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Development of MHD model of the turbulent magnetosphere

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The mean free path of plasmas surrounding the magnetosphere is about 1 AU and thus it is usually referred to as a super-high Reynolds flow or collision-less plasma. Actually, it was reported that the Reynolds and the magnetic Reynolds numbers are order of 10ˆ11 based on the coulomb collision rate [Borovsky, 1997]. The actual situation is therefore much more turbulent than we expect from the recent global MHD simulations of the magnetosphere interacting with the solar wind.

To show importance of turbulence in the context of an energy transport at the boundary layer (low beta) and an acceleration of plasmas in the plasma sheet (high beta), we are developing a new MHD model of the global magnetosphere. The model is based on the CIP algorithm [Yabe et al., 2001] which enables us to solve MHD equations stably with a low numerical dissipation, i.e., a high Reynolds number. The code solves MHD equations based on the Elasser variables [Elsasser, 1950; Matsumoto and Seki, 2008] for the advection and the Alfven wave propagation. The compressive terms are remained as non-advective terms which are descretized on a staggered grid system and solved by the 3rd order Adams-Moulton predictor-corrector method. Some 1-D and 2-D numerical tests are shown in this presentation. A 1-D test shows that the present code successfully reproduces shock formation by introducing a shock capturing artificial viscosity [Ogata and Yabe, 1999]. 2-D simulations of the Kelvin-Helmholtz instability (KHI) with a variety of spatial resolutions are examined to show that the KHI is well reproduced with a initial shear width represented by 2 grids, ensuring that the KHI will be reproduced in the MHD model of the global magnetosphere with a resolution of dx=1/3Re. The preliminary result of our new global MHD model is also shown in this presentation.