INITIAL REPORT ON THE LUNAR PLASMA MEASUREMENT BY MAP-PACE ONBOARD KAGUYA.

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Introduction: 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 were 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 [1], the lunar wake plasma data obtained by WIND during its Moon fly-by [2], and reports on remote detection of the lunar ions and electrons [3][4] there has been almost no new information about the low energy charged particles around the Moon.

KAGUYA is a Japanese lunar orbiter that studies the origin and evolution of the Moon by means of global mapping of element abundances, mineralogical composition, and surface geographical mapping from 100km altitude. KAGUYA was successfully launched on 14 September 2007 by HIIA launch vehicle from Tanegashima Space Center in Japan. KAGUYA was inserted into a circular lunar polar orbit of 100km altitude and started continuous observation in mid-December. One of the fourteen science instruments MAP-PACE (MAgnetic field and Plasma experiment - Plasma energy Angle and Composition Experiment) was developed for the comprehensive three-dimensional plasma measurement around the Moon.

Instrumentation: MAP-PACE consists of 4 sensors: ESA (Electron Spectrum Analyzer)-S1, ESA-S2, IMA (Ion Mass Analyzer), and IEA (Ion Energy Analyzer) [5]. ESA-S1 and S2 measure the distribution function of low energy electrons below 15keV. IMA and IEA measure the 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 [6]. IEA consists of only an energy analyzer that is the same as the energy analyzer of IMA. Each sensor has hemispherical field of view. Since SELENE is a three-axis stabilized spacecraft, a pair of electron sensors (ESA-S1 and S2) and a pair of ion sensors (IMA and IEA) are necessary for obtaining three-dimensional distribution function of electrons and ions.

Science Objectives of MAP-PACE: The scientific objectives of MAP-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 KAGUYA 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 MAP-PACE. The rarefied atmosphere is thought to be produced mainly by solar photons and the solar wind. Detection of the magnetic anomaly on the lunar surface is another important aim of MAP-PACE. MAP-PACE-ESA sensors will survey the remnant magnetic field on almost all the lunar surface with high spatial resolution.

Lunar Plasma Measurement: After the successful functional check of the low voltage part of MAP-PACE, high voltage power supplies were turned on. The applied high voltage was gradually raised to the observation level. Since MAP-PACE has nearly 20 channels of high voltage, it took almost one week to test all the high voltage power supplies.

Since the start of continuous operation of MAP-PACE on 14 December 2007, MAP-PACE has been observing plasma around the Moon. Electron Sensors (ESA-S1 and S2) have been measuring solar wind electrons, electrons in the wake region of the Moon and electrons in the Earth's magnetosphere. Ion Energy Analyzer (IEA) has been measuring solar wind ions and ions in the Earth's magnetosphere. Though the operation period of IMA as a mass spectrometer is limited to several hours/day (during the commissioning period), IMA has already discovered the existence of alkali ions coming from the lunar surface or lunar atmosphere [7].

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