Co-rotating Interaction Regionsに伴って観測される月起源重イオン

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Moon originating heavy ions associated with Co-rotating Interaction Regions

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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. It is well known that the Moon has neither global intrinsic magnetic field nor thick atmosphere. Different from the Earth's case where the intrinsic global magnetic field prevents the solar wind from penetrating into the magnetosphere, solar wind directly impacts the lunar surface. On the other hand, the ions generated or reflected/scattered at the lunar surface are accelerated by the solar wind convection electric field and are detected by ion detectors on the spacecraft orbiting around the Moon. MAP-PACE on Kaguya made observations of low energy charged particles around the Moon at a circular lunar polar orbit of 100km altitude for about 1 year, at ˜50km-altitude for about 2months, and some orbits had further lower perilune altitude of ˜10km during the last 4 months. Besides the solar wind, MAP-PACE-IMA (Moon looking ion analyzer) found four clearly distinguishable ion populations on the dayside of the Moon. 1) Solar wind protons reflected/backscattered at the lunar surface, 2) solar wind protons reflected by magnetic anomalies on the lunar surface, 3) reflected/backscattered protons picked-up by the solar wind, and 4) ions originating from the lunar surface/lunar exosphere. One of the dayside plasma populations 4) consisted of heavy ions such as C+, O+, Na+, and K+. These heavy ions were accelerated by the solar wind convection electric field and detected by the ion energy mass spectrometer MAP-PACE-IMA on Kaguya. Since the gyro-radius of these heavy ions was much larger than the Moon, the energy of these ions detected at 100km altitude was in most cases lower than the incident solar wind ion energy. Recently, two special examples were found where the energy of the heavy ions was higher than the incident solar wind ion energy. These high-energy heavy ions were observed on the dayside of the Moon when CIR (Corotating Interaction Region) passed the Moon. The high-energy heavy ions were observed for several hours with the highest heavy ion flux observed when the solar wind pressure increased due to the passage of the CIR. The mass spectrum of the heavy ions observed associated with CIR showed H+, He++, He+, C+, N+, O+, Na+/Mg+, Al+/Si+, P+/S+, K+/Ar+, Ti+/Fe+. Although many observational features of the alkali ions around the Moon show that the major generation mechanism of the lunar alkali ion is photon-stimulated desorption, existence of the high-energy non-alkali heavy ions associated with CIR indicates that the contribution of the solar wind sputtering becomes important when the solar wind pressure is high.

The newly obtained knowledge about the solar wind-Moon interaction by Kaguya must contribute to the understanding of the plasma environment around non-magnetized solar system objects.