

## Global Kinetic MHD Simulation by the Gyrokinetic PIC Code

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In order to simulate global kinetic magnetohydrodynamic phenomena in tokamaks, a new gyrokinetic PIC (particle-in-cell) code, Gpic-MHD, is developed. The present version of Gpic-MHD is written in cylindrical geometry and is based on the electromagnetic gyrokinetic PIC code in rectangular coordinate (gyr3d[1]) and the gyro-reduced-MHD code in cylindrical coordinate (GRM[2]). Gpic-MHD and GRM are based on the same MHD-type normalization and use common subroutines and diagnostics. The physical model of Gpic-MHD is more fundamental and inevitably needs huge computer resources. On the other hand, GRM captures the basic physics of kinetic MHD but the validation of the soundness of model is necessary (the so-called 'closure' problem). The benchmark runs between the codes are useful to increase the reliability of both codes. The  $m=1$  kinetic (collisionless) internal kink mode is simulated by both Gpic-MHD and GRM. The results are basically same with a slight difference which comes from the approximation used in the estimation of pressure term in GRM. Both codes have single-helicity (2-dimensional) and multi-helicity (3-dimensional) versions. The implementation of split-weight-scheme [3] to Gpic-MHD is ongoing. The formalism has been revisited recently with new perspective and the physical understanding of the resultant equations will be discussed.

[1]H. Naitou, K. Tsuda, W. W. Lee, R. D. Sydora: *Phys. Plasmas* **2** (1995) 4257-4268.

[2]H. Naitou, T. Kuramoto, T. Kobayashi, M. Yagi, S. Tokuda, T. Matshumoto: *J. Plasma and Fusion Res.* **76** (2000) 778.

[3]W. W. Lee, J. L.V. Lewandowski, T.S. Hahm, and Z. Lin: *Phys. Plasmas* **8** (2001) 4435-4440.