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Destabilization of Internal Kink by Suprathermal Electron Pressure Driven by Lower Hybrid Current Drive (LHCD)

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Understanding the stability and behavior of 3D helical modes in the core of an axisymmetric toroidal configuration remains one of the challenges of fusion research [1-3]. A new type of periodic fishbone-like instability with a (1,1) internal kink-like structure [3] has been observed in Alcator C-Mod tokamak during the development of advanced non-inductive scenarios using radio frequency lower hybrid current-drive (LHCD). For the first time, measurements at high spatial and temporal resolution directly connect changes in the fast LH-generated electrons to the mode onset, saturation, and damping. Its radial profile has the characteristic Bessel function form of the cylindrical or lowest order toroidal 1/1 kink eigenfunction [3]. Suprathermal electron energies are measured directly using the downshift of electron gyrofrequency due to relativistic effects and correlate with the mode. The results suggest that the mode is destabilized by the nonresonant suprathermal electron pressure contribution to the central beta instead of the wave-particle resonance of traditional fishbones [3]. The independence of the fast electron pressure from the thermal pressure that drives the conventional internal kink also explains its varied co-existence with the sawtooth crash and precursor oscillations.

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[1] L. Delgado-Aparicio, et al., Phys. Rev. Letters, 110, 065006, (2013).
[2] L. Delgado-Aparicio, et al., Nucl. Fusion, 53, 043019, (2013).
[3] L. Delgado-Aparicio, et al., Phys. Rev. Letters, submitted, (2014).

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