Asymmetric nightside surface charging of the Moon in the solar wind

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We study nightside surface charging of the Moon using SELENE (Kaguya) data. The Moon spends more than 80 percent of time staying in the solar wind (SW), where a quasi-vacuum region called the lunar wake is formed on the night side. A part of SW electrons, having higher thermal speeds than ions come to the lunar night-side region more easily than SW ions, and consequently the lunar nightside surface charges negatively. This negative surface charging gives rise to upward field-aligned electron beams whose energy corresponds to the potential gap between the lunar surface and the spacecraft. Previous studies have shown that the upward electron beams are observed at ˜100 km height when the spacecraft location is magnetically connected the night side surface, and that the electrostatic potential of the nightside surface depends on the solar zenith angle (SZA) of the foot point (the point on the lunar surface magnetically connected to the spacecraft). Here we report that the nightside region with electron beams coming from the lunar nightside surface depends on the IMF direction around the Moon. When the SELENE spacecraft was near the noon-midnight meridian plane and the IMF had a dominant positive Bx with a small negative Bz, up-coming electron beams (˜100 eV) were detected in the northern hemisphere on the night side, while no beam was found in the southern hemisphere even though magnetically connected to the lunar nightside surface. This observation shows that negative charging was stronger in the northern hemisphere than in the southern hemisphere for the interval. By examining data during other intervals with several SW conditions, we found that the nightside region with up-coming electron beams varies as a function of the IMF direction. These fact means that surface potential on the lunar surface depends not only on the foot-point SZA but also on the IMF direction, suggesting asymmetric electron supply from the SW to the lunar nightside surface.