Photoelectron emission from an airless body and dust motion above the surface of the body

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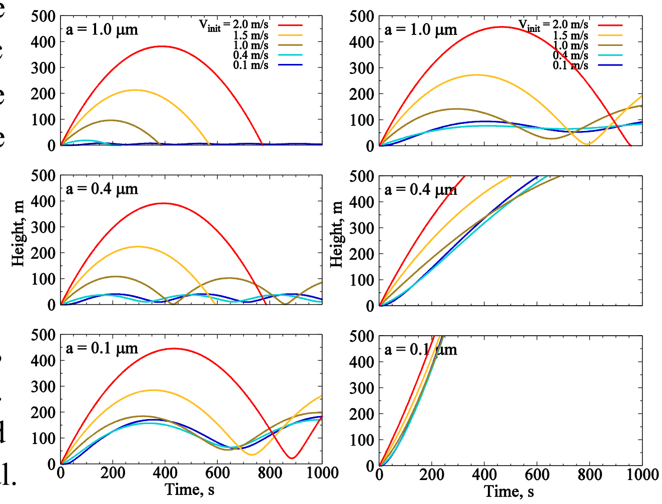
When an airless body such as asteroids, Moon and Mercury, is irradiated with solar EUV, photoelectrons emitted from the surface of the body form a thin electron sheath above the surface. The vertical structure of the photoelectron sheath, namely, the electron density and the electrostatic potential, are determined by the vertical component of the velocity distribution function (VDF) of photoelectrons.

The VDF is to be obtained by laboratory experiments. Feuerbacher et al. (1972) performed one and only measurement of the VDF of the surface material analogous to a regolith of airless bodies (see also Willis et al. 1973). They measured the energy distribution function of photoelectrons from lunar soil as a function of light wavelength and calculated the VDF of the regolith analogue under irradiation of the solar spectrum. Previous numerical studies of the motion of a dust grain in a photoelectron sheath assumed a Maxwellian VDF for photoelectrons and used the root-mean-square velocity of photoelectrons calculated by Feuerbacher et al. (1972) as the mean vertical velocity (e.g., Colwell et al. 2005, Poppe et al. 2012, Hirata and Miyamoto 2012). However, the VDF given in Feuerbacher et al. (1972) is clearly non-Maxwellian and, moreover, the root-mean-square velocity given by Feuerbacher et al. (1972) is not a vertical component of photoelectron velocity (see Fig. 1 of Feuerbacher et al, 1972).

To correctly understand the dynamical behavior of dust grains above the surfaces of airless bodies in the Solar System, we derive the vertical component of the VDF from the energy distribution function given by Feuerbacher et al. (1972) and revise the motion of a dust grain in a photoelectron sheath above the surface as a function of the size of the grain and its initial vertical velocity.

We found that our model results in a thinner electron sheath than the ones previously predicted by the models using the Maxwellian VDF. We show that our model predicts electrostatic levitation of a grain with radius of 1 μm above the surface of Eros is possible as long as the initial velocity is less than 0.4 m/s which is much lower than the previous estimates of about 2 m/s.



Figures: Motion of dust grains above the surface of asteroid Eros launched with various velocities (left: this study; right: Maxwellian VDF model).

References: Colwell et al. (2005) Icarus 175, 159. Feuerbacher et al. (1972) Geochim. Cosmochim. Acta Suppl. 3, 265. Hirata and Miyamoto (2012) Icarus 220, 106. Poppe et al. (2012) Icarus, 221, 135.