磁場のソレノイダル性を満たす MHD コードを用いた水星グローバル磁気圏シミュレーション:太陽風パラメータへの依存性

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Global MHD simulation of the Mercury's magnetosphere based on a new MHD code: Dependence on the solar wind parameters

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From the observations by Mariner 10, it has been suggested that the Mercury's magnetosphere might be an analogous to the Earth's magnetosphere. The temporal and spatial scales of the Mercury's magnetosphere are much smaller than those in the Earth's magnetosphere because of its week intrinsic magnetic field and strong dynamic pressure of the solar wind at the Mercury's orbit. There have been several studies of the numerical simulation for the Mercury's magnetosphere. The MHD simulation is one of the powerful methods to understand global structure of the magnetosphere. However, in the Mercury's magnetosphere, it should be pointed out that the kinetic effects of plasma might not be negligible because of a large gyro-radius of heavy ions. Statistical trajectory tracing of test particles is the important scheme to investigate the kinetic effects of particles. Previous studies by Delcourt et al. [2003; 2005] used analytical models of electric and magnetic fields that are obtained by rescaling the Earth's magnetosphere and calculated the motion of planetary sodium ions. Although this approach is efficient to see the dynamics of heavy ions, resultant properties largely depend on the field models. Therefore, it is important to examine the particle motion in the self-consistent MHD magnetic field. In this study, we developed a new MHD simulation code for the Mercury's magnetosphere that automatically satisfies solenoidal condition for the magnetic field (B) i.e., divB=0. The solenoidal condition of magnetic field is required in the test particle simulation, because non-solenoidal magnetic field causes artificial particle acceleration and/or deceleration. To fulfill the condition, we solve a set of MHD equations based on the vector potential instead of the magnetic field itself. As an initial result of the simulation, we calculated the global structure of the Mercury's magnetosphere, such as the bow shock, magnetopause, and cusp, which are successfully resolved with a few grids. Moreover, we examined the structure of the magnetosphere, especially the distance of bow shock/magnetopause, under different solar wind conditions. In this presentation, we discuss the advantage of the developed code and global structures of the Mercury's magnetosphere and its dependence on the solar wind conditions.