AN IMPACT EJECTA BEHAVIOR MODEL FOR SMALL, IRREGULAR BODIES. J. E. Richardson, H. J. Melosh, and R. Greenberg, Lunar and Planetary Lab, University of Arizona, Tucson, AZ 85721. jrich@lpl.arizona.edu

Introduction: In recent years, spacecraft observations of asteroids *951 Gaspra*, *243 Ida*, *253 Mathilde,* and *433 Eros* have shown the overriding dominance of impact processes with regard to the structure and surface morphology of these small, irregular bodies. In particular, impact ejecta play an important role in regolith formation, ranging from small particles to large blocks, as well as surface feature modification and obscuration.

Basic Model Description: To investigate these processes, a numerical model has been developed based upon the impact ejecta scaling laws provided by Housen, Schmidt, and Holsapple [1], and modified to more properly simulate the late-stage ejection velocities and ejecta plume shape changes (ejection angle variations) shown in impact cratering experiments [2]. A target strength parameter has also been added to allow the simulation of strength-dominated cratering events in addition to the more familiar gravity-dominated cratering events [3].

The result is a dynamical simulation which models -- via tracer particles -- the ejecta plume behavior, ejecta blanket placement, and impact crater area resulting from a specified impact on an irregularly shaped target body, which is modeled in 3-dimensional polygon fashion (see *Fig. 1*). This target body can be placed in a simple rotation state about one of its principal axes, with the impact site and projectile/target parameters selected by the user. The gravitational force from the irregular target body (on each tracer particle) is determined using the polygonized surface (polyhedron) gravity technique developed by Werner [4].

Ejecta Plume Modeling: To more realistically simulate the physical properties of an ejecta curtain and eventual blanket resulting from an impact on a small, irregular target body, the model shown in *Fig. 1* has been expanded to model the ejecta curtain as a 3-dimensional polygon object, rather than randomly generated tracer particles. In this form, the mass loading and opacity of each polygon of the ejecta curtain is calculated at each time step, and rendered appropriately (assuming a user specified particle distribution). *Fig. 2* shows an example of this form of the model, for both a gravity-dominated and strength-dominated cratering event.

Applications: This form of the model is being applied to the Deep Impact comet mission for two purposes: (1) coupled with an appropriate display module, it is being used in planning the instrument image

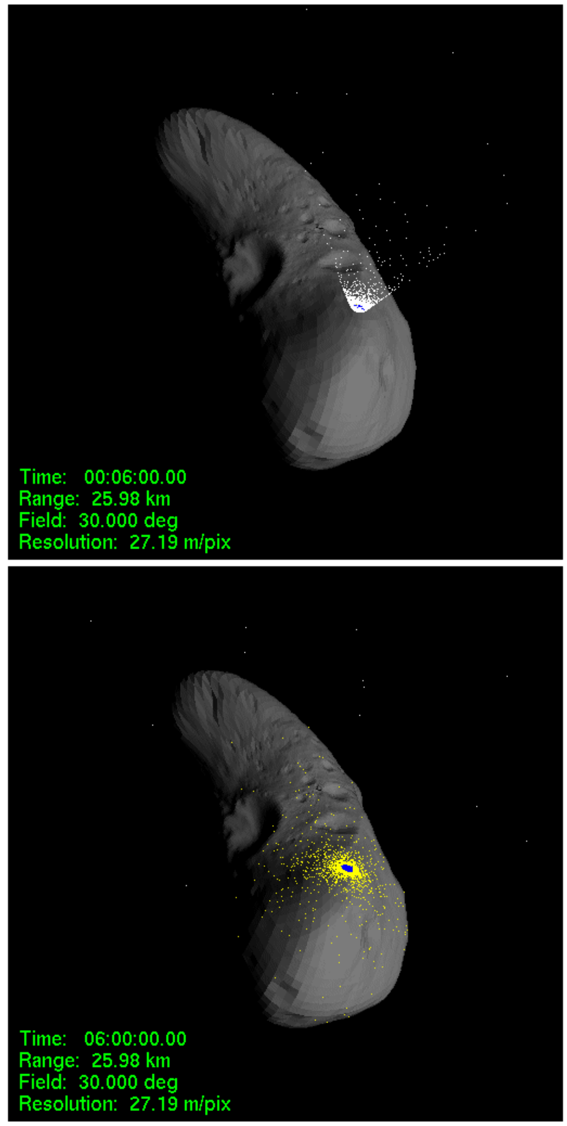

Figure 1: *A simulation showing the ejecta plume (white tracer particles), ejecta blanket (yellow tracer particles), and impact crater area (shown in blue) resulting from a small impact on an Eros-shaped target body having a 6-hour rotation period about its principle z-axis. The top panel shows the state of the ejecta 6 minutes after the impact, using 2000 tracer particles to map its behavior. At this stage, the ejecta plume has been fully formed, with the slowest particles beginning to fall out near the crater rim. The bottom panel shows the state of the ejecta 6 hours (one rotation) after the impact, with most of the tracers particles landed again on the surface to form the ejecta blanket.*

sequences for the comet flyby spacecraft, allowing us to simulate the acquired images from a number of possible impact scenarios. and (2) it will provide a method for directly modeling the behavior of the actually observed ejecta plume, which will then be used to estimate the mass/density of comet *Temple 1* based upon the effects of the comet's gravity field on crater formation and ejecta plume behavior.

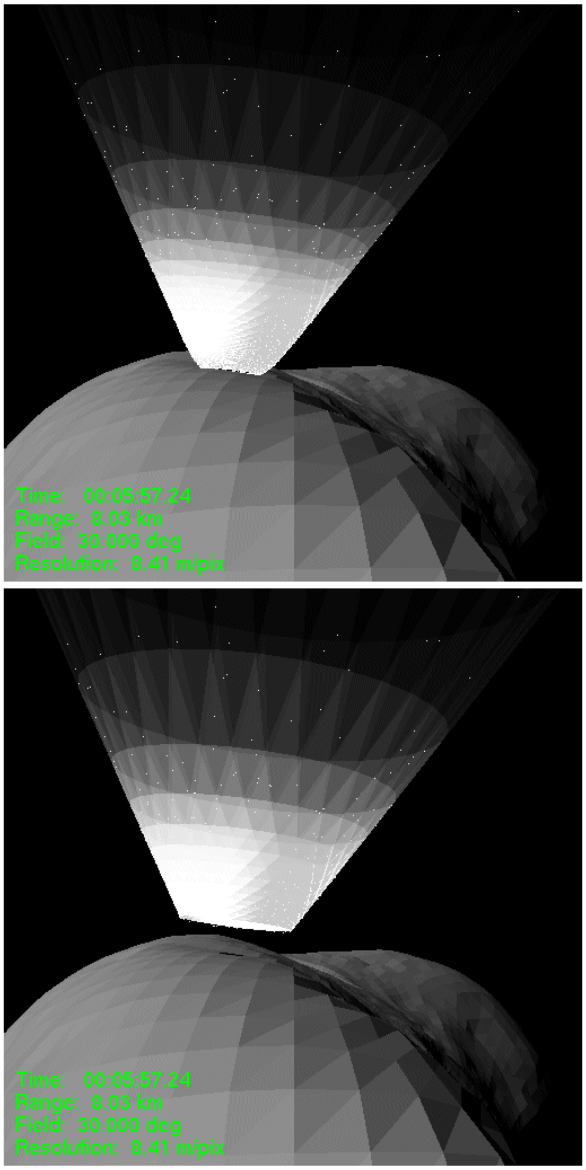

Figure 2: *A simulation showing the ejecta plume as a 3-dimensional shape model for a small gravity-dominated cratering event (top panel) and a small strength-dominated cratering event (bottom panel) on an Eros-shaped target body. An ejecta particle size distribution has been assumed (maximum particle size, minimum particle size, and power law distribution slope) with the resulting ejecta curtain opacity calculated and rendered. Note that the ejecta plume detaches from the target body in the case of strength-dominated cratering, with the first particles landing on the surface again at some distance from the impact crater site (if they do at all). In both simulations, a few random ejecta blocks are also included as discrete points.*

We are also applying this model to the issue of the ability of one impact to erase or obscure the visible evidence of previous impacts (beyond the simple geometric effect of the new impact crater itself), by burying the older craters in ejecta. Such erasure processes have been shown to be critical in controlling the cratering statistics observed on small asteroids such as *Gaspra* and *Ida* [5, 6]. These modeling results are necessary for a reconciliation of the diverse impact cratering records on *Gaspra*, *Ida*, *Mathilde*, and *Eros*. The objective is to gain a better understanding of their histories and their common collisional environment.

This model also represents an improvement over earlier techniques for modeling the spatial distribution of impact ejecta over the surface of a target body (e.g. Geissler et al. [7]), by including a more realistic representation of initial ejecta launch positions and velocities (angle and speed) for a given impact scenario. As such, these simulations can also be applied to observable surface ejecta distributions, including surface spectral units and boulder emplacements on the surfaces of observed asteroids.

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