Geophysical Research Abstracts, Vol. 7, 08999, 2005
SRef-ID: 1607-7962/gra/EGU05-A-08999

High-energy particle instruments for the exploration of the Mercury's magnetosphere by BepiColombo-MMO

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Not only in the aspect of solid planetary science but also from the viewpoint of magnetospheric physics, Mercury is still one of unknown planets. In the past, only one spacecraft mission, Mariner 10, has explored Mercury through three fly-by observations. In these restricted opportunities, the dipole-type magnetic field and the high-energy particle bursts were obviously detected, which should be regarded as the most remarkable results in the magnetospheric physics. These amazing observations strongly suggest the existence and active phenomena of the Mercury's magnetosphere. For the next Mercury's magnetospheric exploration by the BepiColombo mission based on a collaboration of ESA and ISAS, two types of high-energy particle instruments were proposed and approved for the Mercury Magnetospheric Orbiter (MMO), one of two spacecraft of the mission. The scientific targets of the high-energy particle measurement selected for MMO are as follows. 1. Re-examination of high-energy particle burst events observed by Mariner 10. 2. Probing particle acceleration and injection related to the Mercury's substorm. 3. Investigation of whole or partial ring current. 4. Diagnostics of the magnetic field configuration by high-energy particle tracing. 5. Research of the shock formation near the Mercury's orbit. 6. Search of energetic particles in typical or possible regions in and near the Mercury's magnetosphere (e.g., cusp, boundary, tail or plasma sheet, and sheath). The high-energy particle instruments sufficiently covering a high-time resolution, and wide energy, angular, and dynamic ranges, will be crucial to reveal the structure and dynamics of the Mercury's magnetosphere. The thermal condition of the spacecraft in orbit around Mercury is very severe, and the budgets of the weight and the electric power consumption for

the scientific payloads are quite restricted, which requires a special design concept for instrumentation. We are currently developing two principal methods for high-energy particle measurements. One is a time of flight (TOF) system for the particle velocity analysis, and another is a solid-state detector system for the particle energy analysis. We have finalized the detailed design for the velocity analysis using a TOF unit with a numerical method. The characteristics of the proto-type TOF unit and SSD system are now being investigated in our laboratory. This paper presents the design principle and specifications of our high-energy particle instruments for MMO.