Understanding and Predicting the H-Mode Pedestal Height*

P.B. Snyder[1], A.W. Leonard[1], T.H. Osborne[1], and H.R. Wilson[2]

[1]General Atomics, PO Box 85608, San Diego, California 92186-5608, USA
[2]University of York, York, United Kingdom

The pressure at the top of the edge transport barrier (or "pedestal height") strongly impacts fusion performance. Predicting the pedestal height in future devices such as ITER remains an important challenge for plasma theory. While uncertainties remain, MHD stability calculations, accounting for diamagnetic stabilization, have been largely successful in predicting the observed pedestal height, when the barrier width is taken as an input (e.g. [1-2]). Such peeling-ballooning stability studies typically find that the predicted pedestal height (β_{Nped}) scales roughly with the 3/4 power of the pedestal width [2], a relation that can be understood to result from the balance of relatively local ballooning modes and non-local peeling-ballooning and kink-peeling modes. This strong correlation between the stability-constrained height and the width, along with significant measurement uncertainty in the width, have complicated prior efforts to discern the dependencies of the width on observed parameters. Here, we employ the peeling-ballooning stability calculations as a constraint, accounting for the strong correlation of the width and height, and allowing study of the dependencies of the width itself. In a large set of DIII-D data, as well as a set of power scans [3], we find a relatively simple scaling for the pedestal width, similar to the β_{pped} scaling observed in [4]. Employing this working model of the pedestal width, along with peeling-ballooning stability calculations using the ELITE code, we are able to predict the pedestal height in both past and future experiments. Here we explore the physics underlying the pedestal width, in an attempt to put this aspect of the successful working model on a more firm theoretical basis.

[1] P.B. Snyder, H.R. Wilson, et al., Phys. Plasmas **9** (2002) 2037.
[2] P.B. Snyder, H.R. Wilson, T.H. Osborne and A.W. Leonard, Plasma Phys. Control. Fusion **46** (2004) A131.
[3] A.W. Leonard, et al., "Influence of Global Beta, Shape and Rotation on the H-mode Pedestal Structure in DIII-D," submitted to Phys. Plasmas (2007).
[4] T.H. Osborne, et al., Plasma Phys. Control. Fusion **40** (1998) 845.

*Work supported by the US Department of Energy under DE-FG03-95ER54309, the UK Engineering and Physical Sciences Research Council, and Euratom.