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Lower Hybrid Wave Electric Field Vector Measurements Using Non-Perturbative Dynamic Stark Effect Optical Spectroscopy on Alcator C-Mod[1]

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Plasma-wave interactions near the lower hybrid (LH) wave launcher can have a major impact on driven LH current, especially in the high-density regime. To identify the relevant physics responsible for this interaction a correlated effort of experimental measurements and simulations of the LH wave electric field vector, $\mathbf{E}_{\mathrm{LH}}$, were carried out on Alcator C-Mod using the SELHF (Stark Effect Lower Hybrid Field) diagnostic and COMSOL modeling. For a range of plasma parameters observations show that: 1) The polarization $\mathbf{E}_{\mathrm{LH}}$ resides primarily in the radial-poloidal plane and becomes increasingly poloidal for locations away and to the top of the LH launcher. 2) Saturation of the radial component of $\mathbf{E}_{\mathrm{LH}}$ is observed at an LH power density of approximately 12 MW/m^2. 3) Reflectometry phase fluctuations were found to be correlated with $|\mathbf{E}_{\mathrm{LH}}|$. These results suggest that the LH resonance cone and power spectrum may be substantially modified near the LH launcher in the high-density regime from the expected radial polarization and square root scaling of the magnitude with LH power. Simulation of the experimental data was carried out through development of a synthetic diagnostic using a full wave cold plasma COMSOL model. Density fluctuations and reflectometry measured density profiles were incorporated. Without density fluctuations, the synthetic $\mathbf{E}_{\mathrm{LH}}$ signal is dominantly in the radial direction and scales with the square root of LH power, as expected. Increasing density fluctuations in the model can cause the magnitude of $\mathbf{E}_{\mathrm{LH}}$ to decrease substantially and greatly vary the direction of $\mathbf{E}_{\mathrm{LH}}$. The observations and results outlined above will be presented in detail and the applicability of density fluctuations as a mechanism behind the behavior of $\mathbf{E}_{\mathrm{LH}}$ will be discussed.

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