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新しいハイブリッドコードによる磁気回転不安定性の非線型シミュレーション
Numerical Simulation of Kinetic Magnetorotational Instability using a new Hybrid Technique

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The evolution of Magnetorotational instability (MRI) is considered to be important in the context of efficient angular momentum transport in the accretion disks in our universe. Conventionally, the nonlinear evolution of MRI is studied under the MHD approximation which assumes the mean free path of the plasma is sufficiently small compared to the actual size of the disk. However some classes of the accretion disks, for example the disk around SgrA∗, are found to be constituted with a collision less plasma and therefore the kinetic effect of the plasma, such as generation and relaxation of the pressure anisotropy, should be taken into account.

For the inclusion of the kinetic plasma effects, hybrid code, which treats ions as particles and electrons as massless charge neutralizing fluid, may provide a robust approach resolving the ion scale physics and integrating over the Keplerian time scale. However in the 2 dimensional simulation of the MRI, it is well known that the system eventually grows to a set of channel flows. In this state, the density of the plasma is found to be extremely low in the region where the magnetic field is enhanced as a result of a strong dynamo effect of the differential rotation of the disk. In this low density, strong magnetic field region, the CFL condition determined by the R-mode wave is found to be severe. Moreover, since the extremely low density region is generated in the channel flow, the division-by-density operation in the conventional hybrid code leads to an unexpected termination of the calculation.

In this study we adopted a new approach of hybrid simulation to a differentially rotating system. In this approach, the finite electron inertia is taken into account which gives a upper bound in the phase velocity of the R-mode wave, providing a reduced CFL condition. In addition, the new approach is almost free from the division-by-density operation and the extremely low density region generated in the channel flow can then be calculated appropriately. With this new code we would like to discuss the nonlinear evolution of the 2 dimensional kinetic MRI.

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