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The Wavelet Nature of Persistent Edge Fluctuations Observed on Alcator C-Mod[1]

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Persistent edge fluctuations in high confinement regimes on Alcator C-Mod are found universally to be wavelet-like, exhibiting limited duration and toroidal extent. These findings, which emerge from analysis of a suite of poloidally and toroidally separated diagnostics, run counter to widely held assumptions that such fluctuations have a global character with long coherence length. Here, we examine the coherence time and length scales for three edge fluctuation phenomena observed on the C-Mod tokamak, existing in the range of $f \sim 30 - 500$ kHz, $5 \leq n \leq 30$, $k_\perp \rho_s < 0.1$: the Quasi-Coherent Mode (QCM) of EDA H-mode, the Weakly Coherent Mode (WCM) of I-mode, and the inter-ELM Quasi-Coherent Fluctuation (QCF). Using data from Mirnov coils, phase contrast imaging, two-color interferometry, and reflectometry, we find that these modes have a relatively short coherence time (several periods), and similarly short coherence length (several wavelengths). The finite lifetime and toroidal extent of each coherent burst means that a disturbance may become strongly attenuated even before completing half a toroidal transit, consistent with the observation that fluctuation measurements made at the same poloidal, but opposing toroidal, angle are uncorrelated. The intermittent and localized nature of these bursts permits spatial asymmetries in the power spectra, and this can manifest itself in a surprising way: the QCM peak frequency is occasionally found to vary with toroidal angle for a portion of a discharge. These observations suggest the interpretation of these fluctuations as short, uncorrelated bursts of characteristic wavelets appearing at the edge, recalling WCM behavior observed on AUG by Manz *et al.*, and point to the need for a unifying statistical language of intermittency to describe this form of edge turbulence, as applied to blob fluctuation spectra by Garcia *et al.*

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