Impact Ejecta Clouds: A Scientific Resource for Understanding Asteroid Origins and Evolution.

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Introduction: Asteroids are continually bombarded by meteoroids. Each impact typically produces orders of magnitude more mass than the primary impactor, such that impacting meteoroids are an efficient liberator of asteroidal surface material. Hence, the near-asteroid ejecta environment provides a rich scientific laboratory to study both the impacting meteoroid distributions and the chemical composition of asteroidal surfaces. In this presentation, we discuss the impact ejecta environment of asteroids and how it may be used as a valuable scientific resource.

Impact Ejecta Model: The Lunar Atmosphere and Dust Environment Explorer (LADEE) mission [1] has dramatically improved our understanding of impact ejecta clouds. Onboard, it carried the Lunar Dust Experiment (LDEX), an impact ioniziation dust detector capable of individually detecting dust grains with radii $a > 300$ nm [2]. LDEX discovered a permanently present, asymmetric dust cloud at the Moon [3], sustained primarily by the helion, apex, and anti-helion sporadic meteoroid sources, with the apex being the strongest producer of ejecta [4].

To model ejecta clouds near asteroids, we build on an existing model for the dust distribution around asteroids near 1 AU [5]. To extend this model to different heliocentric distances, we must make certain assumptions about the sporadic sources. Incorporating the relative fluxes as a function of heliocentric distance [6], we can estimate the structure and relative densities of ejecta clouds past 1 AU. Figure 1 shows an example ejecta cloud, for a 10 km radius body at 1 and 3 AU.

While there are subtle changes in the structure of the ejecta cloud due to the relative competition between the various sporadic meteoroid sources, the overall structure is very similar. Namely, the ejecta cloud is most dense on the apex hemisphere of the asteroid. These models can be utilized to predict impact rates for transiting spacecraft.

Future Measurements: Were a spacecraft to perform a near flyby carrying a dust detector with chemical composition capability, it could garner critical information about the surface makeup of the asteroid without ever landing [7]. Dust analyzer instruments capable of harvesting this valuable information are now readily available [8]. This presentation will discuss potential in-situ measurements of asteroidal ejecta clouds and how they would provide crucial insight into understanding the origin and evolution of airless bodies in the solar system.

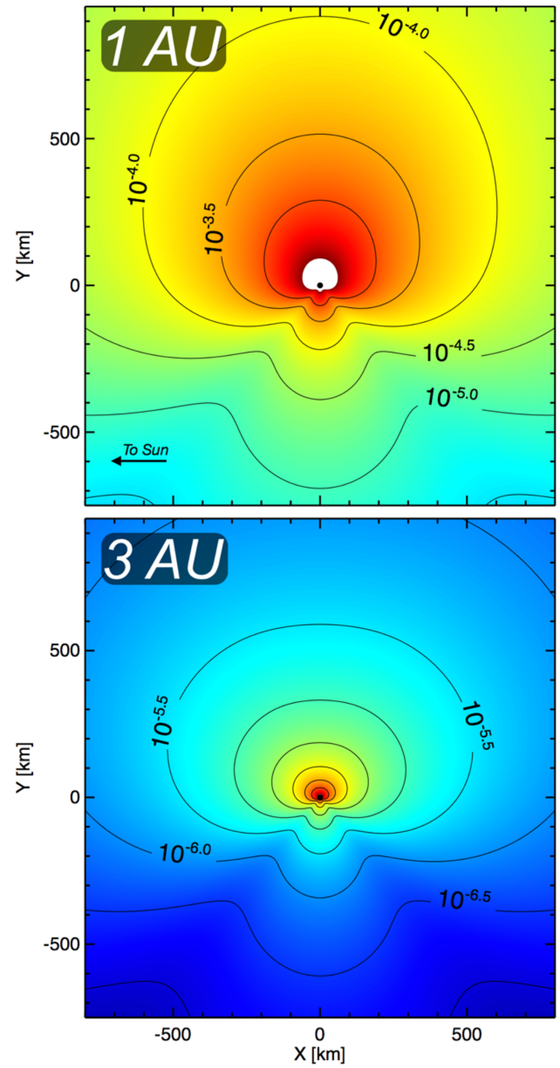

Figure 1. Predicted impact ejecta cloud densities for grain radii $a \geq 50$ nm and asteroid radius $R = 10$ km

References: [1] R. C. Elphic, *et al.*, *Space Sci. Rev.,* 185, 93-113 (2014); [2] M. Horányi *et al.*, *Space Sci. Rev.,* 185 (2015); [3] M. Horányi *et al.*, *Nature*, 522(7556) (2015); [4] J. R. Szalay and M. Horányi, (2015), *GRL*, 42(24); [5] J. R. Szalay and M. Horányi, (2016), *ApJL*, 830(2), L29; [6] Poppe, (2016), *Icarus*, *264*, 369–386; [7] A. S. Rivkin *et al.*, *2016 IEEE Aerospace Conference*, Big Sky, MT, 2016, pp. 1-14.; [8] Sternovsky et al. *2015 IEEE Aerospace Conference*, Big Sky, MT (2015).