Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PPS003-22 Room: 201A Time: May 24 15:30-15:42

Angular dependence of the solar wind proton scattering at the lunar surface

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MAP-PACE on Kaguya (SELENE) completed observation of the low energy charged particles around the Moon from 100km-altitude 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. The interaction of 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. IMA on Kaguya found the scattering of the solar wind protons where the solar wind protons lose energy by the interaction with the lunar surface.
We have investigated this scattering mechanism and energy spectra of the scattered ions by using IMA data obtained dividing the hemispherical field of view into 16*64 sectors.
The maximum energy of the scattered ions was slightly lower than the energy of the solar wind ions, and it had no dependence on the spacecraft position. On the other hand, the minimum energy of the scattered ions has clear dependence on the position (latitude) of the spacecraft. The minimum energy was lowest at latitude 0 deg. and increased when the spacecraft was in the polar region. The output angle of the scattered ions was small in polar region where the incident angle of the solar wind ions was small. On the other hand, the solar wind ions were almost vertically scattered in sub-solar region, and the output angle of the scattered ions were larger than the polar region.
Variations of the magnitude of the energy loss and the output angle with respect to the incident angle of the solar wind strongly reflect the mechanism of the proton scattering at the lunar surface.

Keywords: scattering, lunar, solar wind, proton