Impact Ejecta Environment of an Eccentric Asteroid: 3200 Phaethon

J. R. Szalay[1], P. Pokorny[2], M. Horányi[3], D. Janches[2], M. Sarantos[2], R. Srama[4]
[1]Princeton University, [2]NASA/GSFC, [3]University of Colorado Boulder, [4]University of Stuttgart

Abstract: Airless regolith bodies in the solar system are continually bombarded by meteoroids, modifying their surfaces and sustaining impact ejecta clouds. While large bodies like the Moon retain a significant fraction of ejected regolith, small asteroids shed this material into the interplanetary dust complex. Measurements of the lunar impact ejecta cloud found it was sustained by the known sporadic meteoroid sources. Here, we extend lunar ejecta measurements using a model of the meteoroid environment at 1 au to investigate the structure of an ejecta cloud at an eccentric airless body, asteroid 3200 Phaethon: the target of the upcoming DESTINY+ mission [Sarli et al. 2018].

Due to Phaethon's large eccentricity, Phaethon's impactor fluxes are significantly enhanced throughout the majority of the orbit compared to a body in circular orbit with the same semi-major axis (Figure 1). Subsequently, the peak ejecta density at 1 au is approximately 30 times higher compared to a body in a circular orbit at 1 au, largely due to enhanced ejecta production from meteoroids shed from Jupiter Family Comets [Szalay et al. 2019]. Such asymmetric ejecta production suggests Phaethon experiences significantly different meteoroid-specific space weathering processes than a body with a similar semi-major axis on a circular orbit. We estimate impact ejecta processes at Phaethon shed approximately 1 ton per year, which is not sufficient to appreciably contribute to the Geminids meteoroid complex, yet provides ample ejecta densities to measure with an in-situ dust detector aboard DESTINY+. These results suggest eccentric asteroids shed more material than those on near-circular orbits, and are suitable candidates for in-situ dust detection and chemical characterization due to their amplified asymmetric ejecta production.

In this presentation, we will summarize recent efforts to constrain the evolution and ejection of asteroid regolith for 3200 Phaethon. We will present predicted impact counts for a dust detector on close flybys of Phaethon in preparation for DESTINY+ and discuss how such measurements would provide critical insight into Phaethon’s, and by analogy other airless bodies in the solar system’s, origin and evolution in a manner unique to dust detection data.

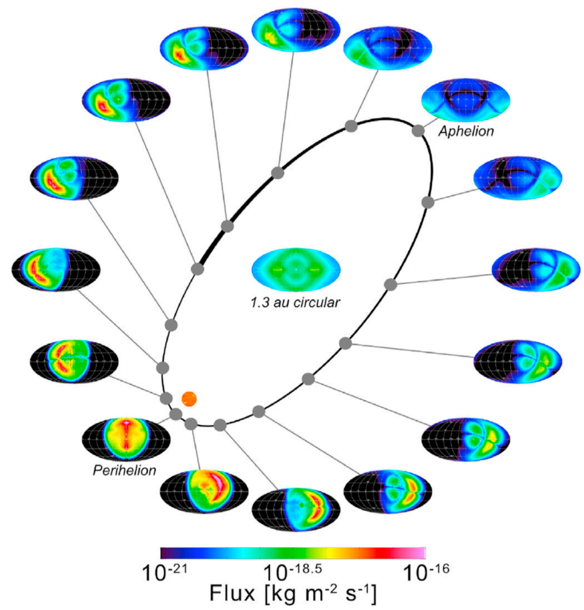

Figure 1. Impact flux throughout Phaethon’s orbit in the ECLIPJ2000 x,y plane. The location of the Sun is given by the orange dot.

References:

Sarli, B.V., Horikawa, M., Yam, C.H., Kawakatsu, Y., Yamamoto, T., 2018. DESTINYþ trajectory design to (3200) Phaethon. J. Astronaut. Sci. 65, 82–110.

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