DUST LEVITATION ABOVE ASTEROIDS DUE TO INSTANTANEOUS CHARGE-UP. H. Senshu[1], H. Kimura[2], T. Yamamoto[2,3], K. Wada[1], M. Kobayashi[1], N. Namiki[1], and T. Matsui[2], [1]Planetary Exploration Research Center, Chiba Institute of Technology (2-17-1, Tsudanuma, Narashino, Chiba, 275-0016 Japan, senshu@perc.it-chiba.ac.jp), [2]Center for Planetary Science, Integrated Research Center of Kobe University, [3]Institute for low temperature science, Hokkaido University.

Introduction: A planetary impact breaks up rocks and/or bedrock into small pieces. Although a fraction of the ejecta might get enough kinetic energy to escape from the gravity to make a source of interplanetary dust [1,2], others return back onto the surface. Break-up of rocks and/or bedrock also occurs by bombardment of micrometeoroids. Thus small pieces of rocks or dust grains are formed continuously on the surface of airless asteroid.

Dust grains at the surface of an asteroid easily levitate due to small gravity. If grains gain enough energy to escape the gravity, the asteroid loses its mass. This could explain the shrinkage of asteroid Itokawa [3]. Otherwise, even when the kinetic energy of dust grain is not enough to escape the gravity, the dust could migrate laterally [4]. In this case dust levitation not only changes the landform features but also affect the thermal evolution of the asteroid since thermal conductivity of dust grain layer is much smaller than rocks or bedrock. If dust grains are heterogeneously distributed on the surface of asteroid, the distribution pattern can be observed as the heterogeneity of thermal inertia [5].

The possible triggers for dust levitation are: another impact, tidal force from sun and/or planets, seismic shaking [6], granular flow [6,7], photoelectric force [4,8,9,10], etc. Among them, photoelectric force is one of the most plausible processes to levitate dust grains constantly [4,8,9,10,11]. For example, a horizontal glow on the moon taken by television camera on Surveyors 5, 6 and 7 [12,13,14] and the similar phenomena observed by astronauts on Apolo 17 mission [14,15] and by Clementine spacecraft [16,17] are thought to be caused by forward scattering of sunlight from transient dust cloud due to photoelectric dust levitation [18,19]: An airless asteroid with resistive surface is charged up by a balance between photoelectric effect due to solar EUV and implantation of solar wind electrons, resulting an upward electric field above the surface. At the same time a dust grain at the surface also charged up resulting electric repulsion between the dust grain and the surface [4,8,9,10].

Dust motion within the photoelectric sheath above the surface is not so simple because electric charge of the dust grain changes with time due to sticking of photoelectrons. To trace the dust motion, we need to simulalte the time evolution of the charge of the dust grain numerically [8,9,10].

Recently Hartzell and Scheeres [20] compared cohesive force between a dust grain and surface with electric repulsion force between them. They showed that cohesion force exceeded the electric repulsion force for dust grain smaller than 10 um and concluded that it is difficult for sub-micron-sized dust grain to be separated from the surface by electric repulsion [20]. However they assumed the charge of a dust grain was given as time-averaged one, which is smaller than the charge of one electron for 10 um or smaller sized dust grain. Instantaneous electric force should be estimated for quantized charge and one electron charge is enough for 1 um-sized dust grain to be detached from the surface. On the other hand it is not clear how high detached small dust grains can levitate since the motion of dust grains is not so simple. Thus in this study we carry out numerical simulation to trace the motion of dust grains on and above the surface of Eros, Moon, and Itokawa.

Numerical Model: Basically we follow the numerical method by Colwell et al.[4] but the energy distribution function for photoelectrons and the formulation of sticking of photoelectrons onto dust are revised. For the initial condition we do not assume lauch velocity of a dust. Instead we assume that a dust grain rests on the surface with positive charge of one electron.

Numerical Results: Fig. 1 shows vertical motion of dust above Eros. The grain size is varied from 0.01 to 0.04 um. As is shown in this figure dust grains with radius between 0.02 and 0.04 um librate above the surface for a long time. This is because of the balance

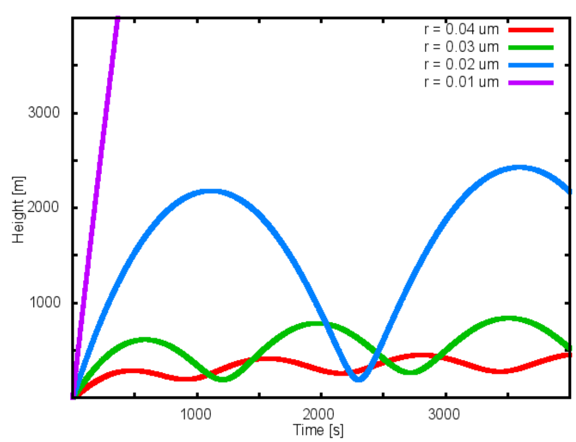

Figure 1: Motion of dust grains with radius from 0.01 to 0.04 um above Eros.

between gravitational force and electric repulsion. When the radius of dust grain is smaller than 0.01 um, the dust grain can escape from the gravity of Eros. On the other hand when the radius of dust grain is larger than 0.05 um, it plunge into the surface immediately after detachment due to negative charge up by sticking of photoelectrons from the surface.

For the case of Moon, dust grains whose radius is smaller than 0.01 um can librate (Fig. 2). The critical size for libration of dust is smaller for Moon than for Eros due to larger gravitational acceleration. For the case of Itokawa we find that dust grains smaller than 0.04 um escape from the gravity (Fig. 3). We have not obtained libration solution for the case of Itokawa.

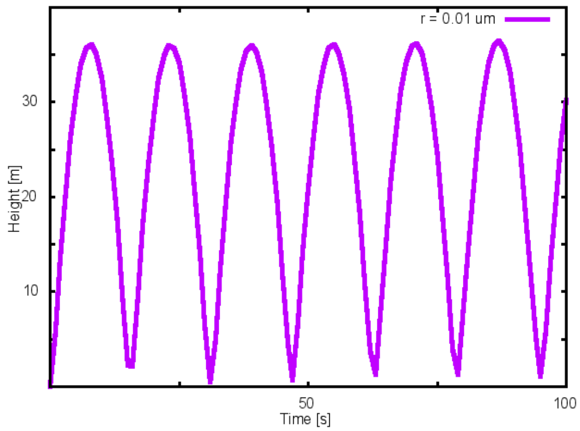

Figure 2: Motion of a dust grain with radius of 0.01 um above lunar surface.

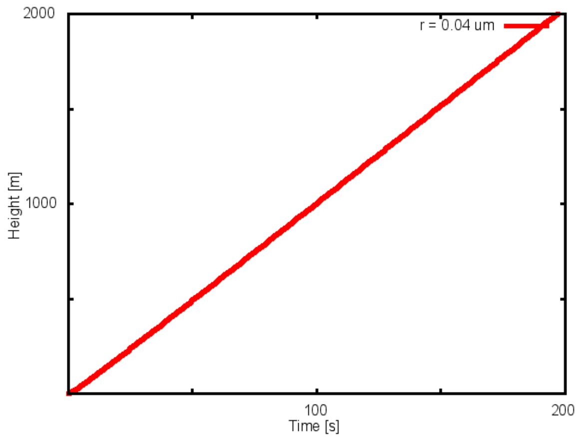

Figure 3: Motion of a dust grain with radius of 0.04 um above the surface of Itokawa.

Conclusion: We developed numerical model for the motion of dust grains within thin photoelectron sheath and simulated the dust motion above surface of Eros, Moon, and Itokawa. Our numerical results show the critical size for dust grain to librate above surface is among 0.02 and 0.04 um for Eros, less than 0.01 um for Moon, and not found for Itokawa. These sizes are about one orders of magnitude smaller than previous model [4] in which each dust grain has a launch velocity as an initial condition. Such a small dust grain might be picked up by solar radiation pressure.

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