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Evolution of the magnetic field in quasi-two-dimensional chaotic flow

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Turbulent flow of conducting liquid can lead to spontaneous generation of sufficiently large magnetic field fluctuations which is the essence of the dynamo effect [1]. It has been shown for three-dimensional chaotic flow [2-4] that magnetic field correlation moments growth exponentially with time. The evolution of the magnetic field is determined by the change in time of the streamlines in the moving conducting liquid and the diffusion of the magnetic field due to the finite conductivity [1].

The dynamo effect in two-dimensional flows with three-dimensional magnetic field hasn't been studying for a long time since it was shown [5-7] that the value of magnetic field stops to growth and decays exponentially at very large times. This is in agreement with the so-called "anti-dynamo theorem" [5,6]. The statement is supported by rigorous mathematical results [8,9], showing the absence of unlimited growth of the magnetic field in two-dimensional flows on a number of manifolds. However these results don't give us any about factors limited field's growth.

The evolution of small-scale fluctuations was solved at large times in two-dimensional chaotic flow which doesn't depend on vertical component [10]. More precise asymptotics at large times compared to earlier papers [1,11,12] was found in [10].

The magnetic field behaviour at large time in quasi-two-dimensional chaotic flow is studied in presented work. The velocity field is assumed to be chaotic and depending on z. The difference between quasi-two-dimensional and two-dimensional chaotic flows appears to be essential.

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