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Edge Instabilities Limiting the Pedestal Evolution[1]

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Identifying the transport mechanism and instabilities limiting pedestal properties and global confinement are essential to predict and control the performance of ITER and future fusion devices. Measurements of the edge density and magnetic fluctuations on the DIII-D and Alcator C-Mod tokamaks provide direct evidence for the onset of quasi-coherent edge fluctuations limiting the pedestal temperature recovery after an edge-localized-mode (ELM). These instabilities onset at the critical pressure gradient for kinetic ballooning mode (KBM) instabilities, which is consistent with predictions of EPED model. On both C-Mod and DIII-D, the low-k coherent fluctuations are observed having magnetic signatures, localized near the pedestal top. At low current on DIII-D these fluctuations are observed to correlate well with the density gradient recovery (measured with high temporal resolution) suggesting that particle transport is responsible for limiting the pedestal. At higher plasma current, the density gradient recovers on the same time scale as in the low current case. However, the temperature gradient increases until saturation, which suggests a different transport mechanism compared to the low current case. This plasma current dependence is consistent with changes of heat flux from the core needed to replenish the pedestal after an ELM crash. This paper reports detailed measurements of the pedestal recovery dynamics and associated edge fluctuations in two fusion devices, which clearly indicate that quasi-coherent edge fluctuations with magnetic signatures limit the temperature pedestal evolution. These new measurements as well as the recovery time of the pedestal strongly suggest that the pedestal temperature is a potential control knob, if acted on early in the recovery phase, for optimizing the pedestal in future fusion devices.

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