Hybrid simulation of interaction the solar wind and the mini-magnetosphere

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A three-dimensional electromagnetic hybrid simulation (kinetic ion, fluid electron) is being developed for a study of interaction between the solar wind and the mini-magnetosphere of the dipolar magnetized objects. The study is important for not only understanding of the physical interaction processes for magnetized asteroids but also evaluation of the magnetic sail propulsion that uses a static artificial dipole magnetic field to deflect the solar wind. One of important physical parameters characterizing the magnetosphere is a distance ahead of the object where the dipole magnetic field pressure balances the solar wind ram pressure. If the distance is much smaller than the ion inertial length, the interaction is very weak and changes in the solar wind velocity and density is negligible. On the other hand, if the distance becomes much larger, it will approach an earth-like magnetohydrodynamic magnetosphere. However if the distance is the order of the ion inertial length, the ion kinetic effects become much crucial for the formation and structure of the mini-magnetosphere. For the study of such mini-magnetospheres, the hybrid simulation is suitable. We still need to develop the inner boundary condition around the magnetized objects, the initial condition bringing on an over-development of the plasma wake in the shadow of the dipole field and the inclusion of the background thermal plasma in the magnetosphere, etc.