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Internal measurement of pedestal-localized broadband magnetic fluctuations in ELMy H-mode plasmas in DIII-D[1]

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In DIII-D ELMy H-mode plasmas, pedestal-localized broadband magnetic fluctuations have been directly observed internally, for the first time, using a new Faraday-effect polarimeter diagnostic to identify their role in pedestal transport. The broadband magnetic fluctuations have many characteristics indicative of micro-tearing-modes (MTM): (a) poloidal wave number ~0.3/cm, frequencies ranging from f=100-500 kHz with peak at 250 kHz, and propagation in the electron diamagnetic direction in the plasma frame, as expected for unstable MTM from linear GYRO calculation at the pedestal; (b) radial magnetic field amplitude lower bound $|\delta B_r| \sim 25$ Gauss and $|\delta B_r/B| \sim 0.12\%$ (B=2 T is total magnetic field) over bandwidth 100-500 kHz, comparable to the saturated MTM amplitude predicted by non-linear theory ($\rho_e/L_{Te} > 0.1\%$ in pedestal); (c) non-monotonic dependence of mode amplitude on collision frequency, peaking at $\nu_{ei}/f \sim 0.4$-2 (ν_{ei} is pedestal top collision frequency), consistent with lowest order MTM theory; (d): poloidally asymmetric spatial distribution with minimum amplitude near mid-plane. Between ELMs, the broadband magnetic fluctuation amplitude correlates with saturation of the pedestal gradients of T_e, n_e and p_e, indicating a role in regulating the pedestal. Based on stochastic field theory, the measured $|\delta B_r|$ can lead to experimentally-relevant electron thermal transport while mode growth has been observed to correlate with decreased pedestal pressure and global stored energy. The observations provide strong evidence that MTM exists in H-mode pedestal and play an important role in pedestal transport. These findings provide critical experimental input for model validation and development of predictive physics understanding of pedestal confinement.

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