

Study of heavy ion dynamics in the Mercury's magnetosphere on the basis of multi-scale simulations

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Based on observations by Mariner 10 and MESSENGER, Mercury's magnetosphere is thought to be a miniature of the Earth's magnetosphere. While these two magnetospheres have several characteristics in common, some critical differences are also evident. First, there is no atmospheric layer, but only tenuous exosphere. Second, the kinetic effects of heavy ions might not be negligible because Mercury's magnetosphere is relatively small compared to the large Larmor radii. Trajectory tracings is one of the dominant methods to estimate the kinetic effect of heavy ions which originate the exosphere, though the results of the simulation are quite sensitive to the electric and magnetic field. Hence, it is important to provide a realistic field model in the trajectory tracings. In order to construct a large scale structure, we developed a MHD simulation code, and adopted to the global simulation of Mercury's magnetosphere. We performed four solar wind conditions of the northward IMF, and the results showed that the global configurations such as the location of magnetopause depend heavily on the dynamic pressure, while the solar wind electric field contributes little to the magnetospheric configuration. On the other hand, the results of statistical trajectory tracings of exospheric sodium ions depend not only on the dynamic pressure but also on the solar wind electric field. In the results, we identified two efficient acceleration processes and formation of 'the sodium ring' which is formed by the accelerated ions drifting around the planet by magnetic gradient of the dipole field. When the solar wind dynamic pressure is low, acceleration by magnetospheric convection is efficient in the vicinity of Mercury. When the dynamic pressure is high, entry of the accelerated ions picked-up in the magnetosheath into the magnetosphere becomes dominant. The entry point of sodium ions changes due to the variation of the solar wind electric field, which causes a difference in the sodium ring's shape for the same solar wind dynamic pressure cases. Recent observation by MESSENGER revealed the weaker dipole field of Mercury than the past estimation based on Mariner 10 as well as large offset of dipole which could change the global configuration of Mercury's magnetosphere and behavior of sodium ions. In the presentation, we will also discuss the ongoing simulation including the above configuration of intrinsic magnetic field of Mercury especially focus on how will this affect the acceleration mechanisms.