Stable Equilibria for Bootstrap-Current Driven Low Aspect Ratio Tokamaks

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Abstract

Low aspect ratio tokamaks (LATs) can potentially provide a high ratio of plasma pressure to magnetic pressure β and high plasma current I at a modest size. This opens up the possibility of a high power density compact fusion power plant. For the concept to be economically feasible, bootstrap current must be a major component of the plasma current, which requires operating at high β_p. A high value of the Troyon factor β_N and strong shaping is required to allow simultaneous operation at high β and high bootstrap fraction. Ideal magnetohydrodynamic stability of a range of equilibria at aspect ratio 1.4 is systematically explored by varying the pressure profile and shape. The pressure and current profiles are constrained in such a way as to assure complete bootstrap current alignment. Both β_N and β are defined in terms of the vacuum toroidal field. Equilibria with $\beta_N \geq 8$ and $\beta \sim 35\%$ to 55% exist which are stable to $n = \infty$ ballooning modes, and stable to $n = 0$, 1, 2, 3 kink modes with a conducting wall.

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