Full wave simulation of Lower Hybrid waves in ITER plasmas based on the finite element method

O. Meneghini, S. Shiraiwa

Massachusetts Institute of Technology - Plasma Science and Fusion Center
77 Massachusetts Avenue, Cambridge 02138, Massachusetts, USA

orso@mit.edu

Lower hybrid (LH) waves are strongly damped via Landau damping on electrons which match the phase speed of the wave. Consequently, LH waves having a typical $N_{\|} \approx 2$ are expected to be damped at $r/a \approx 0.6$ of ITER plasmas and to be localized in the outer region of the plasma, in front of the launching system. We used a Finite Element Method (FEM) approach to find the solution to the full wave fields of LH waves in reactor scale plasmas. In particular, we focused our attention on the advanced tokamak operation scenarios on ITER. The FEM approach allowed us to take advantage of the spatial localization of the LH waves, by considering only the region of plasma where the wave fields are non-zero. The size of the computational domain was reduced by a factor of 50 and the inherent sparsity of the FEM technique makes the numerical problem scale linearly with the domain size. We employed the method described in [1] to treat the electron Landau damping. The contribution of the non-Maxwellian distribution was taken into account by coupling this method to a Fokker Planck solver, which self consistently calculates the electron distribution function. The magnetic equilibrium and the density and temperature profiles as provided by the ITER-LH task-force was used. The wide Scrape-Off-Layer (SOL) plays an important role in the propagation of the waves and its presence was included in the simulations. In summary, we ran for the first time a full wave simulation of LH waves in a realistic ITER plasma, proving the efficiency and scalability of the FEM approach.

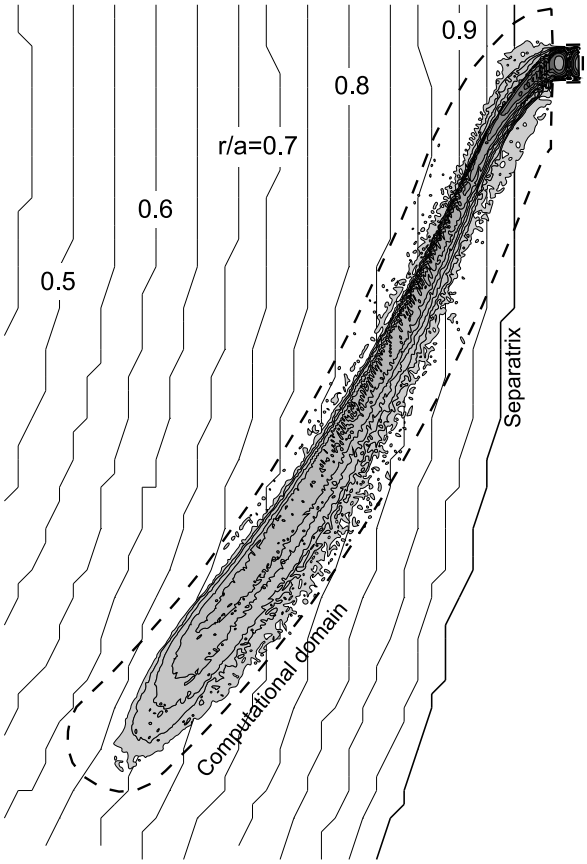

Figure 1: Single toroidal mode-number simulation of LH waves launched from the midplane row of the ITER LH launcher. The plot shows the contour levels of the electric field magnitude of the waves on the plasma poloidal cross section.

[1] O. Meneghini, S. Shiraiwa, R. Parker, Physics of Plasmas, *Full wave simulation of Lower Hybrid waves in Maxwellian plasma based on the finite element method*, to be published Sept. 2009