DIRECT IMAGING OF NEAR EARTH OBJECT 3200 PHAETHON (1983 TB). D. H. Wooden[1], J. L. Dotson[1], S. B. Howell[1], and E. P. Horch[2], [1]NASA Ames Research Center, MS 245-3, Moffett Field, CA 94035-0001, [2]Dept. of Physics, Southern Conneccut State University, 501 Crescent St., New Haven, CT 06515.

Introduction: The Near Earth Object (NEO) 3200 Phaethon (1983 TB) is a B-type and also a potentially hazardous asteroid (PHA). The favorable close flyby of Phaethon offered a rare opportunity on 2017-Dec-13UT to use ‘Alopeke on Gemini-N to obtain speckle images [1]. Direct imaging offers an independent measure of the diameter, as well as an assessment of shape as projected on the plane of sky at the time of the observation.

Phaethon is the largest NEO that comes within 0.025 AU of Earth. The next approach that is closer than this apparition in mid-December 2017 is in 2093. Phaethon is the parent body of the Geminid meteor shower. At perihelion (0.14 AU), its surface temperature can reach 1040 K [2]. In the near-Sun environment, STEREO observed Phaethon release sub-μm to ~1 μm-diameter particles and brighten by a factor of 2 [3]. The mysterious mechanisms for dust ejection could be thermal stresses, fast rotation, radiation pressure or sublimation. The fine-grained dust production near perihelion, however, is insufficient to account for the Geminid stream particles of 10 μm to 4.5 cm size [4]. The Geminids’ impacting the Moon are a significant source term for the lunar exosphere [5]. The DESTINY+ mission to Phaethon, which is under study by JAXA/ISAS, will conduct *in situ* measurements of the dust and search for organics [6]. Other B-type NEOs include Ryuga that is the target of JAXA’s Hyabusa II mission.

Diameter: Phaethon’s diameter is of interest. There are diameter measurements from thermophysical models (TPM) of Phaethon’s thermal emission. Two recent measurements are not consistent within the errors:

5.1 ± 0.2 km, by [7] who fitted TPM to a *Spitzer* IRS spectrum using a light curve inversion shape model.

4.17±0.13 km, by [8] who fitted AKARI data.

If Phaethon has a diameter of 5.1 km then its geometric albedo is pv=0.11±0.20 [8], A larger diameter would imply a lower geometric albedo.

Observations: Speckle imaging observations at simultaneous 832 nm and 562 nm were obtained with ‘Alopeke on Gemini-N during commissioning. The obervations spanned 2017-Dec-13 07:31UT–07:48 UT. The start (JD 2458100.813194) approximately aligns with a minimum in the rotational light curve prior to the primary maximum (rotational period and phasing information from B. Warner, private communication).

Results: Despite poor seeing of 1”–2”, Phaethon is resolved in the speckle images. Preliminary reduction of the images show Phaethon is elongated. If the projected cross section is defined where the deriviative of the surface brightness profile is zero-valued [9], and along the NE to SW direction, then Phaethon viewed at this longitude appears to be 59 mas, which corresponds to ~4.1 km. The high resolution image of Phaethon shows:

- that ‘Alopeke can directly image an NEO;
- that direct images will permit comparison to diameter estimates from thermal models and from radar.

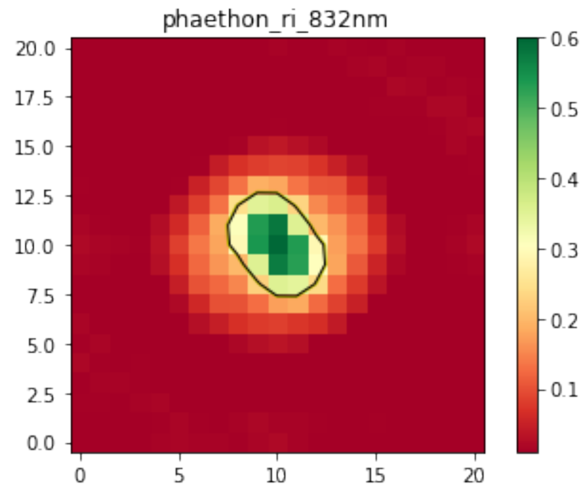

Figure. Phaethon. Direct image at 832 nm with ‘Alopeke on Gemini-N 2017-Dec-13 07:31-07:48 UT. N is up and E is left (0.0105”/pixel).

Implications: Direct imaging can provide in independent measure of the diameter. A precise effective diameter and shape model determine the volume. Multiple apparitions of astrometry (radar, Gaia) allow the Yarkovsky acceleration to be measured [8,10] and a mass derived, yielding the macrodensity. The interior properties like the macrodensity have implications for NEO behavior upon earth atmospheric entry, as well as have implications for the accretional formation and subsequent collisional and dynamical evolution of their progenitors – the asteroidal parent bodies.

References:

[1] www.gemini.edu/sciops/instruments/alopeke/
[2] Jewitt, D. 2010, *AJ*, 145, 133. [3] Jewitt, D., & Li, J. 2010, *AJ*, 140, 1519. [4] Li, J., & Jewitt, D. 2013, *AJ*, 145, 154. [5] Colaprete, A. et al. 2016, *Science*, 351, 249. [6] http://destiny.isas.jaxa.jp [7] Hanuš, M., et al. 2016, *A&A*, 592, id.A34, 15 pp. [8] Usui, F., Kuroda, D., Müller, T. G., et al. 2011, *PASJ*, 63, 1117. [9] Howell, S. B. et al. 2011, *PASP*, 124, 1124. [10] Galushina, T. Y., et al. 2015, *Planet. Space Sci*., 118, 296.