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Magnetic Reconnection in Magnetized Hot Plasmas

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Magnetic reconnection [1] is a physical non-ideal process involving conductive plasma flows. It converts magnetic energy into kinetic energy and heat by a topology modification of the magnetic field line. In presence of magnetic instabilities, the structures resulting from reconnection processes can then grow into "magnetic island(s)".

In tokamaks, due to the high temperature required to reach the ignition condition, it is usually thought that resistivity is to weak and the magnetic field should remain "frozen-in"within the plasma. However, in such devices, magnetic islands can be observed at various spatial scales (from millimeters to a few tens of centimeters) with different impacts on the confinement. Indeed, various non-ideal physical mechanisms can allow magnetic reconnection and be at the origin of an instability letting an island to grow.

By means of theoretical calculations and numerical simulations, we propose, here, to examine 3 physical examples leading to the growth of magnetic island(s) in magnetized hot plasma. First, we will consider the "classical"tearing instability [1] where resistivity plays an important role both to allow reconnection and for the growth at large scale of a magnetic island. Then, we will study the generation of Turbulent Driven Magnetic Island (TDMI) [2,3]. In that example, a large magnetic island draws its energy in a nonlinear beating of turbulent modes. Such TDMI can then by amplified nonlinearly and destroys the confinement. Finally, we will investigate the destabilization at small-scales of a thin current sheet by an electronic temperature gradient leading to the formation of islands (in a millimeter range) that can affect the electronic heat transport [4].

References:

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