



Phaethon's fate by Ovidius

National Maritime Museum Greenwich, London

Simultaneous photometry and spectroscopy of the exceptional asteroid (3200) Phaethon

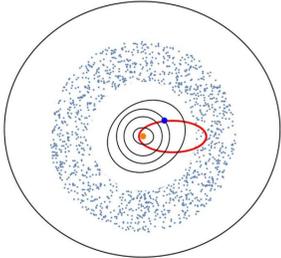
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Salzburg, 3-5 May 2019

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Remarkable Phaethon



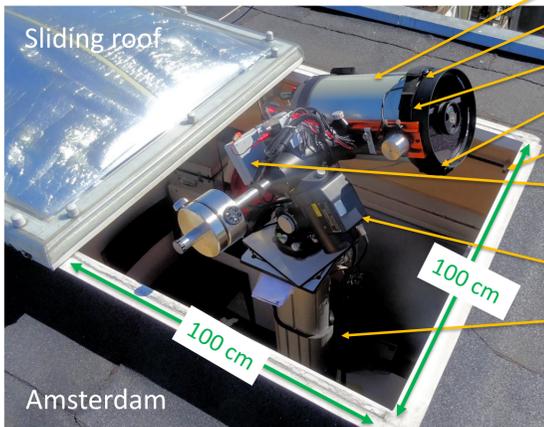
Irregular shape
diameter: 6 km
S. de Vet

- Orbital period: 1.43 year
- Crosses Earth's orbit → **Potentially hazardous asteroid**
- Eccentricity: 0.89 → **future test for Einstein's General Relativity**
- Parent body of the December **Geminids meteor shower, but**
- Temperature at perihelium: 600°C → **cannot be a comet**
- Closest approaches to Earth:
 - 16 December 2017 at 27 lunar distances
 - 14 December 2093 at 8 lunar distances

Summary

- In December 2017 the *potentially hazardous asteroid* Phaethon passed the Earth at only 27 times the distance to the Moon. Its maximum brightness was around $V = 11$.
- From my **remotely controllable home rooftop observatory in the middle of Amsterdam**, a spectrum was obtained with a Shelyak Alpy spectrograph attached to a C9.25 telescope.
- With a **permanently mounted photometric V filter** in the light path of the guider camera, V magnitudes could be determined, simultaneously with spectroscopy.
- The rapid motion of the asteroid was recorded during several days. The V magnitudes were in good agreement with measurements reported by others.
- After removal of the solar contribution, the resulting reflection spectrum allowed an **unambiguous classification** of the asteroid as C-complex type B, similar to earlier results from the 4.2 m William Herschel Telescope on La Palma in 2007.
- This work shows that even **with small equipment professional results are within reach**.

Observatory and equipment



- Celestron 9.25" Edge + f/6.2 Lepus
- GPS
- Dew heater
- Unihedron Sky Quality Meter (clouds!)
- Flat field screen
- Lunatico Platypus controller:
 - focussers + dew heater + Alpy lamps
 - 10micron GM1000 (absolute encoders)
- Movable pier



Remote control by Lunatico Dragonfly:
Roof, Pier, Power, Mount, **Laptop reboot**, Light
through docking station

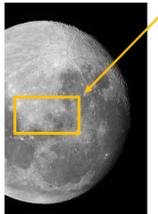
Software: Teamviewer, MaxIm DL, PinPoint

Spectrograph + V filter

Shelyak Alpy spectrograph

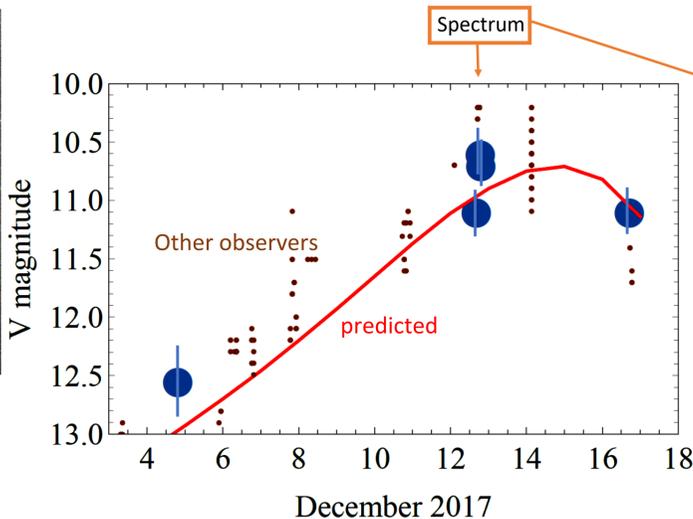
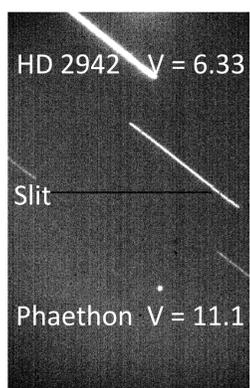
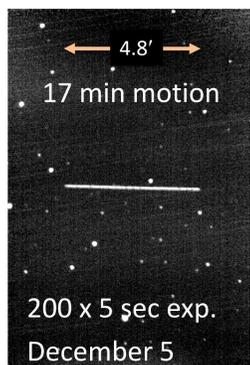


- Range: 3700 – 7500 Å
- Resolution $\approx 400 - 600$
- Ne-Ar and FF calibration
- Guiding module, slit 25 μm
- Johnson V filter in light path of guider camera**
- Main camera: Atik 314L+
- Guider camera, FOV: 9' x 5'
- Focuser



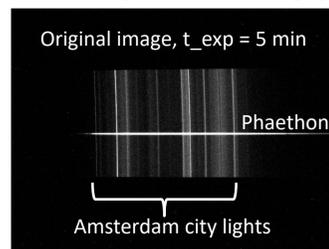
Acquisition software: MaxIm DL

V-photometry and imaging with guider camera



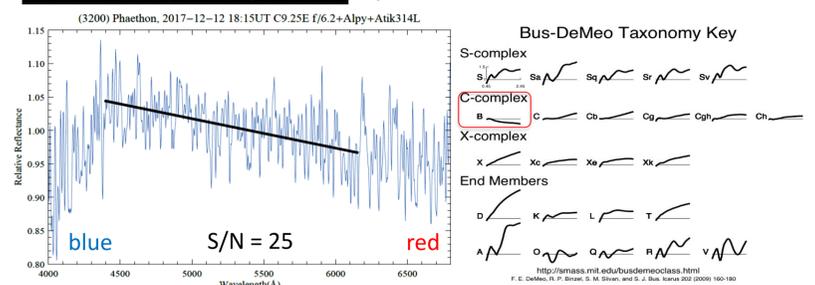
8 min star tracks
100 x 5 sec exp.
2 hours before closest approach

Spectroscopy and classification



Processing (Mathematica):

- Dark en Flatfield corrections
- City-light background subtraction
- Alpy response curve correction
- Solar contribution removal with spectrum of HD 245, a G2V star



Phaethon reflection spectrum → C-complex Type B

(same as found by Licandro et al 2007, with the 4.2m William Herschel Telescope on La Palma, also with $t_{exp} = 5 \text{ min}$)

Science conclusions: Phaethon is a very blue Carbon-type asteroid with a hydrated-silicates surface, similar to Pallas-type meteorites. During close passages near the Sun, 'active' surface outbursts occur: the likely cause of the Geminids, the only confirmed meteor shower caused by an asteroid.