Optical Depth and Albedo of the Deep Impact Ejecta in the First Minutes.
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Introduction: The flow of the Deep Impact ejecta across the limb of the nucleus allows us to map the optical depth and the albedo of the particles as a function of time and azimuth. The obscuration of the limb by the ejecta is used to determine the optical depth, *i.e.*, the total cross-section of grains per unit area. The brightness of the grains doing the obscuration then allows us to directly measure the albedo at the phase angle of the observations (near 60°). Where the optical depth exceeds unity, a radiative transfer model is needed to determine the optical depth. Models are also needed to extrapolate to geometric albedo..

Data Analysis: Images taken with the Medium Resolution Instrument (MRI) have a time resolution of 65 millisec for many seconds after the impact and gradually greater spacing after that as the ejecta are moving more slowly. We emphasize here the data taken in the first 100 seconds after impact, thus limiting the change in geometry due to motion of the flyby spacecraft.

Using an image taken just before impact, at each point on the downrange limb of the nucleus, we measure the brightness of the limb above the background. Then on images after the impact we measure the brightness of the limb above the now higher background and foreground. A simple polynomial fit to the brightness of the ejecta plume normal to and beyond the limb is adequate for determining both the brightness of the ejecta at that point and the attenuated brightness of the limb.

The ratio of the attenuated limb brightness to the pre-impact limb brightness yields directly the optical depth via $I/I_o = \exp(-\tau)$. Where the optical depth is low, the brightness is directly proportional to the optical depth and the average albedo of the particles. Where the optical depth is high, we use a 1D radiative transfer approach (see, e.g., [1]) to estimate the albedo.

Results: The optical depth varies dramatically both with time and with azimuth around the limb. Most importantly, the variation with time is not monotonic indicating significant layering of the material prior to excavation. Fig. 1 shows the optical depth measured at several azimuths from the impact site and it plots the optical depth as color-coded symbols with time from impact starting at 0 near the edge of the figure and increasing toward the impact site. A time scale in seconds is shown in red along the rightmost profile. Fig. 2 shows the albedo corresponding to Fig. 1. Fig. 3 shows perspective contour plots based on many more data but otherwise similar to Figs. 1-2. The highest frequency variations may be noise. The higher albedo locations are likely associated with the relatively higher preponderance of icy grains in certain downrange directions as discussed by Sunshine et al. [2]

The analysis of these data is continuing and we will report on the latest interpretation in terms of layering and ice-refractory mixing. A preliminary version of this work was presented by King et al. [3].

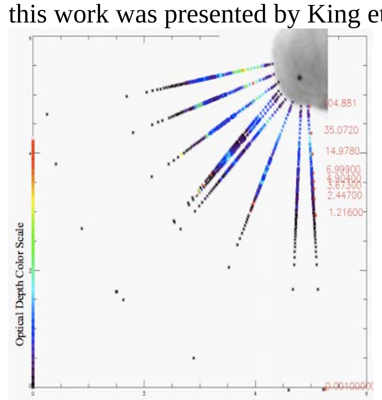

Fig. 1. Optical depth of the ejecta at selected azimuths from the impact site as a function of time. given in seconds at the rightmost profile.

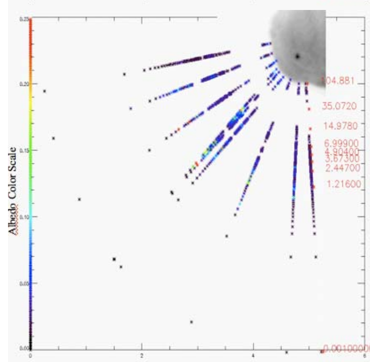

Fig 2. Albedo of the ejecta at selected azimuths as a function of time from impact.

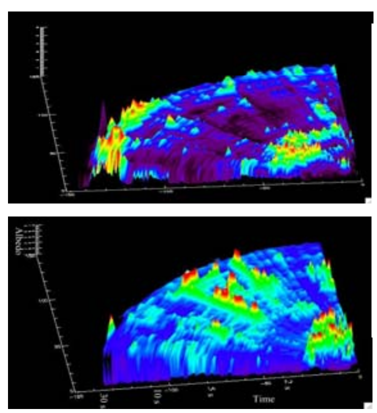

Fig 3. Perspective contour plots of an expanded dataset similar to that in Fig. 1 (top) and Fig. 2 (bottom), but rotated so that one is looking away from the impact site.

References: [1] Kokhanovsky, A. ((2004) Light Scattering Media Optics: Problems and Solutions. [2] Sunshine, J. M. et al. (2007) *Icarus*, *190*, 284. [3] King, A. (2007) *DPS meeting #39*, #21.03.