Effects of solar wind conditions on the sodium ion dynamics in the Mercury's magnetosphere

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From observations by Mariner 10, it has been suggested that the Mercury's magnetosphere might be an analogous to the Earth's magnetosphere and observations by MESSENGER in 2008 seem to support this assumption. On the other hand, 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. 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 an 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. Delcourt and Seki [2006] suggested that dynamics of sodium ions is sensitive to the solar wind conditions based on trajectory tracings of the sodium ions in the magnetic and electric fields obtained from MHD simulation with southward IMF (interplanetary magnetic field) conditions. In the trajectory tracings, satisfaction of divB=0 condition is important to avoid artificial acceleration/deceleration. We have developed a new MHD simulation code that automatically satisfies divB=0 condition and applied it to the Mercury's magnetosphere. Basic structures of the magnetosphere such as the magnetopause, shock, and cusp are successfully formed with the several solar wind conditions. The location of each structure depends largely on the solar wind condition because of the week intrinsic magnetic field of the Mercury. In this presentation, we discuss the effects of the solar wind condition on the sodium ion dynamics by comparing a few cases of statistical trajectory tracings in the MHD field with a focus on the northward IMF conditions.