Remote sensing of electric potential at lunar surface

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The electric field near the lunar surface plays an important role in the lunar environment. Due to a balance between the solar UV photon fluxes, solar wind plasma (protons and electrons), and secondary electrons, the lunar surface can accumulate the charge. The electric potential may loft the dust in regolith, preferably in the terminator region. The lofted dust particles are presumably scatter the solar photons; an interpretation of the horizontal glow recorded by Apollo astronauts. The electric field is more complex in the region of so-called magnetic anomaly, where the various plasma phenomena are responsible to produce electric potential structure.

In this talk, we will present a new method to map the electric potential remotely. An unexpected measurements of energetic neutral atoms (ENAs) from the lunar surface showed a quite stable backscattering of protons with a rate of 19% (±2%). The ENAs follow a Maxwell-Boltzmann (MB) energy distribution function. The MB temperature was found to have dependency only on the impinging proton energy. Therefore, if impinging solar wind energy changed by the electric potential between the spacecraft and the surface, the MB temperature will be modified according to the potential. This indicates that the MB temperature modification directly addresses the potential between the spacecraft and the surface. We applied this technique to a lunar magnetic anomaly region using an existing dataset of SARA/CENA on Chandrayaan-1 (Figure 1). Electrostatic potential larger than +135 V inside the Gerasimovic anomaly is confirmed. This structure is found spreading all over the magnetized region.

The remote-sensing technique of electric potential provides a complementary way of measuring the electric potential by plasma distribution functions or by electric field probe at the lunar surface. The advantages of this technique are first that the measurement is "passive", i.e. no disturbance to the environment, and second that it can provide 2D map of the electric potential.

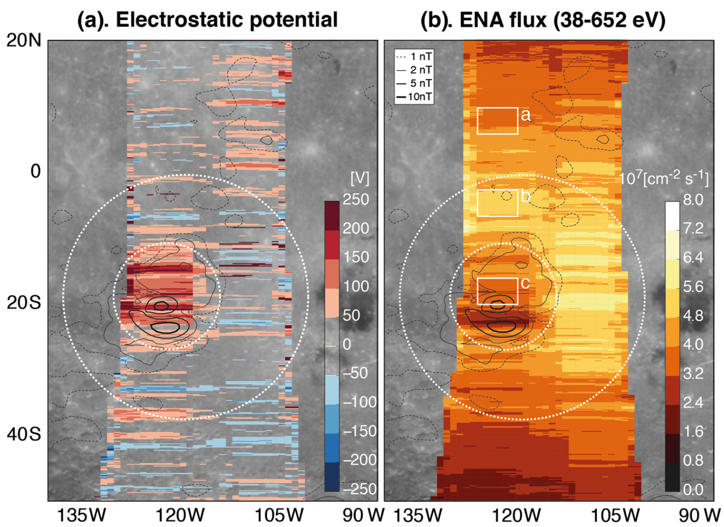

Figure 1: Maps of 1) the electrostatic potential and 2) the ENA flux near the Gerasimovic magnetic anomaly. These are created by using the energetic neutral atom data measured with bu the CENA sensor onboard the Chandrayaan-1 spacecraft. Figure is taken from Futaana et al. [2013].