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External Excitation of a Drift-Alfvén Wave Response in the Alcator C-Mod Edge Plasma and its Relationship to the Quasi-Coherent Mode[1]

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Experiments indicate that short-wavelength, $k_\perp \rho_s \sim 0.1$, drift-Alfvénic turbulence plays an important role in C-Mod edge plasma transport. A Quasi-Coherent Mode (QCM, $50 < f < 150$ kHz, $k_\perp \sim 1.5$ cm^{-1}) regulates particle and impurity transport in C-Mod's EDA H-modes. A Weakly Coherent Mode (WCM, $150 < f < 500$ kHz, $k_\perp \sim 1.5$ cm^{-1}) plays a similar role in I-mode discharges, suppressing the formation of a density pedestal while maintaining a temperature pedestal. ELMs are not present in either confinement regime. With the idea of exciting, probing, and perhaps exploiting this transport behavior, we have developed a novel antenna system to excite drift-Alfvén-like modes at the outer midplane. A winding with a "shoelace" geometry is placed $\sim 3-5$ mm from the LCFS. The principal design parameters, $k_\perp = 1.5 \pm 0.1$ cm^{-1} and $45 < f < 300$ kHz, match the QCM and WCM properties, so that the antenna induces parallel currents in the boundary plasma that mimic those observed for the intrinsic modes. Phase-locking to intrinsic modes is also accomplished via a custom circuit. The antenna produces perturbations in density and field comparable to amplitudes of the intrinsic QCM. The plasma response exhibits a resonance near the natural QCM frequency, which generally satisfies the drift wave dispersion relation. While a driven $\tilde{B}_\theta$ fluctuation is visible throughout the discharge, the driven $\tilde{n}_e$ is only observed during H-mode, though it precedes the onset of the intrinsic QCM. Like the QCM, the driven mode propagates in the electron diamagnetic drift direction and is approximately field-aligned. Recent mirror probe measurements show the intrinsic QCM structure is predominantly drift-Alfvénic, and we might expect the same of the driven mode. However, the induced perturbation is not global, but is localized to field lines which map to the antenna, suggesting a damped response, and direct measurements of the damping rate indicate $\gamma/\omega_0 \sim 5\%$. If the antenna response is, indeed, a linearly-stable drift wave, this may suggest that additional interchange physics and curvature drive are involved to make the QCM unstable.

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