ECE-Imaging of the H-mode Pedestal*

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Localized, 2D measurements of electron temperature fluctuations deep within the tokamak plasma core have produced breakthroughs in our understanding of phenomena such as the sawtooth crash and the formation of Alfvén eigenmodes in the presence of fast ions. For edge fluctuations, a new method of modeling the emission from spatially inhomogeneous and optically grey plasma accounts for the presence of significant anomalous emission at frequencies below the cold-resonance of the LCFS. In particular, the identification of a finite regime between optically thick and weakly relativistic, optically thin emission, where T_{rad} is anti-correlated to temperature fluctuations, demonstrates that the narrow H-mode pedestal has a broad and structured emission spectrum that may be diagnosed by heterodyne radiometry. A synthetic diagnostic reproduces 2D ECEI data through forward modeling of perturbations to electron temperature and density profiles, including the effects of localized suprathermal electron populations. This modeling reveals that the electron cyclotron emission (ECE) spectrum generated by a steep pressure gradient is rich in information about pedestal height and width, the dynamics of edge localized modes (ELMs), the edge harmonic oscillation of QH-mode plasmas, and the physics of ELM suppression by resonant magnetic perturbation.

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