Nonlinear dynamics of neoclassical tearing modes Driven by micro-turbulence

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Magnetic reconnection is a physical process involving conductive plasma flows that leads to a modification of the magnetic field topology. Controlling the processes involved in such dynamical effects could lead to a major breakthrough towards the realization of fusion experiments. In particular, a large magnetic island (with a size of the order of centimeter) can lead to the destruction of the plasma confinement. This phenomenon, known as Neoclassical Tearing Mode (NTM), requires a seed island, which will be nonlinearly amplified by the so-called bootstrap current. Although a lot of studies [1] are devoted to the crucial question of the NTM control in a fusion reactor, the origin of the seed island and the NTM triggering mechanism are still open questions.

Moreover, in fusion experiments, large magnetic islands coexist with micro-turbulence. By means of fluid simulations as well as gyrokinetic simulations, it has been underlined that a Turbulence Driven Magnetic Island (TDMI) can be generated thanks to a nonlinear beating of small-scale interchange modes [2, 3]. Then, in [4] it has been found that the bootstrap current can amplify the TDMI size.

From an experimental point of view, in [5] the mutual interaction between island and a micro-scale turbulence has been investigated in DIII-D. Recently, these experimental results have been compared with gyrokinetic simulations using a static magnetic island [6]. A qualitative agreement has been found without solving the question of the magnetic island origin.

Here, we propose to investigate the question of the nonlinear dynamics of a NTM driven by micro-turbulence by means of numerical simulation of a 2D self-consistent Reduced-MHD model. More specifically, we focus on the impact of micro-turbulence on the island dynamics. The possibility of its modelisation through Rutherford type equations is explored. Finally, in order to search for an experimental signature of TDMIs amplified by bootstrap current, simulation results are compared with experimental ones [5].

References:

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