Physical and Orbital Characterization of NEA (3200) Phaethon

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The near-Earth asteroid (3200) Phaethon is an intriguing object: its perihelion is at only 0.14 au, it is associated with the Geminid meteor stream, it regularly experiences surface temperatures of more than 1000 K, it also shows comet-like activity associated with dust particles of an effective diameter of one μm ejected from the surface, or it might be an escapee from the Pallas collisional family. Moreover, Phaethon is one of the targets of the proposed JAXA DESTINY+ mission.

To further understand the nature and origin of Phaethon, we utilized the available optical light curves to improve the spin and shape model of Phaethon and to determine its surface physical properties derived by thermophysical modeling (diameter, geometric visible albedo, thermal inertia, average grain size) by analyzing the Spitzer mid-infrared spectra. We also used the available astrometric observations of Phaethon, including those obtained by the Arecibo radar and the Gaia spacecraft, to constrain the secular drift of the orbital semimajor axis of $-(6.9\pm1.9)\times10^{-4}$ au Myr^{1}. This constraint allowed us to estimate the bulk density of 1.67±0.47 g cm^{-3} by assuming that the drift is dominated by the Yarkovsky effect. We further discuss the Spitzer emissivity spectra of Phaethon.

Phaethon's bulk density is consistent with typical values for large (>100 km) C-complex asteroids and supports its association with asteroid (2) Pallas, as first suggested by dynamical modeling. These findings render a cometary origin unlikely for Phaethon.

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