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Solar wind proton scattering at lunar surface

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Interaction between the solar wind and a solar system object varies largely according to the object's properties, such as the existence of a global intrinsic magnetic field and/or thick atmosphere. The Moon's case is characterized by the absence of both of them. Until recently, understanding of the lunar plasma environment has suffered from a lack of in situ measurements of low energy ions. The interaction between the solar wind and the lunar surface has not been understood well until Kaguya observed the plasma environment around of the Moon. Especially, the behavior of the solar wind ions after impacting the lunar surface has never been observationally clear.

MAP-PACE on Kaguya (SELENE) completed observation of the low energy charged particles around the Moon from low altitude (less than 100km) polar orbit. MAP-PACE consists of 4 sensors: two electron sensors (ESA-S1, ESA-S2) and two ion sensors (IMA, IEA). Since each sensor has a hemispherical field of view, two electron sensors and two ion sensors that are installed on the spacecraft panels opposite to each other can make full 3-dimensional measurements of low energy electrons and ions. IMA on Kaguya found scattering of the solar wind ions where the solar wind ions lose energy by the interaction with the lunar surface. Initial analysis found that most of the scattered ions was protons and 0.1% ~ 1% of solar wind protons were scattered at the lunar surface.

We have investigated the angular dependence of the scattering and energy spectra of the scattered protons by using high angular resolution IMA data that were obtained dividing the hemispherical field of view into 16x64 sectors. We have found that the scattered protons have two components : backscattering and specular reflection. Backscattered component distributes within +-40 deg. scattering cone whose axis is aligned with the direction opposite to the incident solar wind ion velocity. The energy loss of the backscattered component is largest along the scattering cone axis and it is smaller at the edge of the cone. We have also found that the energy loss of the specular reflection component is less than that of the back scattered component. We have succeeded in explaining the characteristics of the angular dependence of the backscattered component by making a simple numerical model.

Keywords: solar wind, lunar surface, scattering