Physical Characterization of (3200) Phaethon: Target of the DESTINY+ Mission Theodore Kareta Lunar and Planetary Laboratory, U. of Arizona

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Small Bodies & Solar System History

- Small bodies formed in the early solar system.
- To understand the early solar system, we need to know how these small bodies have changed since their formation.

Why (3200) Phaethon? (1/2)

- Until the 1980s, meteor showers were thought to be made only by comets.
- In 1983, an asteroid, (3200)
 Phaethon is discovered and linked to the Geminid Meteor Shower.

Artistic interpretation of Phaethon's surface by OSIRIS-REx's Heather Roper.

Why (3200) Phaethon? (2/2)

- Phaethon gets very close to the Sun, with temperatures exceeding 1050 K (~1500 F)!
 Hot enough to melt aluminum!
- Phaethon is also *blue* in color, which is rare among asteroids

Phaethon is a weird blue asteroid that gets incredibly hot and created the Geminids.

Artistic interpretation of Phaethon's surface by OSIRIS-REx's Heather Roper.

Big-Picture Questions

- Is Phaethon a dormant comet, or is it a weird asteroid that wandered too close to the Sun?
- What will JAXA's DESTINY⁺ mission see when it gets to Phaethon in about 2025?



Observations of Phaethon

We did *rotationally-resolved reflectance spectroscopy* of the whole surface of Phaethon.

- In the near-infrared, we used the NASA Infrared Telescope Facility in December, 2017.
- At visible wavelengths, we used the 1.5m Tillinghast Telescope on Mt. Hopkins, Arizona.



Teddy Kareta, Vishnu Reddy, Dante Lauretta, and Tomoko Arai at the NASA IRTF in December, 2017.

Two Primary Results (1/3)

After analyzing all our data, we have two primary results we'd like to highlight:

- Phaethon is *darker* (less reflective) than previously thought. It has an albedo of about 8%, a little brighter than charcoal.
- 2. Phaethon's surface is nearly uniform in reflective properties across the part of the surface we saw.



Two Primary Results (2/3)

Why does Phaethon's lower albedo matter?

- Phaethon has been suggested to be a fragment of the asteroid (2) Pallas, but our new albedo for Phaethon is half that of Pallas!
- If the near-sun environment has changed Phaethon's albedo so much, we think it should have changed its reflective properties, too.
- We argue that Phaethon and Pallas are not related.

Geminids

From Wikipedia, the free encyclopedia

The **Geminids** are a meteor shower caused by the object 3200 Phaethon,^[4] which is thought to be a Palladian asteroid^[5] with a "rock comet" orbit.^[6] This would make the Geminids, together with the Quadrantids, the only major meteor showers not originating from a comet. The meteors

Two Primary Results (3/3)

Why does the surface being homogenous matter?

- Previous work on this subject has shown huge variation.
- Our work confirms that the surface has been 'scorched' evenly.
- If that variation is real, should be near the North Pole.
- DESTINY⁺ can test this! We'll see in 2025.

Future Work

There are two candidate Phaethon fragments, 2005 UD and 1999 YC, which we should study in depth.

We should also try to integrate studies of the Geminids with laboratory work on how materials respond to heating to tell the whole story.

Summary / Overview

Tweet Length: We investigated the strange near-earth object (3200) Phaethon, the parent body of the Geminid Meteors, and found it to be darker and more homogenous than expected. These results will be an asset to the DESTINY⁺ mission and complicate our understanding of where Phaethon came from.

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