Probing the different dust grain populations by ejecta curtain modeling

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Abstract

An ejecta curtain is produced as a result of impact cratering of celestial bodies that excavates and ejects their surface and underground material. As seen in laboratory impact experiments, ejecta particles often fly collectively, making an inverted cone like structure. Since ejecta particles are thought to reflect the interior materials and structures of celestial bodies, ejecta and ejecta curtains provide us with valuable information about the interior of the bodies. Following the Deep Impact mission, more and more in-situ data on ejecta curtains are expected to become available in future space missions. To draw valuable information from such insitu measurements, a radiative transfer model of the ejecta curtain plays an important role. This urges us to calibrate the model parameters with experimental results as well as understand the contribution of each model parameter to the predicted intensities of the radiative calculations. In this work, we study the dependences of the scattering phase function and the geometry of an ejecta curtain produced by impact on an airlessbody's surface, on the projected intensity images of the ejecta, as a first step toward a correct interpretation of ejecta observations. In our model, we consider the detector to be 1 km away from the surface of the body irradiated by sunlight at 1AU from the Sun, as a typical case in exploration missions. We assume an ejecta curtain cone with a height of 10m and opening angle 90°. The thickness of the curtain is 0.1m. Using the Monte Carlo multiple scattering method, we have calculated the scattered intensities for three different orientations of the ejecta curtain (Figure 1).

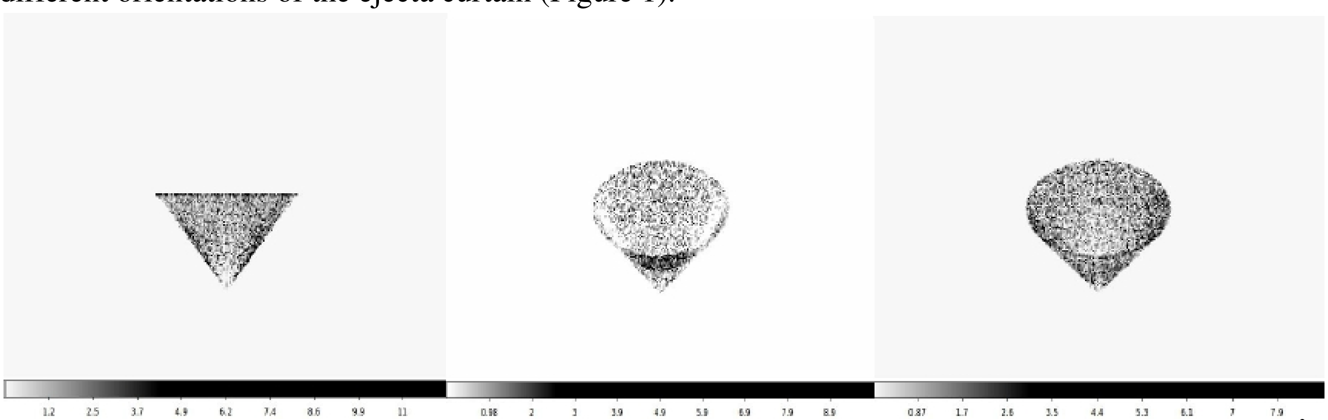

Figure1.Scattered intensities for three different orientations of the ejecta cone in units of 10^{15}photons/cm2/s/sr/Å.

The dependence of the optical depth, τ, of the curtain has been studied by considering the values in the range of $0.1 < \tau < 1000$. The scattering phase function is a very important parameter in our model and is dependent on the grain composition and size distribution. Here we have computed the intensities for ejecta material using three different phase functions (isotropic, Henyey Greenstein phase function and the cometary phase function). We find that the scattered intensities are highest for isotropically scattering grains irrespective of the orientation of the ejecta cone. This could imply that if small isotropically scattering grains are the predominant constituents, we can use our model predictions to deduce the column densities of these small grains from in-situ observations. There is also a significant variation in the intensity for different phase functions or grain sizes with the orientation, which can be used to derive the sizes of the scattering dust grains in the ejecta curtain.