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Experimental Evidence of Lower Hybrid Wave Scattering in Alcator C-Mod due to Scrape Off Layer Density Fluctuations

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We present new experimental measurements of the Lower Hybrid (LH) wave electric field vector, E_{LH}, obtained in Alcator C-Mod and provide a direct comparison with 3D full-wave COMSOL simulations using the cold plasma dielectric tensor and reflectometry measured density profiles. Two key results are reported: 1) The direction of E_{LH} was found to have a substantial poloidal component and is in strong disagreement with the nearly radial full-wave simulation result. 2) Adding Scrape Off Layer (SOL) density fluctuations to the density profile implemented in the full-wave simulations can be used to explain the E_{LH} direction discrepancy.

Polarized passive optical emission spectroscopy was implemented to determine E_{LH}. This technique entails measuring two orthogonally polarized D_β spectral line profiles. The spectra are simultaneously fit to the Schrodinger equation containing both magnetic and time periodic electric field operators. The three components of E_{LH} are the only fit variables. The experimental E_{LH} results were compared to axisymmetry 3D full-wave COMSOL simulations via a synthetic diagnostic. Comparing the experimental and simulation results, good agreement was found with regard to the magnitude of E_{LH} both as a function of measurement location and LH power. However, it was found experimentally that E_{LH} contained a poloidal component having a magnitude on the order or greater than that of the radial component. The poloidal component was found to be a strong function of poloidal angle, increasing towards the midplane, and a weak function of toroidal angle, remaining nearly constant. This result strongly disagrees with the nearly radial E_{LH} predicted by the full-wave simulations. SOL density fluctuations based on an experimentally verified 3D BOUT turbulence simulation of a similar Alcator C-Mod discharge were added to the density profile. We found that diffraction and scattering from a realistic turbulence model generates a substantial poloidal component in E_{LH}, significantly closing the gap between the experimental and simulation results. This result indicates that SOL turbulence can have a detrimental effect on LHCD performance if the wavelength is on the order of the turbulence characteristic scale length.

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