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INTERACTION OF METEOROIDS WITH THE MARTIAN ATMOSPHERE

Abstract

We develop the model which describes meteoroids entering the atmosphere of a planet, and apply our results to the Martian atmosphere. With the help of our model, we categorize different consequences of the collisions of cosmic bodies with the atmosphere and the surface. We give our attention to two types of possible results: meteorite fall, when a fragment of a meteoroid can be found on the surface, and full ablation, when meteoroid does not reach the planetary surface.

The proposed model is based on the analytical solution of the classical equations of meteor physics. The dimensionless solution for the mass-velocity dependence and the height-velocity dependence can be expressed using two main dimensionless parameters with the following physical meaning: the ballistic coefficient, which shows the ratio between the mass of the atmospheric column along the trajectory and the body's pre-entry mass, and the mass loss parameter, which is proportional to the ratio between the initial kinetic energy of the body and energy which is required to insure total mass loss of the body due to ablation and fragmentation. For every given meteoroid, there is a corresponding unique pair of these parameters.

We can write the meteorite fall condition - the terminal mass of a meteoroid exceeds or is equal to a certain chosen value - using the values of the parameters described above. Thus, we get a boundary curve on the parameter plane, and associate different events with the location of the point relative to this curve. As an example, we take two meteoroid types: a chondrite with the entry velocity 10 km/s, and an iron meteoroid with the entry velocity 15 km/s. For each type, we take several pre-entry mass values and show the impact consequences by constructing the boundary curve on the parameter plane and the point corresponding to the meteoroid. We also compare our results for the Martian atmosphere with the same meteoroid cases produced in the terrestrial atmosphere (Gritsevich et al., 2012). This shows that for a certain range of pre-entry masses, a meteoroid entering the atmosphere of Earth would be fully ablated, while a meteoroid with the similar properties entering the atmosphere of Mars would result in a meteorite event.

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Reference: Gritsevich M.I., Stulov V.P., and Turchak L.I. Consequences for Collisions of Natural Cosmic Bodies with the Earth Atmosphere and Surface // Cosmic Research 50(1), 56-64, 2012.