NUMERICAL SIMULATION OF LUNAR SURFACE CHARGING AND ELECTROSTATIC DUST LOFTING DUE TO SOLAR WIND AND UV IRRADIATION

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The interaction with the surrounding plasma has several effects on the Moon, and one of them is suggested as electrostatic transportation of the lunar dust grains while the lunar surface is simultaneously charged by the continuous flux of the ambient plasma and the solar irradiation. The lunar surface emits photoelectrons when it is exposed to the solar ultraviolet and X-ray radiation, and this photoemission current establishes a current balance with the secondary electron emission and the collection of electrons and ions from incoming plasma. Since the Moon orbits the Earth under the solar wind influence most of the time, the upstream plasma conditions are typically driven by the solar activity. In addition, the lunar surface potential, electric field and Debye length change with variations in solar wind conditions, and the lunar dust grains can be lofted and/or levitated above the surface according to the current sources. Therefore, the conditions of fast and slow stream solar wind as well as post-shock plasma, early CME and late CME passages are investigated in order to figure out how the lunar dust particles can reach higher altitudes in this study. In addition, the electrostatic forces acting on the submicron-sized lunar dust particles are compared to the gravity and cohesive forces. Through the numerical simulations of the lunar surface and dust charging, the following outcomes were obtained. First, it has been observed that solar flare events produce strong electric field on the dayside of the Moon, and the dust grains can travel through dense and thin plasma sheath above the dayside surface. Second, very cold and low-density plasma, which can be seen during early CME passages, creates large positive potentials on the subsolar point similar to the solar flare events. Third, the results showed that strong electrostatic forces are not sufficient solely to loft the dust particles to higher altitudes since the time to travel through the plasma sheath above the surface is important to accelerate the charged dust grains to proper velocities. Lastly, the post-shock plasma limits the positive charging of the subsolar point while it increases the electrostatic force acting on the dust grains above the terminator region.

Keywords: lunar dust, lunar surface charging, dust lofting, solar wind, coronal mass ejection