Tokamak equilibria and edge stability when non-axisymmetric fields are applied

C. J. Ham[1]

[1]*CCFE, Culham Science Centre, Abingdon, Oxon, OX14 3DB, UK*

Tokamaks are traditionally viewed as axisymmetric devices however this is not always true, for example in the presence of saturated instabilities, error fields, or resonant magnetic perturbations (RMPs) applied for ELM control. We use the VMEC code [1] to calculate three dimensional equilibria by energy minimization for tokamak plasmas. MAST free boundary equilibria have been calculated with profiles for plasma pressure and current derived from two dimensional reconstruction. It is well known that ELMs will need to be controlled in ITER to prevent damage that may limit the lifetime of the machine [2]. ELM control using RMPs has been demonstrated on several tokamaks including MAST [3]. However, the application of RMPs causes the plasma to gain a low field side displacement or corrugation. Previous work has shown that the phase and size of the corrugations is in agreement with experiment [4]. The interaction of these corrugations with the plasma control system (PCS) may cause high heat loads at certain toroidal locations if care is not taken [5]. VMEC assumes nested flux surfaces but this assumption has been relaxed in other stellarator equilibrium codes. These codes allow equilibria where magnetic islands and stochastic regions can form. We review these codes and give some first results. ELM mitigation is not fully understood but one of the factors that influences peeling-ballooning stability, which is linked to ELMs, is a three dimensional corrugation of the plasma edge [6]. The infinite *n* ideal ballooning stability of the equilibria with and without the RMPs applied has been calculated using the COBRA [7] code. When RMP coils are applied the most unstable ballooning mode growth rate increased. We investigate other approaches towards stability calculations for non-axisymmetric plasmas including the finite *n* stability code CAS3D [8] and using energy minimizing equilibrium codes to investigate stability [9] and we show some first results. We also discuss results from using local equilibria used to model the effect of RMPs on stability.

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