Controlling fluctuations in an Internal Transport Barrier with on-axis ICRF heating

D. R. Ernst, C. L. Fiore, A. Dominguez, N. Tsujii, S. Wolfe, I. O. Bespamyatnov,[†]
R. Granetz, M. Greenwald, J. W. Hughes, A. Hubbard, J. Irby, Y. Ma, D. Pace, P. Phillips,[†]
Y. Podpolay, M. L. Reinke, J. E. Rice, W. L. Rowan,[†] J. L. Terry, S.Wukitch

Plasma Science and Fusion Center, Mass. Inst. of Technology, Cambridge, MA
[†]Fusion Research Center, Univ. Texas-Austin
Email: dernst@psfc.mit.edu

We present our recent experiments utilizing modulated on-axis ICRF minority heating to trigger fluctuations and core electron thermal and particle transport in Alcator C-Mod ITB's. The modulated on-axis heating pulses produced temperature swings of 25%, and were accompanied by strong bursts of density fluctuations measured by phase contrast imaging (PCI), while edge fluctuations from reflectometry and Mirnov coils simultaneously diminished. The bursts of fluctuations observed by PCI consist of a series of shorter bursts, in phase with central electron temperature modulation by sawteeth. This further suggests the line-integrated density fluctuations seen by PCI originate within the ITB foot.

The ITB's are reliably formed using off-axis ICRH. Following the transition to H-Mode, the central density steadily rises over tens of confinement times, with little change in on-axis temperature, to reach central densities as high as 6×10^{20} m^{-3}. In the absence of on-axis heating, the density profile continues to peak until impurity accumulation in the ITB results in radiative collapse or an H- to L-mode transition. Carefully timed on-axis heating, delivered in successive pulses, produces sufficient particle and impurity transport to halt the density rise and impurity accumulation. Initial linear gyrokinetic stability analysis indicates the ITB is marginally stable to density gradient driven trapped electron modes, which are destabilized by an increase in temperature.

With well-resolved profile measurements for both ions and electrons, including flows, and both core and edge fluctuation measurements, these recent experiments provide a validation testbed for gyrokinetic simulations of electron transport. Previously, we observed strong density fluctuations during steady on-axis heating of C-Mod ITB's. In a first-of-kind comparison,[1] nonlinear gyrokinetic simulations of TEM turbulence in the ITB reproduced the shape of the measured wavelength spectrum of density fluctuations during on-axis heating, introducing a synthetic PCI diagnostic in GS2, while matching the particle flux.[2]

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[1] D. R. Ernst *et al.*, in Proc. 21st IAEA Fusion Energy Conference, Chengdu, China, 2006, IAEA-CN-149/TH/1-3 (http://www-pub.iaea.org/MTCD/Meetings/FEC2006/th_1-3.pdf).

[2] D. R. Ernst *et al.* Phys. Plasmas **11** (2004) 2637.