Role of inward particle flux on pedestal dynamics of edge transport barrier in the HL-2A experiments

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In a transition from low (L) to high (H) confinement regime, a transport barrier usually develops in a narrow layer and so called pedestal with high temperature and density gradients forms at tokamak plasma edge [1]. The accumulation of energy and particles inside the pedestal normally leads to an explosive relaxation of the gradients through edge localized mode (ELM) [2-3]. Then the gradients develop again until a next ELM onset under a variety of physics mechanisms. This is a typical self-organization process of edge gradients in magnetic confinement fusion plasmas. Such behaviors as pedestal collapse and re-build in tokamak edge plasmas are very common phenomena in complex nonlinear systems. In particular, the pedestal crash has significant influence not only on plasma performance but also on in-vessel components such as first wall and divertor. Understanding the dynamics of edge transport barrier in particular is essential for future fusion energy development.

Detailed analyses of the dynamic evolutions of plasma parameters, including density, temperature, pressure and their gradients in pedestal were performed in recent H-mode experiments on HL-2A tokamak. Dramatic increases of density and its gradient were observed in the pedestal just prior to each ELM in a series. An inward particle flux inducing quasi-coherent mode was found to be responsible for such changes. The mode appears in floating potential, density and its gradient, radial electric field etc. and grows very rapidly just about 200 microseconds before each ELM. It has electromagnetic fluctuation characteristic and the spatial structure is demonstrated to be m/n=20-24/6-8, finite radial width. The mode has strong nonlinear interaction with the ambient turbulence, and it inducing inward particle plays a dominant role in the particle balance and increases of local density gradient in the pedestal. Detailed analysis will be presented in ref. [4].

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