Modeling the electron cyclotron emission below the fundamental resonance in ITER - DTU Orbit (09/08/2019)

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The electron cyclotron emission (ECE) in fusion devices is non-trivial to model in detail at frequencies well below the fundamental resonance where the plasma is optically thin. However, doing so is important for evaluating the background for microwave diagnostics operating in this frequency range. Here we present a general framework for estimating the ECE levels of fusion plasmas at such frequencies using ensemble-averaging of rays traced through many randomized wall reflections. This enables us to account for the overall vacuum vessel geometry, self-consistently include cross-polarization, and quantify the statistical uncertainty on the resulting ECE spectra. Applying this to ITER conditions, we find simulated ECE levels that increase strongly with frequency and plasma temperature in the considered range of 55–75 GHz. At frequencies smaller than 70 GHz, we predict an X-mode ECE level below 100 eV in the ITER baseline plasma scenario, but with corresponding intensities reaching keV levels in the hotter hybrid plasma scenario. Benchmarking against the SPECE raytracing code reveals good agreement under relevant conditions, and the predicted strength of X-mode to O-mode conversion induced by wall reflections is consistent with estimates from existing fusion devices. We discuss possible implications of our findings for ITER microwave diagnostics such as ECE, reflectometry, and collective Thomson scattering.

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