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On pedestal fluctuations in H-modes without large ELMs during the transition to a detached tungsten divertor in EAST

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Simultaneous control of the damaging erosion induced by the transient and steady-state heat/particle fluxes on the divertor target material is one of the critical issues for next-step magnetic fusion devices. Studying on the pedestal fluctuations in small/no ELM H-modes may provide important insights into sustainment of large ELM elimination when compatible with a radiative divertor.

H-mode operation without large edge-localized modes has been achieved in EAST with an ITER-like tungsten divertor, while being compatible with the partial and pronounced detachment in divertor, via either ramping-up of bulk density or injection of low/high-Z impurities. The pedestal characteristics during the transition from the attached to the detached divertor and the reversed transition (detached to attached) under different detachment methods are studied in detail, where the evolution of multi fluctuating structures commonly residing in the H-mode pedestal of EAST (edge coherent mode (ECM) [1], magnetic coherent mode (MCM) [2] and high frequency mode (HFM) [3]) is highlighted.

It is found that in the pronounced detachment which EAST has successfully achieved at the auxiliary heating power P_{source} = 2-6 MW, the ECM tends to disappear either by ramping plasma density up or by impurity injection in the divertor, while evolutions of the MCM and the HFM behaviors are not uniform, as summarized in Table 1[4]. Further analysis shows that in addition to the pressure gradient which is considered as a primary free energy source for the pedestal instabilities including the ECM, the MCM and the HFM, the pedestal collisionality also appears to play a crucial role in affecting the ECM amplitude, and subsequently influencing the MCM and the HFM intensities possibly via re-allocating free energy among the three modes

In addition, the radial structures of ECM, MCM and HFM are detected, for the first time, in one discharge. The ECM peak position is localized in the steep gradient region, while the MCM and the HFM peak positions are slightly more radially outside than the ECM, but still within the separatrix. Distinct from the ECM and the MCM, the HFM seems to exhibit a non-monotonous radial distribution of intensity, and even be detectable in the SOL region.

References
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	Pronounced detachment induced by ramping-up plasma density		Pronounced detachment induced by injecting impurity	
Heating P_{source} (MW)	Low heating 2-4	High heating 4-6	Low heating 2-4	High heating 4-6
Edge coherent mode	Plasma confinement degrades severely, ECM, MCM and HFM all disappear		Disappear	Disappear
Magnetic coherent mode			Disappear	Weaken
High-frequency mode			Disappear, weaken or even enhance	Weaken

Table 1. The relative amplitude of ECM, MCM and HFM in the pronounced detachment at EAST.