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Observation, Identification, and Impact of Multi-Modal Plasma Responses to Applied Magnetic Perturbations[1]

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Experiments on DIII-D have demonstrated that multiple kink modes with comparable amplitudes can be driven by applied nonaxisymmetric fields with toroidal mode number n=2, in good agreement with ideal MHD models. In contrast to a single-mode model [1], the structure of the response measured using poloidally distributed magnetic sensors changes when varying the applied poloidal spectrum [2]. This is most readily evident in that different spectra of applied fields can independently excite inboard and outboard magnetic responses, which are identified as distinct plasma modes by IPEC modeling. The outboard magnetic response is correlated with the plasma pressure and consistent with the long wavelength perturbations of the least stable, pressure driven kinks calculated by DCON and used in IPEC. The models show the structure of the pressure driven modes extends throughout the bad curvature region and into the plasma core. The inboard plasma response is correlated with the edge current profile and requires the inclusion of multiple kink modes with greater stability, including opposite helicity modes, to replicate the experimental observations in the models. IPEC reveals the resulting mode structure to be highly localized in the plasma edge. Scans of the applied spectrum show this response induces the transport that influences the density pump-out, as well as the toroidal rotation drag observed in experiment and modeled using PENT. The classification of these two mode types establishes a new multi-modal paradigm for n=2 plasma response and guides the understanding needed to optimize 3D fields for independent control of stability and transport.

[1] N.C. Logan, et al., submitted to Nucl. Fusion (2015).
[2] C. Paz-Soldan et al., Phys. Rev. Lett. 114, 105001 (2015).

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