CAMT Seminar

"Turbulence Transport in Edge Tokamaks and Plasma-Facing Surfaces"

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Date: September 29th, 2015 (Tue) 13:00-14:00

Location: Main Conference Room (1st floor), Bldg. A12

Center for Atomic and Molecular Technologies (CAMT)

(A12 棟 1 階会議室)

Abstract

During the normal operation of the high confinement regime (H-mode) in next generation tokamaks, edge-localized modes (ELMs) are a serious concern for divertor plasma-facing components. In the most promising operational regime of future reactors, the edge transport barrier is not stable but relaxes quasiperiodically. During such fast relaxation events, turbulent transport through the barrier increases strongly and the pressure inside the barrier drops. Thereafter, the barrier builds up again on a slow, collisional time scale. This periodic relaxation of edge pressure gradient results in pulses of energy and particles transported across the Separatrix to the scrape-off-layer (SOL) and eventually to the divertor surface. ELMs could, therefore, result in cyclic thermal stresses, excessive target erosion, and consequently shorter divertor lifetime. The basic physical mechanism underlying these relaxation oscillations is not fully understood. In particular, there is no universal explanation why the plasma, instead of remaining in a state of marginal stability, oscillates close to stability limits. Currently, transport barrier relaxations are modeled by phenomenologically constructed dynamical equations for the amplitudes of relevant modes.

Here, we propose 3D fluid turbulence simulations to investigate nonlinear barrier dynamics. In these simulations, a barrier is produced by an externally imposed ExB shear flow and it is found to relax quasiperiodically in a range of E xB shear rates. The relaxation dynamics is found to be governed by the intermittent growth of a mode localized at the barrier center, characterized by low poloidal and toroidal wave numbers. A one dimensional (1D) model for the dynamics of this mode is derived. An analytical study reveals that the effect of the E x B shear flow is different from a shift of the linear instability threshold. In fact, the dynamics is found to be governed by a time delay for effective velocity shear stabilization.

(Host: Satoshi Hamaguchi Ext：7913)