Characterization of density fluctuations during the search for an I-mode regime on the DIII-D tokamak

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Abstract. The I-mode regime, routinely observed on the Alcator C-Mod tokamak, is characterized by an edge energy transport barrier without an accompanying particle barrier and with broadband instabilities, known as Weakly Coherent Modes (WCM), believed to regulate particle transport at the edge.

Recent experiments on the DIII-D tokamak exhibit I-mode characteristics in various physical quantities.

These DIII-D plasmas evolve over long periods, lasting several energy confinement times, during which the edge electron temperature slowly evolves towards an H-mode-like profile, while maintaining a typical L-mode edge density profile. During these periods, referred to as I-mode phases, the radial electric field at the edge also gradually reaches values typically observed in H-mode.

Density fluctuations measured with the Phase Contrast Imaging diagnostic during I-mode phases exhibit three features typically observed in H-mode on DIII-D, although they develop progressively with time and without a sharp transition: the intensity of the fluctuations is reduced; the frequency spectrum is broadened and becomes non-monotonic; two dimensional space-time spectra appear to approach those in H-mode, showing phase velocities of density fluctuations at the edge increasing to about 10 km/s. However, in DIII-D there is no clear evidence of the WCM.

Preliminary linear gyro-kinetic simulations are performed in the pedestal region with the GS2 code and its recently upgraded model collision operator that conserves particles, energy and momentum. The increased bootstrap current and flow shear generated by the temperature pedestal are shown to decrease growth rates, thus possibly generating a feedback mechanism that progressively stabilizes fluctuations.

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