Subject 7: Physics of stochastic edge plasmas with respect to error fields, locked modes, and resistive wall modes

Nonlinear calculation of the penetration threshold of the error field

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The penetration threshold of the error field is an important issue for a fusion reactor like ITER and has attracted much theoretical and experimental studies. The existing theories based on reduced MHD equations, however, differs from experimental results in some important aspects. It is therefore necessary to have a better understanding of the penetration threshold of the error field.

Motivated by the recent experimental results on TEXTOR, here the penetration threshold of the error field is investigated using the two fluids equations and with the experimental data as the input. In particular, the electron temperature and the density perturbations are self--consistently calculated by solving the two dimensional transport equations. It is found that the penetration threshold depends on both the background plasma rotation frequency (electric drift frequency) as well as the diamagnetic drift frequency. When the frequency of the helical field is the same as the mode frequency, the penetration threshold reaches a minimal value, and the threshold increases as the helical field frequency deviates from the mode frequency. For a higher electron diamagnetic drift frequency or a higher plasma β value, the penetration threshold increases, indicating the role of the ion polarization current. Our nonlinear numerical modelling results provide a better understanding for the relevant experimental results of TEXTOR, which also implies the important role of the ion polarization current in the threshold for the onset of the (neoclassical) tearing modes.

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