Kaguya MAP-PACE Plasma Measurements around the Moon

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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. MAP-PACE (MAgnetic field and Plasma experiment - Plasma energy Angle and Composition Experiment) on Kaguya (SELENE) consisted of 2 electron sensors: ESA (Electron Spectrum Analyzer)-S1 and ESA-S2, which measured the distribution function of low energy electrons below 16keV and 2 ion sensors: IMA (Ion Mass Analyzer), and IEA (Ion Energy Analyzer), which measured the distribution function of low energy ions below 29keV/q.

The newly observed data showed characteristic ion populations around the Moon. Besides the solar wind, MAP-PACE-IMA found four clearly distinguishable ion populations on the dayside of the Moon. 1) Solar wind protons backscattered at the lunar surface: The flux of the solar wind ions scattered at the lunar surface was less than about 1% of the incident solar wind ions. Though solar wind consists of alpha particles as a second major component, the scattered ions consisted of almost no alpha particles. 2) Solar wind protons reflected by magnetic anomalies on the lunar surface: When Kaguya flew over strong magnetic anomalies, solar wind ions reflected by magnetic anomalies were observed. Comparing with the ions scattered at the lunar surface, these reflected ions had much higher flux. 3) Reflected / backscattered protons picked-up by the solar wind: The reflected/scattered ions were picked up by the solar wind convection electric field and they were accelerated viewed from the Moon reference frame. Since these ions had initial velocity that was as fast as the incident solar wind ions, the maximum possible acceleration was three times the solar wind velocity. 4) Ions originating from the lunar surface / lunar exosphere: The ions generated on the lunar surface / lunar exosphere were accelerated by the solar wind convection electric field and detected by MAP-PACE-IMA. The mass profiles of these ions show heavy ions including C+, O+, Na+, K+ and Ar+. These heavy ions were also observed when the Moon was in the Earth's magnetotail where no solar wind ions impinged on the lunar surface.

In the lunar wake region, MAP-PACE also found new phenomena in terms of the ion entry into the lunar wake. 1) Type-1 entry: Solar wind protons enter into the lunar wake at 100 km altitude in the direction perpendicular to the magnetic field, as they gain kinetic energy in one hemisphere while lose in the other hemisphere. 2) Type 2 entry: Solar wind protons can enter into the deepest lunar wake (anti-subsolar region at 100 km altitude), and that the entry made strong asymmetry of the near-Moon wake environment.