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TH/P6-05: Effect of Density Fluctuations on LHCD and ECCD and Implications for ITER

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The role played by electron density fluctuations near the plasma edge on rf current drive in tokamaks is assessed quantitatively. For this purpose, a general framework for incorporating density fluctuations in existing modelling tools has been developed. It is valid when rf power absorption takes place far from the fluctuating region of the plasma. The ray-tracing formalism is modified in order to take into account time-dependent perturbations of the density, while the Fokker–Planck solver remains unchanged. The evolution of the electron distribution function in time and space under the competing effects of collisions and quasilinear diffusion by rf waves is determined consistently with the time scale of fluctuations described as a statistical process.
Using the ray-tracing code C3PO and the 3D linearized relativistic bounce-averaged Fokker–Planck solver LUKE, the effect of electron density fluctuations on the current driven by the lower hybrid (LH) and the electron cyclotron (EC) waves is estimated quantitatively. A thin fluctuating layer characterized by electron drift wave turbulence at the plasma edge is considered. The effect of fluctuations on the LH wave propagation is equivalent to a random scattering process with a broadening of the poloidal mode spectrum proportional to the level of the perturbation. However, in the multipass regime, the LH current density profile remains sensitive to the ray chaotic behaviour, which is not averaged by fluctuations. The effect of large amplitude fluctuations on the EC driven current is found to be similar to an anomalous radial transport of the fast electrons. The resulting lower current drive efficiency and broader current profile are in better agreement with experimental observations. Finally, applied to the ITER ELMy H-mode regime, the model predicts a significant broadening of the EC driven current density profile with the fluctuation level, which can make the stabilization of neoclassical tearing mode potentially more challenging.

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