Selection Rule for Turbulent Structural Formation: Study of magnetized cylindrical plasmas

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Turbulent plasmas form a variety of meso-scale structures such as a zonal flow and a streamer [1], and the level of the anomalous transport in fusion plasmas is affected by the turbulent structures. Therefore, the formation and self-regulated mechanism of the turbulent structures should be taken into consideration to determine transport coefficients in H-mode transport barriers. We used a minimal model for analyzing the structural formation mechanism in magnetized plasmas by mode coupling. The analyses were carried out with plasma experiments in a simple linear configuration, which have been revisited recently for quantitative understandings of the structural formation mechanism by turbulence [2]. A three-field reduced MHD model was extended to describe the resistive drift wave turbulence in cylindrical plasmas [3]. In this model, ion-neutral collisions strongly stabilize the resistive drift wave, which can be used as a parameter dictating the structural formation. If the collision frequency is small, modulational coupling of unstable modes generates a zonal flow, which suppresses turbulent transport. On the other hand, if the collision frequency is large, a zonal flow is not generated, and parametric coupling forms a streamer, which induces convective transport. Competitive nature of structural formation was revealed, and the condition to suppress the transport is discussed.

[1] See reviews, e.g. P. H. Diamond, et al., Plasma Phys. Control. Fusion **47**, R35 (2005)
[2] Y. Saitou, et al., Phys. Plasmas (2007) in press; G. R. Tynan, et al., Plasma Phys. Control. Fusion **48**, S51 (2006)
[3] N. Kasuya, et al., J. Phys. Soc. Jpn. **76**, 044501 (2007)