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Inhomogeneity and anisotropy effects in magnetohydrodynamic turbulence

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Most turbulence of interest encountered in the scientific and engineering fields is inhomogeneous: accompanied by the inhomogeneity of large-scale or mean fields such as flow shear, rotation, magnetic field, etc. In addition, as in the geo/astrophysical phenomena, the presence of rotation and/or magnetic field makes turbulence anisotropic. Statistical property of turbulence coupled with the mean field (inhomogeneity) determines the effective transports due to turbulence. In this work, the effects of anisotropy and inhomogeneity on the turbulent transport are investigated. In the current closure theory of inhomogeneous turbulence such as the two-scale direct-interaction approximation (multiple-scale analysis combined with a closure theory of turbulence), the basic or non-perturbed field has been assumed to be homogeneous and isotropic; the effects of inhomogeneity are incorporated in a perturbative manner. In this work, we consider a homogeneous but anisotropic state as the basic field. As compared with the previous formulation, where the anisotropy effects appear in the higher-order contribution, in the present formulation the anisotropy appears as a primary effect. As this consequence, this analysis is expected to be appropriate in the case where the rotation and/or large-scale magnetic field play an essential role. The possibility of the turbulent transport suppression (reduction of eddy transport) due to anisotropy is also discussed.

Keywords: turbulence, inhomogeneity, anisotropy, transport