What are (Neoclassical) Tearing modes

Tearing modes are a non-ideal MHD plasma instability which, due to reconnection (Resistive diffusion):
1. Introduces a deformation of the magnetic topology in the form of a rotating magnetic island.
2. This in turn introduces a radial component of the magnetic field.
3. Fast parallel transport causes rapid radial transport causing flattening of temperature/density/pressure profiles which can be seriously detrimental to energy confinement times and can cause deconfinement.
4. The ion and electron heat fluxes for varying island widths showing a distinct increase in heat flux at large island sizes.
5. Perturbed ion and electron temperatures.

Process of turbulence spreading -> Turbulence advected from areas where it is generated. Turbulence within island means perpendicular transport not negligible.

Passing particles flatten. Experience the full magnetic perturbation. Parallel streaming is dominant.

Trapped particles don’t flatten. Due to their bouncing don’t experience full island. Parallel transport diminished.

Trapped particle fraction \( \gamma = 0.5 \) therefore, as witnessed, flattening is half what it would be.

Traces of Heat Flux and the role of the vortex.

Top time traces of the total electrostatic heat flux and magnetic heat fluxes integrated over the whole simulation volume for ions (blue lines) and electrons (green lines) during the converged stage of a simulation with a magnetic island width of \( w = 24\rho_i \). The thick red dotted line gives the electrostatic heat flux generated by the modes with the same poloidal mode structure as the island. Bottom: Time traces of the normalized average electron (green line) and ion (blue line) density gradients at the O-point. The drop in density gradients is a measure of the strength of the potential vortex within the island.

The coupling of mesoscale magnetic islands with micro-scale turbulence

William Horany, Arthur Peeters, and the GKW group.

Centre for Fusion, Space and Astrophysics, Department of Physics, University of Warwick, Coventry CV4 7AL, United Kingdom

University of Bayreuth, Bayreuth, Germany

Max-Planck-Institute für Plasmaphysik, Boltzmannstrasse 2, Garching, Munich, Germany

This work is Funded by EPSRC in association with EURATOM/UKAEA.