Charge transport between granular particles in an ejecta curtain produced by hypervelocity impacts

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We studied the charge transport between granular particles in an ejecta curtain produced by hypervelocity impacts to access the energy partitioning from the initial kinetic energy to the electrostatic one having the ejecta curtain. We conducted both hypervelocity impact experiments and numerical calculations. The impact experiments were done at ISAS/JAXA hypervelocity impact facility. A vertical gun was used to use granular materials as a target. High-speed video cameras for the visible and infrared were used to observed an impact-generated ejecta curtain. Any light sources were not used in this experiment. We constructed a numerical model by combining the iSALE shock physics code and the REBOUND N-body integrator. The processes of impact ejection under the conditions similar to the laboratory experiments were solved by the iSALE. The time at the ejection, ejection velocity, and the launch position of each particle was extracted as a txt file. Then, the txt file was imported in the REBOUND as a input file. At this time, we added random velocities to simulate the velocity dispersion. Although the dispersion would be inevitably added to each ejected particles in nature, it cannot be modeled in the hydrocode. The absolute magnitude of the random velocity was treated as a free parameter. Subsequent particle motions under the Earth’s gravity field and the resistance force by the surrounding air were calculated. The decceleration due to inelastic collisions and charge transport between particles were included into the calculations. The restitution coefficient was also treated as a free parameter. The degree of charge separation was given by an empirical law proposed by the previous experiment. The results are summarized as follows; (1) We did not observe a large-scale discharge in an ejecta curtain under the experimental condition, (2) we observed a number of bright points along with an produced-ejection flow, (3) we observed a mesh pattern in the ejecta curtain as well as a previous study, (4) we reproduced the mesh pattern in the REBOUND when we chose the degree of the random velocity to be 5-15% of the ejection velocities at the restitution coefficient of 0.8, (5) mutual collisions between granular particles cease at the early stage of the growth of the ejecta curtain, (6) the end time of the mutual collisions depends on the atmospheric pressure, and (7) the empirical law pertaining to the charge separation yields an unphysically-high electrostatic energy. In the presentation, we will present the current status of our research development and discuss the future plans.

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