Lunar Magnetic Field Observation with MAP (Magnetic Field and Plasma Experiment) of the SELENE Project

TSUNAKAWA, Hideo Lunar Magnetic Field Experiment Group (LMAG) of the SELENE Project[1]
[1] -

1. Introduction

The Sun and the planets are scattered like quite tiny spheres in our solar system, most part of which seems vast vacuum space. From the Sun, however, huge amount of ionized particles such as protons are hurled (the solar wind plasma), flowing towards the planet at several hundred km/s. The Earth defends herself from invasion of the solar wind plasma by the shielding effect of the geomagnetism, that is, magnetosphere. As the present Moon has no magnetosphere, it is usually exposed to the solar wind and moves into the Earth's magnetosphere once a month. The Japanese lunar exploration project (SELENE) has started in 1996 and its launch will be done in 2007. MAP (Magnetic Field and Plasma Experiment), which is one of the scientific instruments on the SELENE space craft, enables us to study on the present and ancient (say, 3-4 billion years ago) environment of magnetic fields and plasma on and around the Moon and also on the evolution of its deep interior.

2. Overview of MAP instrument

MAP is composed of two devices: one is for the magnetic field observation (LMAG) and the other for the plasma (PACE). LMAG magnetometer can measure a magnetic field weaker than 10 nT with precision better than 0.1 nT at 1/32 sec sampling intervals. Its sensor is mounted on the edge of a super-lightweight mast extended from the spacecraft at 12m length in order to avoid the magnetic interference. 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 the three-dimensional distribution function of low energy electrons below 15 keV, while IMA and IEA measure the three-dimensional distribution function of low energy ions below 28 keV/q.

3. Principle of observations

We will directly observe three components of the magnetic field at the sensor mounted on the edge of the mast by LMAG magnetometer. As the SELENE space craft is tri-axially controlled with its -z plane facing the lunar surface, each measurement is transformed into the selenographical coordinate system.

PACE sensors are top hat type electrostatic analyzers with angular scanning deflectors at the entrance and toroidal electrodes inside. ESA will be used for the measurement of electrons reflected on the lunar magnetic anomaly due to the mirror effect, which would give the field intensity distribution on the lunar surface (Electron Reflection method). IEA-S and IMA-S have additional electrodes that are used for controlling sensitivity electrically. In order to measure ion mass, LEF (Linear Electric Field) TOF (Time of Flight) ion mass analyzer is attached to IMA.

4. Expected products

There are many magnetic anomalies on the Moon where the field intensity is stronger than ordinary regions. We shall perform the high-precision observation to give more detailed map of anomalies in wider regions, enhancing the study of the magnetic anomaly bearing mechanism and of the existence of the ancient lunar magnetic fields.

The nominal orbit of SELENE will have about 100 km altitude for 1 year observation. During the nominal orbit, detection of magnetic anomalies will be carried mainly by the Electron Reflection method. If the fuel is remaining, the optional observation can be performed with low altitude orbits of less than 50 km, possibly for 1-3 months. In the low altitude observation, we could measure the magnetic anomaly with better precision and spatial resolution.

The observed data of the magnetic field will be analyzed first by the MAP scientific team to provide Level 2 data base (L2DB). L2DB will be opened for the public use about 1 year after the end of observations.