Q06b 非等方磁気流体乱流の統計理論　１．シア・アルフヴェン乱流のＤＩＡ理論

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We develop a statistical theory of strong, homogeneous and anisotropic MHD turbulence within a framework of the Eulerian direct-interaction approximation (DI approximation or DIA). Analysis is concentrated on stationary shear-Alfvén turbulence of which mean magnetic fileld is parallel to the z-direction. We assume that the inertial range (InR) is much larger than the energy-containing range (ECR) in the sense that $p_\perp, |p_z| \ll k_\perp$ for $\boldsymbol{p} \in$ ECR and $\boldsymbol{k} \in$ InR. (The subscript $\perp$ means a component perpendicular to the mean magnetic field.) Then, we can obtain DIA-equations governing time-evolution of the correlation matrix and the propagator matrix in analytically solvable form. The solutions of the DIA-equations include both an Alfvénic oscillation factor depending on k_z and a damping factor depending on $k_\perp$. Applying the solutions to the DIA energy-transfer equation in the wavenumber-space, we can show high anisotropy of energy-cascades. That is, the energy-cascades occur only in the $k_\perp$-direction while k_z-cascades are inhibited. Therefore, we can conclude that InR extends in the $k_\perp$-direction much further than ECR while the k_z-width is the same as ECR. Motivated by this conclusion, we assume functional form of the energy-spectrum of InR to be $E(k_\perp, k_z) = E_\perp(k_\perp)\delta(k_z)$, and find that $E_\perp(k_\perp) \propto k_\perp^{-5/2}$. Thus, the one-dimensional spectrum, $k_\perp \int_{-\infty}^{\infty} dk_z E(k_\perp, k_z)$, is proportional to $k_\perp^{-3/2}$.