M18b　シア・アルフヴェン乱流のラグランジュ的統計理論

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The author has already published two statistical theories dealing with strong shear Alfvén turbulence in a uniform mean magnetic field (Nakayama ApJ1999; 2001). They confirm crucial nature of MHD turbulence: That is, turbulence becomes quasi 2-dimensional at the inertial range scale because of the parallel cascades freezing; further, relaxation of eddies of each inertial-range size is governed by the largest (i.e., energy containing) eddies. As a consequence of this nonlocal nature, our theories reproduce Kraichnan's $-3/2$ power low inertial range energy spectrum. These results well support recent models of MHD turbulence, say, by Oughton et al. (ApJ 2001). Our theories are, however, unsatisfactory in that they are based on a strict assumption, i.e., the detailed energy equi-partition between magnetic field perturbations and velocity perturbations.

In this report, we give a new theory being free from the assumption of equi-partition. It is a 2nd order statistical theory based on a Lagrangian renormalized approximation, which is the same framework as Nakayama 2001. It is shown that the above-mentioned features universally hold for turbulence not satisfying the equi-partition. Also, It is shown that the relaxation timescale is determined by the magnetic field perturbation energy. Thus, the nonlocal nature of MHD turbulence is confirmed.