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Interaction between solar wind flow and the Hermean magnetosphere: hybrid simulations

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We examine the interaction of the Hermean magnetosphere with the solar wind using global three dimensional hybrid plasma simulations. Hybrid simulations treat ions as particles and electrons as a fluid. Having ions as particles allows ion kinetic behavior and waves to be included in the physical treatment of the plasma as compared to magnetohydrodynamic (MHD) modeling that treats the plasma as a single magnetized fluid and does not include such kinetic effects. Kinetic effects are essential for understanding magnetospheric physics. Hybrid simulations scale to the ion inertial length and thus on a global scale are somewhat limited in spatial extent compared to an MHD simulation. We note effects caused by the scalling of the numerical model of the magnetized obstacle interacting with the solar wind flow with the full scale simulation.

In this paper we shall focus on the study of the overal structure of the bow shock and magnetosheath formed in front of Mercury under different solar wind conditions, namely, in the perihelium and aphelium points of the excentric Hermean orbit. We examine the formation of the magnetospheric tail. We study particle distribution functions in different locations of the numerical model of the Hermean magnetosphere. We make qualitative comparison of the numerical results with the observations of Mariner 10.

Hermean magnetosphere is estimated to be only a few times the planetary radius, it can fit within a hybrid simulation system. The overal structure of the interaction between a magnetized obstacle in the solar wind flow is determined by few basic parameters (namely the solar wind density, background magnetic field, and the speed of solar wind, and also the strength of the magnetic dipole of the obstacle and its radius). The

structure of the interaction of the solar wind flow with Mercury is to a large extend unique when compared to other planets. For example, the magnetic moment of the Mercury is over 1000 times smaller than that of the Earth and also the solar wind is stronger nearby Mercury than at Earth's vicinity. The typical magnetosperic scales are comparable to the ion gyroradii and hence kinetic effects are important for the overall structure of the interaction between the Hermean magnetospere and the solar wind.