Comparison of different subgrid models of MRI-driven turbulence

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The magnetorotational instability (MRI) is a promising mechanism to explain magnetic field amplification and angular momentum transport in many astrophysical situations, from accretion disks to neutron stars. Resolving the MRI well in binary neutron star or neutron star black hole mergers is essential, as generating a strong large-scale magnetic field can lead to relativistic outflows and explain some gamma-ray bursts. However, the resolution required by the MRI-driven dynamos makes the global relativistic simulations very expensive. To make the simulations more efficient, some efforts to develop subgrid models of the MRI have been made in the past few years, and further comparisons of these models are needed, especially in the proper parameter regime for the diffusion processes.

I will present the analysis results of stratified MRI-driven dynamos in simulations of various contexts, from local shearing boxes to ideal GRMHD simulations. We compare different subgrid models, such as a mean-field dynamo, the subgrid gradient model, and MinIt, a model that evolves the subgrid turbulent energies. The a posteriori tests show that an alpha-Omega dynamo model with some off-diagonal components is in good agreement with the different simulations for generating the large-scale magnetic field. This off-diagonal component could be important to model the development of magnetized winds. However, this model does not take into account the angular moment transport by the turbulence, as does the other models. These results are promising to be able to model the MRI turbulence more efficiently and require further investigation of the consequences when these models are implemented.