Lunar Magnetic field And Plasma experiment (MAP) onboard SELENE

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Magnetic field and 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 plasma environment were made during the period. Though there were some satellites that explored the Moon afterwards, most of them were dedicated to the global mapping of the lunar surface. Except the magnetic field and 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 magnetic filed and low energy charged particles around the Moon was obtained.

MAP (Magnetic field And Plasma experiment) is one of the scientific instruments onboard the SELENE satellite. MAP consists of LMAG (Lunar MAGnetometer) and PACE (Plasma energy Angle and Composition Experiment). LMAG is a tri-axial flux gate magnetometer that is equipped at the top plate of a 12m long mast in order to avoid the interference magnetic fields caused by the spacecraft. LMAG measures the vector magnetic field in the frequency range below 10Hz with a resolution of 0.1nT. 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 LMAG are 1) to measure the magnetization structure of the lunar magnetic anomalies, 2) to measure the magnetic field environment caused by the moon-solar wind interaction, and 3) to estimate the electric conductivity structure of the lunar interior by measuring the induced magnetic field. 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.

Detection of the magnetic anomaly on the lunar surface is one of the most important aims of MAP. MAP measures lunar magnetic anomaly by two ways: 1) direct magnetic anomaly measurement by LMAG and 2) magnetic anomaly detection by the simultaneous measurement of LMAG and PACE ESA sensors as an electron reflectometer. 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 remanent 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 remanent magnetic field on the lunar surface can be deduced. The previous remanent 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 remanent magnetic field on various areas of the Lunar surface using electron reflectometer. The SELENE LMAG and PACE-ESA sensors will survey the remanent magnetic field on almost all the lunar surfaces with higher spatial resolution than previous electron reflectometer measurement.