Magnetoclinicity: Density variance effects in large-scale instability in magnetohydrodynamic turbulence

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In the presence of strong compressibility an oblique configuration between the mean density gradient and magnetic field contributes to the electromotive force [1,2]. This effect can be called “magnetoclinicity” and may contribute to the formation of large-scale magnetic-field structure in compressible magnetohydrodynamic (MHD) turbulence. With the aid of the multiple-scale direct-interaction approximation (Multi-Scale DIA), a combination of the DIA and multiple-scale analysis, analytical expressions of the turbulent correlations (turbulent electromotive force, turbulent mass flux, turbulent heat flux, Reynolds stress, turbulent Maxwell stress, etc.) are obtained for the compressible MHD turbulence. Utilizing these analytical results, a large-scale instability of the strongly compressible MHD turbulence is investigated. An analysis into normal modes of the periodic plane waves is performed to get a dispersion relation of the instability modes [3]. It is shown that, depending on the mean density configuration, the inhomogeneity of the mean density variation coupled with the density variance \( \langle \rho'^2 \rangle \) (\( \rho' \): density fluctuation, \( \langle ... \rangle \): average) leads to a finite growth of the mean magnetic disturbance at large scales. This magnetoclinicity effect counter-balance to the turbulent magnetic diffusivity, and contribute to the formation of large-scale magnetic fields. This magnetoclinicity effect is expected to play essential roles in global structure formation in strongly compressible plasma turbulence.

Reference


