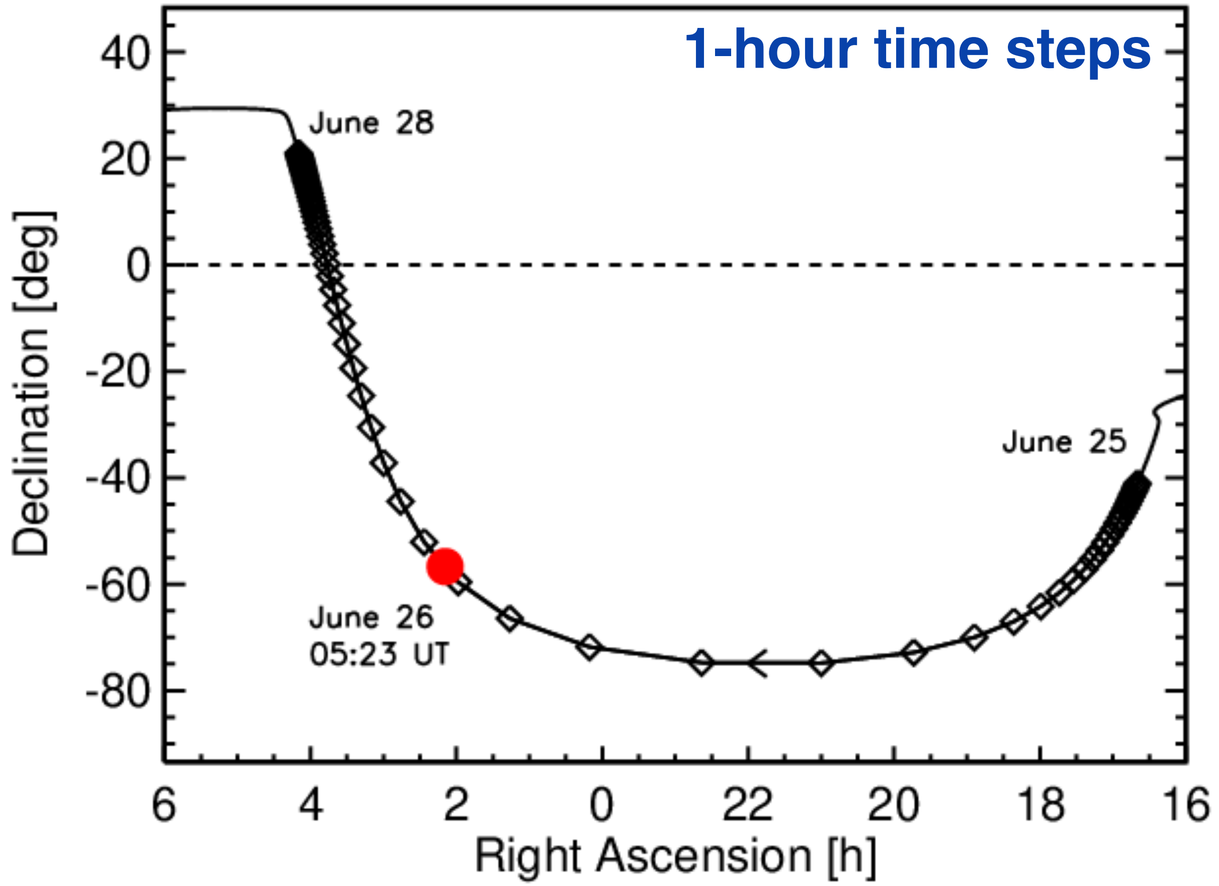
2019 Aug 21: 75 m x 0.24 Hz


2019 Aug 24: 75 m x 0.24 Hz

Observing Circumstances in 2028





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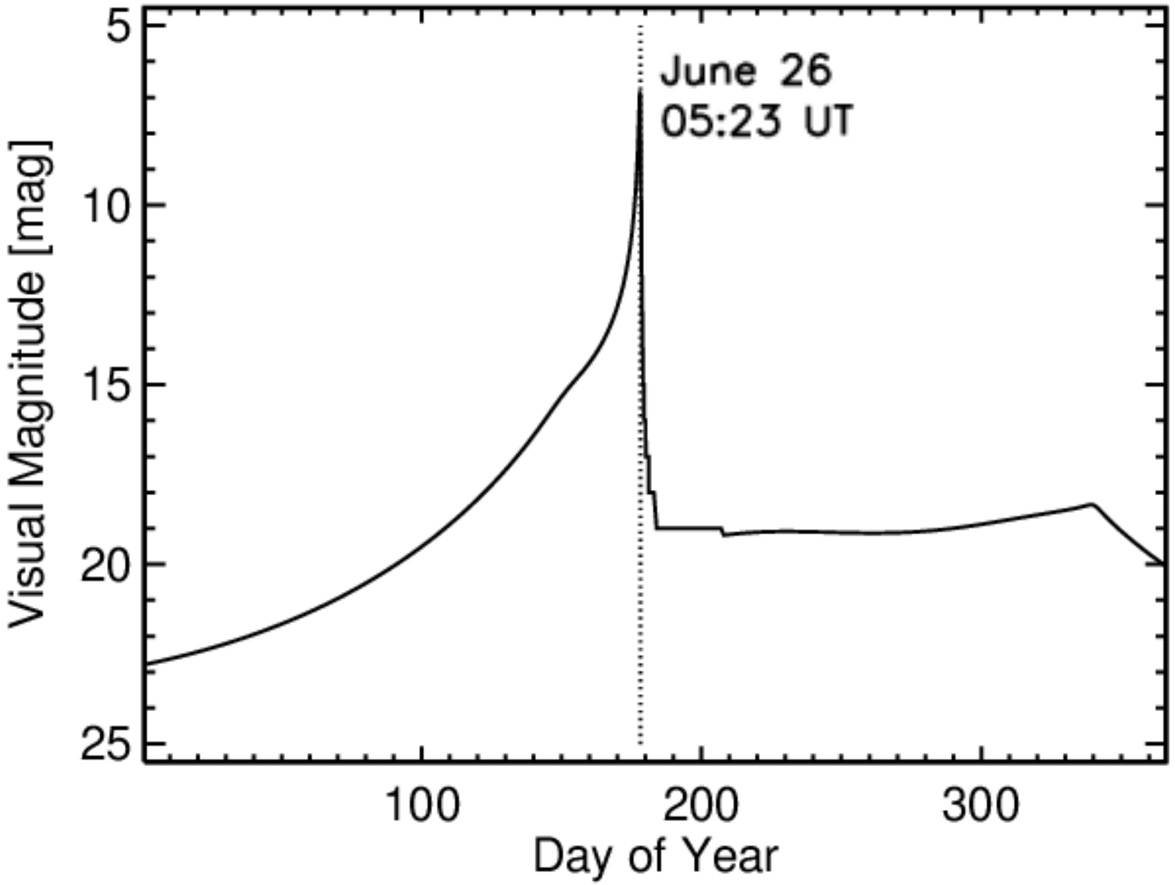

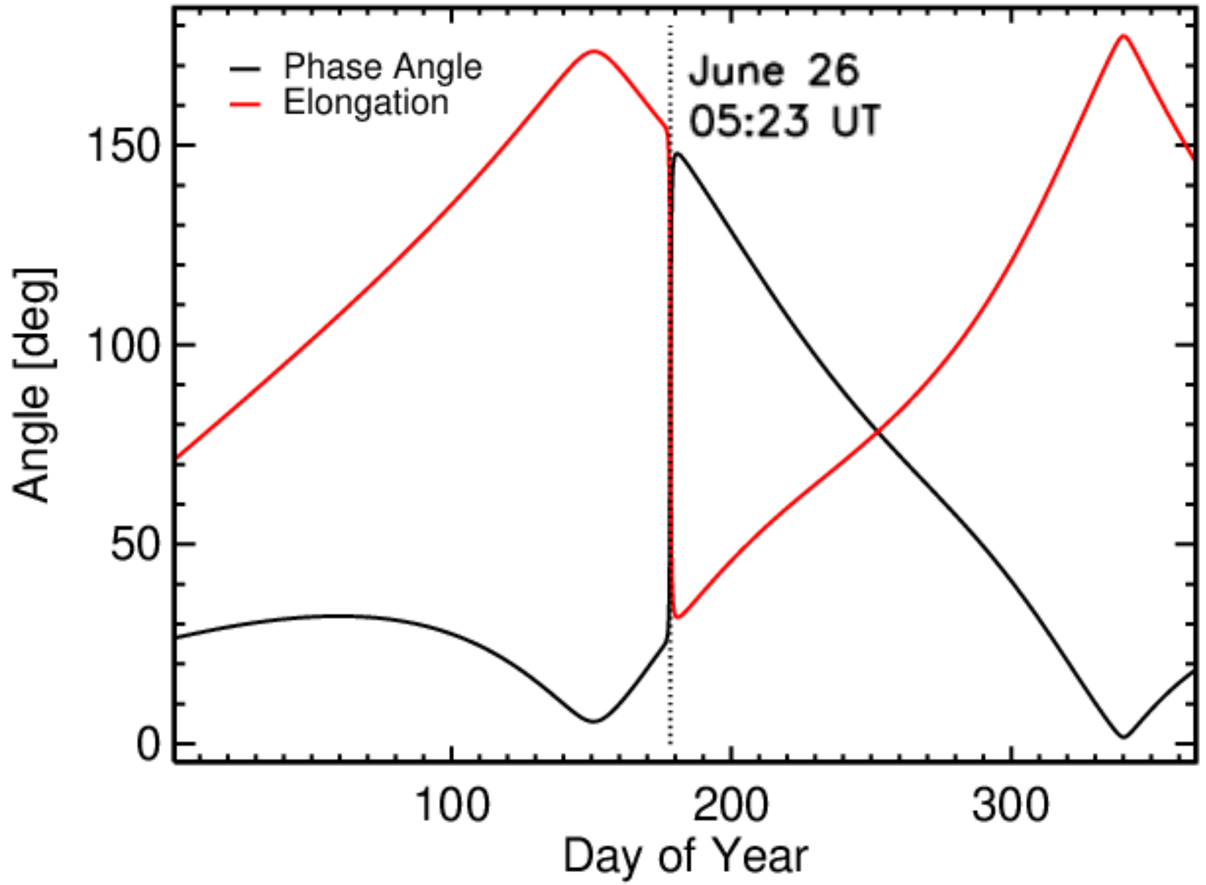

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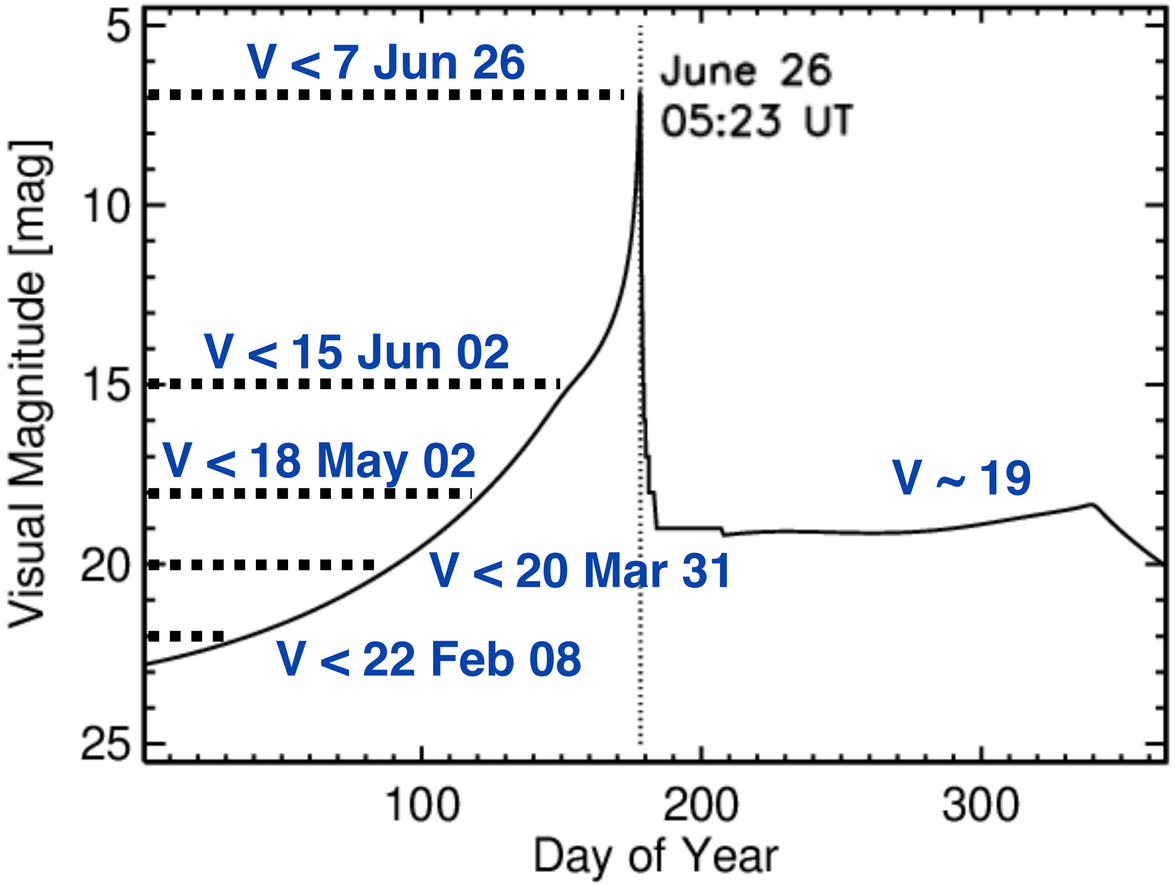

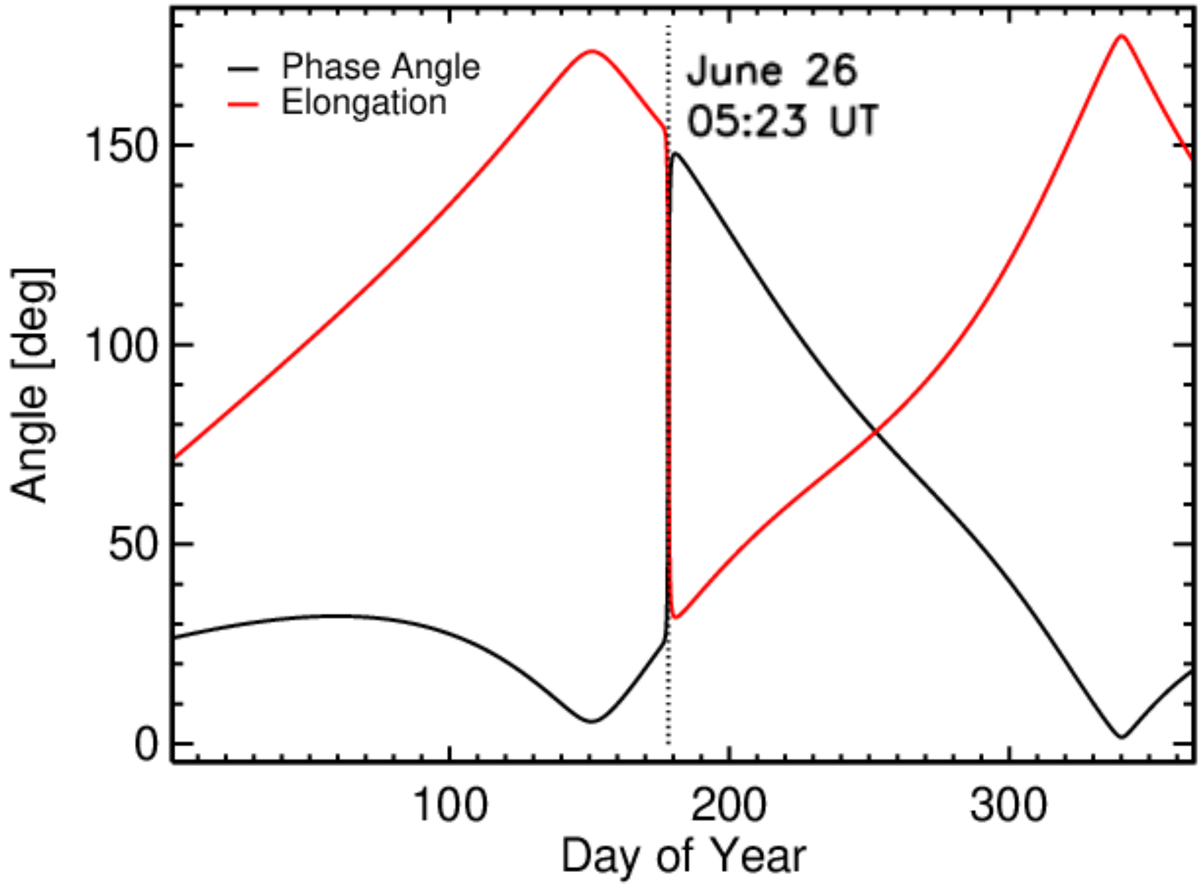

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Prospects for Observations in 2028

- **Optical/Spectroscopy:** V < 18 for at low phase and high elongation from May through June, rapidly fades to V ~ 19 after close approach
- **Tracking:** POS uncertainty < 0.5 arcmin, sky motion up to 8 deg/hour
- **Radar:** an extremely strong radar target
  - **Goldstone:** DSS-14/-13, meter-scale resolution, mid-June to early July
  - **Green Bank:** similar window to Goldstone, will depend on TX capability
  - **Australia:** DSS-43/-35/-36, ideal target for *southern hemisphere* radars
- **NEO Surveyor (NEOCam):** within the nominal survey field of view during multiple epochs prior to the 2028 close approach

Summary of 153814 (2001 WN5)

- Physical characterization ongoing…
- **1+ km elongated body** with possible large surface features
- Rotation period well known at **4.25 h**, but spin axis is not yet well constrained
- **Basic shape modeling** (ellipsoid + large-scale features) **possible**
- Better knowledge of the shape may help understand **discrepancies in the NEATM and TPM fits** to NEOWISE observations

2028 will present an effective practice run for Apophis in 2029