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Stratified simulation of collisionless accretion disks by kinetic MHD with anisotropic pressure

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Abstract

An accretion disk around a supermassive black hole is thought to consist of a collisionless plasma. Particle-in-cell and Vlasov simulations are typical numerical approaches to investigate such a collisionless system. In the case of the accretion disk, however, the large deviation between the disk scale and the kinetic scale of particles makes it impossible to apply these simulation techniques directly. To study the large-scale dynamics of collisionless disks, therefore, the so-called kinetic magnetohydrodynamics (MHD), which can take into account some of kinetic effects, is required.

We, particularly, focus on the effect of anisotropic pressure. It can modify the nature of magnetorotational instabilities (MRIs), which play important roles for the angular momentum transport in accretion disks. We carried out series of kinetic MHD simulations using a *stratified* shearing box model, and found that, by inclusion of the pressure anisotropy, the magnetic energy in the saturated MRI-driven turbulence reduces to one third of that in the isotropic case, due to the anisotropy with $P_{\|} > P_{\perp}$ generated by the MRI itself. On the other hand, the magnetic energy in large-scale structure gets much smaller roughly by one order of magnitude, which implies that the dynamo action might not work efficiently in the collisionless disks.