Lunar low energy charged particle measurement by SELENE-MAP-PACE

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Low energy charged particles around the Moon were vigorously observed by Moon orbiting satellites and plasma instrumentation placed on the lunar surface in 1960s and 1970s. Many new discoveries concerning the lunar plasma environment were made during the period. Though there are some satellites that explored the Moon afterwards, most of them were dedicated to the global mapping of the lunar surface. Except the low energy electron measurement by Lunar Prospector, and the lunar wake plasma data obtained by the WIND satellite during the Moon fly-by, almost no new information about the low energy charged particles around the Moon was obtained.

SELENE (SELenological and Engineering satellite) is a Japanese lunar orbiter that will be launched in 2007. The main purpose of this satellite is to study the origin and evolution of the moon by means of global mapping of element abundances, mineralogical composition, and surface geographical mapping from 100km altitude. PACE (Plasma energy Angle and Composition Experiment) is one of the scientific instruments onboard the SELENE satellite. PACE consists of 4 sensors: ESA (Electron Spectrum Analyzer)-S1, ESA-S2, IMA (Ion Mass Analyzer), and IEA (Ion Energy Analyzer). ESA-S1 and S2 measure three-dimensional distribution function of low energy electrons below 17keV. IMA and IEA measure the three-dimensional distribution function of low energy ions below 28keV/q. IMA has an ability to discriminate the ion mass with high mass resolution. IMA consists of an energy analyzer that is basically the same as ESA and an LEF (Linear Electric Field) TOF (Time Of Flight) ion mass analyzer. IEA consists of only an energy analyzer that is the same as the energy analyzer of IMA.

The scientific objectives of PACE are 1) to measure the ions sputtered from the lunar surface and the lunar atmosphere, 2) to measure the magnetic anomaly on the lunar surface using two ESAs and a magnetometer onboard SELENE simultaneously as an electron reflectometer, 3) to resolve the moon - solar wind interaction, 4) to resolve the moon - Earth's magnetosphere interaction, and 5) to observe the Earth's magnetotail. The research of the lunar atmosphere and lunar surface material is one of the most important aims of PACE on SELENE. Ground-based observations revealed the existence of tenuous alkali-atmosphere around the Moon in the end of 1980s. The rarefied atmosphere is thought to be produced mainly by solar photons and the solar wind. Sputtering by the solar wind that is one of the source mechanisms that presumably produces the secondary ions reflecting the composition of the lunar surface. In-situ measurements of low energy ions around the moon will provide us with fruitful information on the lunar surface and atmosphere. Detection of the magnetic anomaly on the lunar surface is another important aim of PACE. The solar wind electrons and the magnetotail electrons that reach the Moon will be absorbed if there is no magnetic field on the lunar surface. However, with the existence of the remnant magnetic field on the Moon, the electrons moving with large angle around the ambient magnetic field will be mirror reflected back to SELENE. Measuring the pitch angle distribution of the reflected electrons, the remnant magnetic field on the lunar surface can be deduced. The previous remnant magnetic field measurement using mirror reflected electrons were conducted by the Apollo 15, 16 sub-satellites whose orbits were limited around the equator region of the Moon. Lunar Prospector also measured remnant magnetic field on various areas of the Lunar surface using electron reflectometer. The SELENE PACE-ESA sensors will survey the remnant magnetic field on almost all the lunar surface with higher spatial resolution than previous electron reflectometer measurement.