A GRID-SHELL MODEL OF TURBULENT DISK DYNAMO

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The theory of large-scale (mean field) and small-scale (turbulent) dynamos is mainly developed separately. The interaction of these two dynamo mechanism in real astrophysical systems is a weak developed topic. Very high values of hydrodynamic and magnetic Reynolds numbers make impossible relevant direct numerical simulations. Some progress in modelling of turbulent MHD-dynamo is achieved recently using the shell models of turbulence, which also do not describe the turbulent dynamo in all details, but allows one to reproduce many intrinsic features of dynamo action in fully developed turbulence of conductive fluids. It is suggested to combine the mean-field description of large scale dynamo with a shell description of small scale turbulence in a large range of scales. First attempt was done for an α^2-dynamo with prescribed spatial structure of the large-scale poloidal end toroidal magnetic field was considered. We have developed this idea for the case of the $\alpha\Omega$-dynamo in a thin disk taking into account the evolution of the profile of large-scale fields across the disk. The model allows us to keep the balance of energy and helicity of the mean and turbulent fields and the flux of these quantities. The suggested approach gives a possibility to study the role of magnetic helicity in the generation process.

We consider mean-field magnetic field generation subjected to joint action of helical turbulence and differential, rotation in a thin galactic disk. To describe the generation of small-scale magnetic field and its interaction with the turbulent motion we have used the shell-model of MHD-turbulence, introduced by Frick and Sokoloff. The key point is the conjugation of mean field and turbulent fields. We consider the z-depending α which includes the hydrodynamic and the magnetic parts of the α-effect.

The numerical solution of the model reproduces the main features of the magnetic field dynamo:generation of large-scale magnetic field in the fully developed turbulence from random seed field, saturation and the possibility of the global field inversion.