

Fundamentals of Magnetic Island Theory in Tokamaks

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Tearing modes are magnetohydrodynamical (MHD) instabilities that often limit fusion plasma performance in tokamaks. As the name suggests, “tearing” modes tear and reconnect magnetic field lines, in the process converting nested toroidal flux surfaces into helical magnetic islands. Such islands degrade plasma confinement because heat and particles are able to travel radially from one side of an island to another by flowing along magnetic field lines, which is a relatively fast process, instead of having to diffuse across magnetic flux surfaces, which is a relatively slow process.

This lecture will review the standard theory of magnetic islands in large aspect-ratio, low-beta, circular flux-surface tokamak plasmas. Topics covered will include the derivation of the Rutherford island width evolution equation, island saturation, island destabilization via the perturbed bootstrap current and average field-line curvature, island stabilization or destabilization via the ion polarization current, and island rotation.