Benchmarking PB3D: a new code for 3D ideal linear peeling-ballooning stability

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Magnetic nuclear fusion devices are a promising candidate for the confinement of thermonuclear plasmas but various instabilities set important limits on their operation. Peeling-ballooning perturbations, which can be described appropriately using high-n linear ideal MHD stability theory, are two of them, where high-n indicates that the perturbations are localized along the magnetic field lines [1].

A new numerical code, called PB3D (Peeling Ballooning in 3D) was written to investigate the stability of these instabilities in a fast and reliable way, solving the generalized Eigensystem presented first in [3]. The important new aspect of this theory is that it describes stability in fully 3D systems, in contrast with previous axisymmetric treatments such as used in the popular ELITE [4] or MISHKA code [2].

3D effects are important for numerous reasons: In tokamaks axisymmetry is often broken, either deliberately, such as when RMP techniques are used to suppress periodic plasma relaxations called ELMS, or due to imperfections in the axisymmetric design, such as the toroidal ripple introduced by discrete toroidal field coils. Stellarators devices, on the other hand, are inherently 3D and cannot be approximated using axisymmetric theory.

In this work, the benchmark of PB3D with axisymmetric codes is presented, indicating that their results are accurately reproduced, as well as first 3D results.

References