The determining role of pseudo-Alfvén waves in balancing of MHD turbulence in plane strongly sheared flows

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We investigated the dynamical balance of MHD turbulence in three-dimensional plane flows with strong shear and magnetic field parallel to the main flow focusing on incompressible MHD turbulence. Our research involved direct numerical simulations of the turbulence in both physical and spectral/Fourier space. We analyzed the dynamics of three modes of perturbations existing in such flow system: (1) Alfvén waves with two different polarizations, namely pseudo- and shear Alfvén waves, and (2) uniform along the flow and shear, a basic hydrodynamic mode. We investigated linear and nonlinear processes of the system. The linear coupling between pseudo- and shear Alfvén waves is asymmetric. In the considered shear flow, pseudo-Alfvén waves are the source of energy, they experience transient growth and, due to the coupling, also cause the growth of shear Alfvén waves. These transient growths occur with the overreflection - the emergence and amplification of counter-propagating waves - of both waves. Direct numerical simulations have shown that under strongly sheared flows, the energies of the counter-propagating waves balance out. The connection between Alfvén waves and the basic hydrodynamic mode is nonlinear and plays an important role in the overall dynamics of disturbances/turbulence.