Contribution ID: **569** Type: **Poster**

Roles of an inward particle flux inducing quasi-mode in pedestal dynamics on HL-2A tokamak

Friday, 21 October 2016 08:30 (4 hours)

Detailed analyses of the dynamic evolutions of the pedestal, including density, temperature, pressure and their gradients were performed in recent H-mode experiments on HL-2A tokamak. Dramatic increase of density gradient and decrease of electron temperature gradient were observed in the pedestal just prior to each burst in a series of ELM eruptions. An inward particle flux inducing quasi-coherent mode was found to be responsible for such changes, and triggering the ELM eruption. The results clearly show that the mode grows very rapidly 200 microseconds before each ELM burst in the H-mode plasma. The auto-power spectrum analysis indicates that the mode peaks at f=50-60 kHz. A higher harmonic at 120 kHz also appears in the density spectrum, but not in the floating potential. The poloidal and toroidal mode numbers are estimated as m≈20-24 and n=m/q≈6-8, respectively. The poloidal propagation velocity of the mode is estimated as 6.0-7.2 km/s at Δr=-10.0 mm. The radial wave vector of the mode is kr≈3.5-7.5 cm-1, propagating inward with a velocity of 400-850 m/s. The mode propagates in plasma current direction toroidally. The squared auto-bicoherence analyses of the floating potential and density fluctuations indicate that nonlinear three-wave coupling might be a plausible mechanism for the generation of the quasi-coherent mode. Decoupling of the mode induced density transport from energy transport, similar to that observed in I-mode discharges, was observed. A very interesting observation in the experiments is that the gradient scale length of electron density is always shorter than that of temperature at the starting point of the ELM burst and, therefore, the dominant role of density gradient over temperature gradient for ELM triggering is demonstrated. The results are consistent with I-mode discharges where high temperature gradient does not lead to ELM and in contrast with the previously reported quasi-coherent modes which play significant roles in sustaining H-mode discharges [1-3].

References:
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Paper Number

EX/P7-24

Country or International Organization

China

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Session Classification: Poster 7

Track Classification: EXC - Magnetic Confinement Experiments: Confinement