Safety factor profile dependence of turbulent structure formation in relevant to internal transport barrier relaxation

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It is widely understood that the improved confinement mode with transport barrier is necessary to achieve the self-ignition condition in ITER. The negative magnetic shear, mean ExB flow shear, and zonal flow are considered to play important roles for ITB formation. In our previous study, it is found that the non-linear interaction between the meso-scale modes produces non-local energy transfer to the off-resonant mode in the vicinity of $q_{\min}$ surface and brings global relaxation of the temperature profile involving ITB collapse [1]. Experimental studies indicate that a relationship exists between the ITB formation and safety factor q-profile, with a reversed magnetic shear (RS) configuration [2]. Transitional ITB events occur on the low-order rational resonant surface. The ITB shape and location depend on the q-profile and $q_{\min}$ position. These observations indicate that the q-profile might play an essential role in determining the turbulent structure.

In this study, the effect of safety factor profile on the ion temperature gradient driven drift wave (ITG) turbulence is investigated using a global non-linear simulation code based on the gyro-fluid model [3]. A heat source and toroidal momentum source are introduced. Dependence of safety factor profiles on ITB formation and its stability is examined to clarify the influence of the radial distribution of the rational surfaces and the $q_{\min}$ value. It is found that the nonlinearly excited meso-scale mode in the vicinity of $q_{\min}$ depends on the value of $q_{\min}$. A detailed analysis of the structure selection rule is in progress.

Reference

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