Impact of Rotation Forcing on MRI-Driven alpha-Omega Dynamos

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The magnetorotational instability (MRI) is a promising mechanism to explain the amplification of the magnetic field and the angular momentum transport in numerous astrophysical situations, particularly in stellar radiative zones. This dynamo, long studied in accretion disks and local shearing boxes, has recently been shown to generate a large-scale magnetic field in fast-rotating proto-neutron stars and in the remnants of binary neutron star mergers. It could thus explain the formation of highly magnetized neutron stars, known as magnetars. However, in the previous simulations of the proto-neutron stars, the forcing of the differential rotation was limiting the MRI-dynamo to low density regions and further exploration is therefore necessary.

I will present the results of new 3D direct numerical simulations of a stratified MRI-driven dynamo with different methods of forcing differential rotation. In all cases, we observe the development of strong turbulence and the generation of an oscillating large-scale axisymmetric field. This behavior can be well described by an alpha-Omega dynamo, and its properties depend on the type of forcing used in the simulation. We also compare the results to global ideal MHD relativistic simulations of binary neutron star mergers and find a good agreement when the differential rotation forcing is strong. This corresponds to the case where the effective shear rate inside the simulation matches the one set by the balance between gravity, pressure, and centrifugal force. These results raise the question of the origin of differential rotation in stably stratified objects, such as stellar radiative zones, and its consequences on dynamo action.