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A new model of the lunar ejecta cloud

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Abstract

Every airless body in the solar system is surrounded by a cloud of ejecta produced by the impact of interplanetary meteoroids on its surface [1]. Such "dust exospheres" have been observed around the Galilean satellites of Jupiter [2, 3]. The prospect of long-term robotic and human operations on the Moon by the US and other countries has rekindled interest on the subject [4]. This interest has culminated with the recent investigation of the Moon's dust exosphere by the LADEE spacecraft [5].

Here a model is presented of a ballistic, collisionless, steady state population of ejecta launched vertically at randomly distributed times and velocities. Assuming a uniform distribution of launch times I derive closed form solutions for the probability density functions (pdfs) of the height distribution of particles and the distribution of their speeds in a rest frame both at the surface and at altitude. The treatment is then extended to particle motion with respect to a moving platform such as an orbiting spacecraft. These expressions are compared with numerical simulations under lunar surface gravity where the underlying ejection speed distribution is (a) uniform (b) a power law. I discuss the predictions of the model, its limitations, and how it can be validated against near-surface and orbital measurements.

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