

Numerical simulation of Langmuir probe characteristics near the lunar surface

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In recent years, lunar utilization has been planned, as exemplified by NASA's Artemis Project. If the Moon becomes available, it is believed that it can be used as a base for exploration into deep space and as a space for human activities. However, the Moon does not have an atmosphere or a global-scale intrinsic magnetic field, and the interaction of space plasma with the lunar surface results in electrification. The charged state of the lunar surface is determined by the balance between the inflow of solar wind and magnetospheric plasma and photoelectron emission due to solar irradiation and is thought to occur on a variety of spatial scales, from global to topographic and even regolith scales. It is assumed that the electrostatic force associated with charging causes dust in the regolith to fly up on the lunar surface. During the Apollo program, problems such as malfunctions of space suits and equipment and adverse effects on the human body due to dust have been reported. Therefore, it is important to understand the charged environment prior to lunar utilization, but currently no accurate measurement method has been established. The objective of this study is to devise this method through computer simulations. To achieve this objective, it is necessary to simulate various patterns because conditions differ in the solar wind and in the magnetosphere, and in sunlight and shade, but this requires long computation time. In this study, we aimed to reduce the computation time as the first step, and specifically attempted to run simulations in two dimensions instead of three.

To simulate the lunar surface environment under various plasma environments, this study uses the 3D spatial simulation code EMSES, which can solve the charging of objects in plasma. In this study, we decided to perform the simulation in two dimensions in order to shorten the computation time, and we can theoretically obtain the current-voltage characteristics of a conductor in two dimensions by deriving the case of two dimensions from the theoretical equation for the current-voltage characteristics of a conductor in plasma in three dimensions and comparing it with the results of EMSES performed in two dimensions. We confirmed that the current-voltage characteristics of a conductor in two-dimensional space can be obtained theoretically. Currently, we are running simulations in 2-D space to obtain the current-voltage characteristics by vertically extending a probe from equipment installed on the lunar surface to investigate the peculiarities in the lunar environment. In this presentation, we will present the theoretical equation for the current-voltage characteristics of a conductor in 2-D plasma and its demonstration, as well as the results of the current-voltage characteristics obtained from equipment installed on the Moon's surface.

Keywords: EMSES, Moon, Langmuir probe, 2D, OML Theory, I-V Characteristics