Ideal magnetohydrodynamic constraints on the pedestal temperature in tokamaks

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Abstract. The ideal magneto-hydrodynamic (MHD) stability limits for the edge transport barrier region in tokamaks are explored, concentrating in particular on the intermediate to high toroidal mode number, n, modes. These calculations take full account of the effect of the edge bootstrap current on the stability of both ballooning and peeling modes. Because the current plays an important role in MHD stability, the temperature and density independently influence stability and, in particular, the pressure gradient that the edge transport barrier can support. The stability calculations therefore provide limits to the achievable temperature pedestal associated with the transport barrier which are not simply pressure pedestal limits, as is often assumed. One important result is that increasing triangularity is predicted to be beneficial in providing access to a higher temperature pedestal at fixed pedestal width, at least up to triangularity ~0.5. Another significant result is that the finite n corrections, which are stabilizing for ballooning modes, are important for narrow pedestal widths and permit significantly higher temperature pedestals than one would obtain using the leading order (n=∞) ballooning theory. Specific calculations for equilibria characteristic of ITER and FIRE suggest that temperature pedestals in the region of a few keV should be achievable, but the precise value depends on the pedestal width, a prediction for which is beyond the scope of this paper.

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