TURBULENT DYNAMO PROBLEM IN ANISOTROPIC HELICAL MAGNETOHYDRODYNAMIC TURBULENCE

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One fundamental theoretical problem in the magnetohydrodynamics is the turbulent dynamo problem, i.e., the problem of the generation of a large-scale homogeneous magnetic field by the energy of the turbulent motion, which attracts large attention due to many applications in both the astrophysical and laboratory plasmas. It is known that the dynamo problem can be investigated on the fundamental level of a microscopic model by using the field theoretic formulation of the stochastic problem based on the stochastic magnetohydrodynamics equations with the presence of helicity (spatial parity violation) [1, 2]. In Refs. [1, 2], it was shown by using the field theoretic renormalization group technique that the presence of the helicity in the system leads to instabilities which are stabilized by the spontaneous occurrence of a non-vanishing homogeneous mean magnetic field which, at the same time, breaks the symmetry of the system. Namely, the generation of the large-scale magnetic field is the necessary condition for damping all perturbations to obtain stable system. However, because the instabilities are not manifested at the level of the action function itself but are found only starting from one-loop approximation, therefore the symmetry is broken dynamically (dynamical symmetry breaking mechanism). In this respect, in Refs. [1, 2] this mechanism was used for investigation of the stochastic magnetohydrodynamics with helical isotropic energy pumping and the absolute value of the generated magnetic field was found. However, the direction of the generated magnetic field remains arbitrary here. On the other hand, as we shall show in the present work the direction of the generated magnetic field is determined uniquely when the presence of anisotropy is supposed in the system. In this respect, we consider the stochastic magnetohydrodynamics with helical and, at the same time, uniaxial anisotropic energy pumping. By using the field theoretic renormalization group approach in the one-loop approximation it is shown that the presence of the uniaxial anisotropy causes that the spontaneously generated large-scale magnetic field has to be oriented in parallel to the axis that defines the direction of the uniaxial anisotropy. Besides, the explicit dependence of the absolute value of the generated magnetic field as function of the anisotropy parameters is found.

References

[1] Adzhemyan, L., Vasil'ev, A.N., Gnatich, M.: Theor. Math. Phys. 72 (1987) 940.
[2] Hnatich, M., Jurcisin, M., Stehlik, M.: Magnetohydrodynamics 37 (2001) 80.