PDC 2021
Vienna, Austria

○ **New NEO Characterization Results**

Shape model of 3200 Phaethon from radar, lightcurve, and occultation observations

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Keywords: Phaethon, shape, radar, lightcurves, occultations

We present the shape and rotation state of near-Earth asteroid 3200 Phaethon, the target of JAXA's upcoming DESTINY+ mission [1]. This physical model was derived using Arecibo and Goldstone radar data from Phaethon's 2007 and 2017 close approaches to Earth, stellar occultations from 2019, and lightcurves from many apparitions.

Phaethon (1983 TB) is one of the largest potentially hazardous asteroids. It was discovered in 1983 by the Infrared Astronomical Satellite (IRAS). It is the parent body of the Geminid meteor stream [2, 3].

Phaethon passed 0.0689 au from Earth (27 lunar distances) on December 16, 2017. This was its closest approach to Earth since its discovery and the best chance to observe it before the DESTINY+ mission. Phaethon will not come closer to Earth until 2093.

In December of 2007, Phaethon was observed from Arecibo Observatory on two dates. In December of 2017, Phaethon was observed from Arecibo Observatory on five dates and from NASA's Goldstone Deep Space Communications Complex (DSS-14) on nine dates. The Arecibo delay-Doppler images from 2017 resolve Phaethon's shape, with range resolution as fine as 75 meters [4].

There are lightcurves of Phaethon from many apparitions, covering a wide range of sky positions over twenty years.

Five stellar occultations by Phaethon were observed in 2019, from Algeria, France, Italy, Japan, and the United States [5, 6]. Chords derived from these occultations constrain Phaethon's size and shape.

We used the SHAPE software [7] to determine Phaethon's shape and other properties from all available radar and lightcurve data. Occultation chords could not be directly incorporated into SHAPE, but they were compared against the model's predictions. The size that best fits the occultation chords is a few percent smaller than the size that best fits the radar data, but this difference is within the expected uncertainties, so the radar and occultation data are consistent.

We find Phaethon's pole position to be near ecliptic coordinates $(315°, -45°)$, which agrees with previous analyses [8, 9]. Our final shape model is approximately spheroidal with an equatorial ridge, resembling the shapes of 101955 Bennu [10] and 162173 Ryugu [11], though Phaethon is larger. Phaethon has a maximum breadth of about 6.5 kilometers; a sphere of equivalent volume would have a diameter of about 5.3 kilometers.

Comments:
No preference for poster or oral presentation

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