PEELING-BALLOONING STABILITY OF TOKAMAK PLASMAS WITH APPLIED 3D MAGNETIC FIELDS

M.S. ANASTOPOULOS TZANIS, C.J. HAM, P.B. SNYDER, H.R. WILSON

- Development of a variational approach for the calculation of the linear non-axisymmetric ideal MHD stability of tokamak plasmas using the unstable peeling-ballooning modes of the axisymmetric equilibrium as basis functions for the non-axisymmetric eigenmode.
- According to ballooning theory for an axisymmetric equilibrium, the decoupled toroidal normal modes $\vec{\xi}_n$ are composed by different poloidal Fourier modes $\vec{\xi}_{mn}$ that have the same radial structure and are centred at their corresponding rational surface where $m = nq$.
- The radial dependence of the background equilibrium defines how these poloidal Fourier modes m are coupled, i.e. determines the relative amplitude of each poloidal Fourier modes m for a given toroidal normal mode n.
- A similar picture is expected in the case where the background equilibrium is non-axisymmetric. As a result it is postulated that the radial structure of the individual $\vec{\xi}_{mn}$ remains unchanged but the relative poloidal and toroidal coupling of the different Fourier harmonics $\vec{\xi}_{nm}$ is changed.
- Therefore, existing axisymmetric stability codes can be used to provide the trial or basis functions in order to minimise the non-axisymmetric linear ideal MHD energy functional.
- In our case the ELITE stability code is used to obtain the trail functions. In addition, ELITE is modified to provide a non-axisymmetric linear plasma response for a given external 3D magnetic field. In such a way, a framework is created for the simultaneous examination of the linear ideal plasma response and stability of tokamak plasmas under the application of external 3D magnetic fields.
- The main outcome of this study for high-β D-shaped plasmas is the further destabilisation and field-line localisation of ballooning modes, as local ballooning theory suggests.
- In addition, it is observed that unstable kink-ballooning like modes are highly destabilised by the external 3D magnetic field due to a synergistic destabilising contribution from the toroidal coupling.
- Finally, it is shown that the largest destabilisation for a given amplitude of the external 3D magnetic field at the plasma surface, occurs when the displacement of the equilibrium flux surfaces is largest within the pedestal.