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Modification of Edge Profiles and Stability with Lithium Wall Coatings in NSTX[1]

RAJESH MAINGI, Oak Ridge National Laboratory

Rapidly growing instabilities known as Edge Localized Modes (ELMs) are commonly observed in high-confinement (H-mode) regimes in many toroidal confinement devices. The reduction or elimination of ELMs with high confinement is essential for ITER, which has been designed for H-mode operation. Large ELMs are thought to be triggered by exceeding either edge current density limits (peeling modes) and/or edge pressure gradient limits (ballooning modes) [1]. Edge stability calculations have indicated that spherical tori should have access to higher pressure gradients and H-mode pedestal heights than higher aspect ratio tokamaks, owing to high magnetic shear and possible access to second stability regimes [2]. Such a regime was recently discovered in the National Spherical Torus Experiment (NSTX) following the application of Lithium onto the graphite plasma facing components [3]. ELMs were eliminated in phases [4], with the resulting pressure gradients and pedestal widths increasing substantially [5]. The modification of the pressure profile originated mainly from reduced recycling and edge fueling, which relaxed the edge density gradients. PEST and ELITE calculations have confirmed that the resulting pressure profiles were further from the stability boundary than reference discharges. The resulting discharges are ELM-free with a 50% increase in normalized energy confinement, up to the global $\beta_N \sim 5.5$-6 limit. While the ELM-free discharges ultimately suffer radiative collapse, pulsed 3-d magnetic fields are used to trigger ELMs and purge impurities [6].

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[2] P. B. Snyder, *Plasma Physics Controlled Fusion* **46** (2004) A131.
[3] H. W. Kugel, et. al., *Physics of Plasmas* **15** (2008) 056118.
[4] D. M. Mansfield, et. al., *J. Nucl. Materials* **390-391** (2009) 764
[5] R. Maingi et. al., *Physical Review Letters* (2009) at press.
[6] J.M. Canik, et. al, *Nucl. Fusion* (2009) submitted.

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