Exploring stellarator β-limits with nonlinear MHD modelling

A. M. Wright[1*], N. M Ferraro[1]
[1] *Princeton Plasma Physics Laboratory, PO Box 541, Princeton NJ 08543, USA*

We present the first results from a parametric exploration of β-limits in a 10-field period heliotron, showcasing the M3D-C1 code′s new capability to perform extended-MHD simulations in stellarator geometry. We examine the effect of heating power and transport on MHD dynamics and nonlinear stability, observing low-n core mode activity that is broadly consistent with experimental observations on the Large Helical Device (LHD). This paves the way for quantitative validation with LHD experiments.

We capture the self-consistent evolution of both the magnetic field and pressure gradients using sources and anisotropic thermal transport. Importantly, we impose no assumptions or constraints on the magnetic field topology (such as the existence of magnetic surfaces) or the plasma shape.

Understanding nonlinear MHD stability is important for fusion. Clarifying the role of 3D effects is critical for determining when macroscopic instabilities are benign or have the potential to become disruptive. Like tokamaks, stellarators can be susceptible to (sometimes disruptive) pressure and current-driven instabilities; ′soft′ linear stability limits, corresponding to benign core-MHD activity, and disruptions, have both been observed experimentally.

The extended-MHD, initial value-code, M3D-C1, was recently extended to accommodate stellarator geometry, providing a unique capability to explore nonlinear MHD and the effect of 3D transport in stellarators.