SPECTRUM OF MHD TURBULENCE

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We propose a phenomenological theory of strong incompressible magnetohydrodynamic turbulence in the presence of a strong large-scale external magnetic field. We argue that in the inertial range of scales, magnetic-field and velocity-field fluctuations tend to align the directions of their polarizations. However, the perfect alignment cannot be reached, it is precluded by the presence of a constant energy flux over scales. As a consequence, the directions of fluid and magnetic-field fluctuations at each scale λ become effectively aligned within the angle $\phi_\lambda \propto \lambda^{1/4}$, which leads to scale-dependent depletion of nonlinear interaction and to the field-perpendicular energy spectrum $E(k_\perp) \propto k_\perp^{-3/2}$. Our results may be universal, i.e., independent of the external magnetic field, since small-scale fluctuations locally experience a strong field produced by large-scale eddies. We discuss numerical results and astrophysical applications of the proposed model.