THE SURFACE-BOUNDED EXOSPHERES OF CERES AND THE MOON

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Key words Ceres, continuum approximations, diffusion, exosphere, ice, Moon, random walk

Sufficiently large airless bodies, such as dwarf planet Ceres or the Earth's Moon, can hold on to a tenuous exosphere of thermalized molecules that hop along ballistic trajectories [1]. Various molecular species have been detected in the lunar exosphere, but it is the water exosphere that is significant for transporting molecules to cold traps. Thanks to the Dawn spacecraft, asteroid Ceres is the newest example of an exosphere under study [2]. Although the number of investigations and questions is growing, a general mathematical description of this type of exosphere is in its infancy [3, 4].

Surface-bounded exospheres are collisionless, and although three-dimensional in nature, they can be fully described in terms of a two-dimensional random walk or as a two-dimensional partial (or integro-partial) differential equation, derived from the probability distribution of thermal ballistic hops. As a step toward a general mathematical description, a continuum equation is derived and used to calculate the steady state distribution of the surface concentration of volatile water molecules. This leads, for example, to a determination of the mass- and the length-scale of the pile-up of water molecules near the morning terminator.

In the specific case of Ceres, the water exosphere is expected to seasonally condense around the winter pole. Recent discoveries from the Dawn mission and relevant questions about Ceres and its exosphere will be presented.

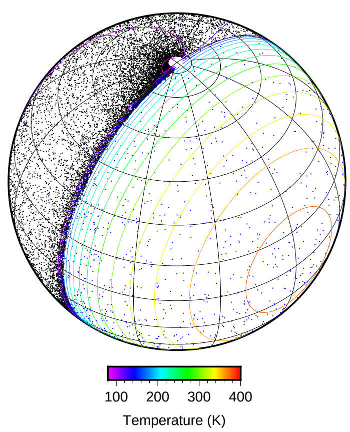

Figure 1. Monte-Carlo model calculation for the lunar water exosphere, where black dots correspond to molecules resident on the surface and blue dots to molecules in-flight [4].

References

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