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Solar wind-regolith interaction: High reflection of the solar wind
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In this talk we will review new findings of the solar wind interaction with Moon and with Phobos based on the recent observations by the SARA instrument on board Chandrayaan-1 and the ASPERA instrument on board Mars Express. We also discuss potential future contributions of the space plasma investigation to lunar sciences.

High backscattered proton flux of the solar wind from the lunar surface was first reported by Saito et al. (2008) from Kaguya's plasma observations. The flux of the backscattered protons was 0.1-1%. The high backscattering was a big surprise because the lunar surface had been believed a complete absorber of the solar wind. Energetic neutral atom (ENA) observations by the CENA (Chandrayaan-1 Energetic Neutral Analyzer) sensor on board Chandrayaan-1 spacecraft consistently provided data of extremely high (~20%) neutral atom flux of the solar wind origin. The observed reflection efficiencies of backscattered particles both in forms of neutral atoms and ions are too high to be explained by theoretical predictions developed in laboratory experiences. On the other hand, the ratio of the backscattered fluxes between the backscattered neutrals and the ions are in the range of the expectation (10-100).

Not only from the Moon's surface, we also have tried to search for the backscattered protons in the Martian moon Phobos for comparison. We found significant proton flux during a flyby of the Mars Express spacecraft close to Phobos (Futaana et al. 2010). After careful removal of noise counts and comparing with the calculated ray tracing of the observed signals, we concluded that the detected signal can be explained by 0.6-10% reflection of the solar wind at the surface of Phobos. This result indicates that the solar wind backscattering is a general feature of the solar wind-regolith interaction in space.

Even though the interaction mechanism is not yet fully known, such high backscattering fluxes of the ENAs and plasma can be used to monitor solar wind proton access to the lunar surface remotely. We also analyzed the CENA data when the spacecraft flew over magnetic structures of crustal origin (called magnetic anomalies). By inverting the ENA flux obtained by CENA in orbit, we obtained a map of the backscattered ENAs (Wieser et al. 2010). The backscattered ENA flux shows a depletion inside the magnetic anomaly with an enhancement around the anomaly. This observation indicates that the magnetic anomaly deflectes the solar wind protons, and that the lunar surface inside the lunar magnetic anomaly is partially shielded from the solar wind. Consistently, we found clear correlation between the map of magnetic anomalies and the flux of charged protons, which are deflected by the magnetic anomaly (Lue et al. 2011). More than 50% of the solar wind flux are deflected by the strongest magnetic anomalies. The map also showed that even weak and distinct small magnetic anomaly could deflect the solar wind. The deflection of solar wind by the magnetic anomalies indicates a strong reduction of the solar wind access to the surface in the magnetic anomalies, reducing the space weathering effect at the upper crust of the magnetized regions.

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