Multi-scale transport simulation with ion temperature gradient driven drift wave turbulence

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To achieve the self-ignition condition in ITER, it has been widely recognized that improved confinement is necessary. H-mode and/or internal transport barrier (ITB) are candidates of operational mode. Therefore, understanding the mechanisms of transport barrier formation is crucial issue for ITER. The ion temperature gradient driven drift wave (ITG) turbulence has been considered as an ion loss channel, and many studies have been done using gyro-kinetic or gyro-fluid model[1,2]. We have also studied this subject, using extended gyro-fluid model proposed by Ottaviani et.al.[3], and found turbulence spreading in the reversed shear plasma[4]. In this work, the generation and collapse mechanisms of ITB are investigated. The heat source term is introduced as a constraint in our model, and the self-consistent evolution of the ion temperature profile is taken into account. The reversed shear profile is employed. The ITB is formed around the q-min: the fluctuations are reduced there, although linear instability criteiron is exceeded. Then, the ITB collapse event occurs after the saturation of low (m,n) mode, such as (4,3), which is linearly stable but excited via nonlinear interaction. The system exhibits quasi-periodic behavior with intermittent burst accompanied with avalanches. It indicates that (4,3) mode which grows around q-min plays an important role in the collapse of ITB. Such mode has a broad eigen-function, which gives rise to the non-local interaction. In terms of meso-scale dynamics, the effect of safety factor on ITB formation and collapse is discussed. Relation between heat source profile and temperature relaxation is also studied.

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