Geophysical Research Abstracts
Vol. 17, EGU2015-2769, 2015
EGU General Assembly 2015

Night side lunar surface potential in the Earth's magnetosphere

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In the Earth's magnetotail, Kaguya repeatedly encountered the plasmoid or plasma sheet. The low energy ion signatures including lobe cold ions, cold ion acceleration in the plasma sheet-lobe boundaries, and hot plasma sheet ions or fast flowing ions associated with plasmoids characterized the encounters. On the dayside of the Moon, tailward flowing cold ions and their acceleration were observed. However, on the night side, tailward flowing cold ions could not be observed since the Moon blocked them. In stead, ion acceleration by the spacecraft potential and the electron beam accelerated by the potential difference between lunar surface and spacecraft were simultaneously observed.

Similar night side ion/electron signatures were often observed at low altitude $<\sim$50km when Kaguya was in the magnetotail lobe. When Kaguya stayed in the hemisphere where lobe plasma convection direction was from lobe toward the night side of the Moon, MAP-PACE ion sensors found that the lobe cold ions intruded into the night side of the Moon. The ExB drift motion by the dawn-to-dusk electric field facilitated the intrusion of the lobe cold ions. In addition, very cold ions flowing towards the Earth (towards the Moon) were observed in the opposite hemisphere. It was also found that the flow direction of the lobe cold ions intruded into the night side of the Moon gradually changed from tailward to Earthward (Moonward) while slightly increasing their energy. Acceleration of the intruded cold ions by the electrostatic potential distributed on the night side of the Moon could explain the characteristics of the ions. The electron beams accelerated by the potential difference between lunar surface and spacecraft were also simultaneously observed. These electron and ion data enabled us to determine both the night side lunar surface potential and spacecraft potential only from the observed data.