Electron and Ion Spectrometer (EIS) onboard NOZOMI

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The EIS is designed to measure the composition of electron and heavy ions in the Mars and interplanetary space from energies 40 keV to 800 keV. This system contains two types of energetic particle telescopes. One is TOF-E telescope which employs time-of-flight/energy analysis to determine the mass of ions. The other is deltaE-E telescope which consists of two silicon detectors. The main parameters for EIS sre shown in Table 1.

The TOF-E component consists of grids and a silicon detector. The flight time between start grid(G1) and stop grid(G2) is measured by two microchannel plates(MCPs). Secondary electrons emitted from a scatter foil are reflected by the reflector, and the time difference between the start and stop signals from MCPs, which is proportional to 1/v (v:particle velocity), is measured. Particle energy is measured by the silicon detector (480 micron thickness). The flight-time (TOF) vs energy (E) table determines the ion species. The count efficiency of TOF-E spectrometer for singly charged particles (electrons and protons) is very low, because of low ionization loss rates in the grids G1 and G2. Electrons and protons are measured by the deltaE-E telescope. There sre two separated areas is deltaE detector, one of which has an aluminum foil to prevent low energy ions (less than 40 keV protons). The lower limit of energy is 40 keV.

We list below the main scientific objectives of the EIS instrument for the NOZOMI mission.

(1) Ion pick-up processes: Mars is expected to possess an extended oxygen corona. Because of the low gravity, oxygen atoms produced through dissociative recombination of O_2^+ in Martian ionosphere may extend deep into the exosphere. The energy coverages and the wide field-of-view of EIS detectors (owing to the spacecraft spin) are well suited for the detection of heavy picked-up ions and will add significantly to the observation results of Phobos-2 mission, for which the field-of-view of energetic particle detectors was limited.

(2) Acceleration at the bow shock: It has been suggested that energetic particles appear preferentially near the Martian bow shock. Such accelaration processes have also been detected at the earth's bow shock and other planetary bow shocks. An interesting point for the case of Martian bow shock is the way oxygen ions influence the shock dynamics. It is necessary to evaluate the importance of the shock acceleration processes for the overall budget of acceleration and transport around Martian magnetosphere for different IMF conditions, and compare it to the case of earth.

(3) Ion escape from Mars: Phobos-2 observation has established that Mars has an induced magnetic tail consisting of draped IMF field lines. Limited information derived from Phobos observations indicates that ions of diffetent mass gain the same amount of energy through the acceleration processes. The presence of this kind of acceleraion mechanism constitutes an important target of the EIS observation in the tail.

(4) Transport and energization of solar particles: Monitoring of solar energetic events from Mars and the earth orbits by NOZOMI and other spacecraft will provide new insights into the transport of energetic particles in the interplanetary medium. Compression of the solar wind and IMF near the Martian ionopause around the subsolar point will lead to energization particles due to the conservation of the first adiabatic invariant. Some of the solar particles and Jovian electrons may be trapped or quasi-trapped because of the Martian local magnetic field. Contribution of ions and electrons of exterior origin to energetic population around Mars is an important subject that should be addressed by the NOZOMI mission.