Numerical Simulations of Plasma and Charged Dust Transport near Lunar Holes

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The moon has neither dense atmosphere nor intrinsic magnetic field, and solar wind interactions with lunar surfaces are one of major plasma processes. The near-surface, dayside electrostatic environment is governed mainly by volume charges of solar wind plasma and photoelectrons as well as charged lunar surfaces. In fact, the electric environment strongly depends on surface topologies, as it will produce a shaded region, the electric environment of which can be very different from that in a sunlit condition. As one of high-profile terrains on the Moon, we have been focusing on the lunar vertical holes (or lunar pits), identified by the KAGUYA satellite and the Lunar Reconnaissance Orbiter. In order to model the distinctive electric and dust environments near the holes, we have started three-dimensional particle simulation analysis.

The present study addresses the plasma environment of a lunar hole that is accompanied with a subsurface cavern. Besides the topographical effect of having a cavern, an investigation is focused on the following points. The first point is how deeply the solar wind protons are accessible into the hole and cavern. This point is relevant not only to an electric environment but also to possible existence of volatiles at permanently shaded regions of the hole. In order to examine the possibility, we implemented a proton scattering process at lunar surfaces into the simulation model. The other is the role of some minor current components such as secondary electrons, scattered protons, and charged dust grains at the lunar surface. Such minor currents become important for the charging of shaded surfaces, as major current components (solar wind plasma and photoelectrons) are not accessible there. We address these points based on kinetic model descriptions.

Keywords: the moon, plasma, dust grains, lunar surface charging, vertical hole, particle simulation

