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A Novel Turbulence Transition Induced by Lower Hybrid Wave in an ELMy H-mode Pedestal at EAST

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Effective control of the quasi-periodic spontaneous crashes of type-I or giant edge-localized modes (ELMs) [1, 2] is needed to prevent intolerable divertor heat and particle loads, which are foreseen as a critical lifetime issue of plasma-facing components in reactor-scale fusion devices such as ITER[3, 4]. Several candidate methods for controlling the size of ELMs and the resultant particle and energy fluxes onto divertor targets have been explored in the fusion community, including resonant magnetic perturbations (RMPs) generated by in- or out-vessel coils, radiating divertors, vertical kicks, pellet or supersonic molecular beam injection (SMBI), et al. However, these methods are currently still facing respective limitations as they are proposed for ITER or beyond for the purpose of large ELM control. Also serving as a candidate method for ELM control, accomplishments of suppression or mitigation of the spontaneous ELMs using the Lower Hybrid Wave (LHW) were reported first on EAST[5], and then on HL-2A[6]. Nevertheless, the potential physics still remain a mystery.

We report a turbulence transition in an edge-localized-mode (ELMy) H-mode pedestal when modulating the injected power of lower hybrid wave (LHW) arming at surveying its impact on ELM behavior. Simultaneous measurements of lithium beam emission spectroscopy (measuring larger-scale electron density fluctuation with perpendicular wavenumber $k_\perp$ below 3 cm^{-1}) and Doppler backscattering system (measuring smaller-scale electron density fluctuation with $k_\perp$ usually larger than 3 cm^{-1}) show that the dominant electron density fluctuation in the pedestal region transits from the edge coherent mode (ECM)[7] to a broadband fluctuation (BBF) with a more radially-localized distribution as the LHW is switched on, as clearly exhibited in figure 1. Comparing edge profiles with and without LHW suggests that the LHW-induced decrease in the edge electron collisionality seems to account for[8] such a suppression of ECM with the nature of a dissipative trapped electron mode (DTEM), and subsequently allowing for the generation of the BBF. This work may shed more light into the underlying physics behind LHW's influence on ELMs.

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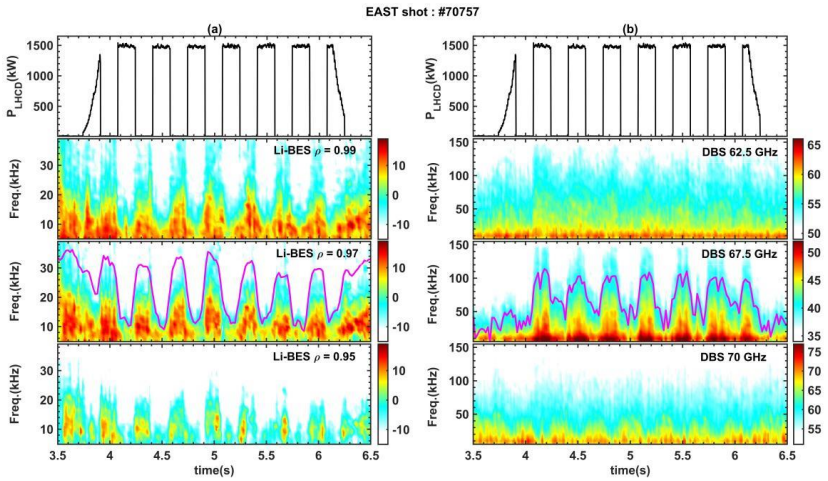

Figure 1. The time-resolved auto-power spectra of pedestal electron density fluctuations during the modulation of LHW input power, measured by three observation channels of the Li-BES (a) and the DBS (b) in the vicinity of the steep-gradient region. The purple solid lines represent the relative integrated power spectral intensity of fluctuations from the measurement channel with the peak intensities of detected fluctuating structures respectively.