

Secondary ions of carbon, nitrogen and oxygen from the Moon

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Since the Moon has no global intrinsic magnetic field and only has a very thin atmosphere, the solar wind continuously bombard the lunar surface except when the Moon stays in the Earth's magnetosphere. The solar wind ion hitting causes the secondary ion emission from the lunar surface.

Although the initial energies of such secondary ions are low around several electron volts, the solar wind electric and magnetic fields pick up the ions and sometimes transport them to the outer space.

MAP(Magnetic field and Plasma experiment)-PACE(Plasma energy Angle and Composition experiment) on the Kaguya spacecraft performed the first direct ion measurements of three-dimensional energy and mass information. KAGUYA is a Japanese lunar orbiter which had conducted 1.5-year observation around an altitude of 100 km in 2008-2009. MAP consists of LMAG (Lunar MAGnetometer) and PACE. MAP-LMAG is a triaxial flux gate magnetometer which measures the vector magnetic field with a sampling frequency of 32 Hz and a resolution of 0.1 nT. MAP-PACE consists of four sensors: two electron sensors and two ion sensors. The two ion sensors are the IMA and the IEA. The IMA, the IEA and the two electron sensors have hemispherical FOVs and cover the full three-dimensional phase space of low-energy ions and electrons. Because Kaguya is a three-axis stabilized satellite, the IMA continuously faces the Moon. Thus, it measures ions that mostly come from the Moon, whereas the mounted IEA on the opposite side of the spacecraft measures ions from outer space. The nadir-pointing IMA measured ions which originated from the lunar surface and were at least composed of He⁺, C⁺, O⁺, Na⁺, K⁺ and Ar⁺. The measurements of ions from the Moon provided us with abundance mapping of the lunar secondary ions by the solar wind. We report the features of the lunar secondary ion abundance, especially of C⁺, N⁺ and O⁺ because such light species are well distinguished. We also discuss the feasibility of the remote observation of small bodies' surface materials by measuring secondary ions by the solar wind.

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