**ELM Suppression and Pedestal Structure in I-Mode Plasmas**

by
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Doctor of Philosophy in Applied Plasma Physics

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## EXECUTIVE SUMMARY

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The development of magnetic-confinement fusion into an economical form of power generation is characterized by two overarching and seemingly-contradictory requirements: first, a high level of energy confinement is necessary to reach the desired level of self-heating of the plasma by fusion products, and second, a low level of particle confinement to avoid the deleterious effects of accumulated impurities (both the helium "fusion ash" and eroded plasma-facing wall materials). The latter is particularly important for the high-Z impurities expected from the metal wall materials necessary for reactor-scale devices [1, 2]. A number of operating regimes, collectively termed *H-modes* [3], have been developed satisfying these requirements in varying degrees. These regimes are characterized by the formation of a *pedestal*, a region of steep gradient in density, temperature, and pressure at the plasma edge that acts as a transport barrier in the plasma. The structure introduces an additional constraint, however – the steep gradients act as a source of free energy for explosive Edge-Localized Modes (ELMs), which on reactor-scale devices drive transient heat loading and erosion damage in excess of material tolerances for plasma-facing surfaces [4].

As the width and height of the pedestal set a strong constraint on both global performance [5] and stability against ELMs [6], a firm understanding of the physics governing the pedestal structure is essential for the extrapolation of high-performance regimes to ITER- and reactor-scale operation. This thesis contributes to the understanding

of pedestal physics and high-performance operation in several key areas:

ELMY H-MODE PHYSICS

ELMy H-mode is commonly accessible

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