Non-linear growth of marginally unstable tearing modes

R. Coelho

Associação Euratom/IST, Centro de Fusão Nuclear, 1049-001 Lisboa, Portugal

Abstract

The onset and evolution of magnetic reconnection events in tokamak plasmas is a potential source for plasma disruptions. The tearing mode, both in a scenario where the drive arises from the equilibrium current density gradient (ohmic) and in a bootstrap current relevant scenario (neoclassical tearing mode-NTM), can play an influential role in the plasma confinement degradation, disruption onset and overall limitation of plasma performance. Recent developments in the understanding of the non-linear evolution of tearing modes have shown that the saturated (steady state solution) island width, for a given magnetic equilibrium, scales approximately linearly with the stability parameter associated to the mode (Δ'). This has important repercussions on feedback control since, in theory, only the most unstable modes need to be identified and controlled (stabilised or reduced to minimal amplitude). In this work, we revisit the problem of non-linear ohmic tearing mode growth through a numerical approach using reduced MHD simulations in cylindrical geometry. In particular, we emphasise on the limiting scenario of a marginally unstable mode, i.e. $\Delta' a<3$, where a is the minor radius. We find that, contrary to expectations, no steady state solution is obtained for plasmas with anomalous viscosity and magnetic Reynolds number below a certain threshold. The physical mechanism behind such non-linear evolution is discussed.