

Transition from wide pedestal QH-mode to ELMy H-mode in DIII-D and Predator-Prey Oscillations of Intermediate-k Density Fluctuations

K. Barada¹, T. L. Rhodes¹, K. H. Burrell², L. Zeng¹ and Xi Chen²

¹University of California Los Angeles, P.O. Box 957099, Los Angeles, CA 90095 USA

²General Atomics, P.O. Box 85608, San Diego, CA 92186-5608, USA

We have observed predator-prey like oscillations of density fluctuations (\tilde{n}) developing when edge harmonic oscillations (EHOs) cease to exist in wide pedestal QH mode discharges created by reducing the input torque. The poloidal flow and amplitude evolution of these \tilde{n} leading to an ELM have been studied. Large ELMs pose a significant challenge for successful operation of ITER. Efforts are underway to achieve ELM suppression in H-mode plasmas using 3D fields as well as developing intrinsically ELM-free QH-mode plasmas, both during ITER relevant low-torque operation. For example, recent experiments at DIII-D have created QH-mode plasmas at negligible torque with very good confinement and plasma beta (K.H. Burrell et al., article in press, *Physics of Plasmas*, 2016). These experiments have shown that the edge pedestal transitions to a state of higher pedestal pressure and width with decreasing plasma rotation. Coinciding with these transitions are simultaneous excitation of broadband MHD and intermediate-k \tilde{n} fluctuations (measured via magnetic probes and Doppler backscattering respectively). The broadband MHD and EHOs can initially co-exist after the transition, and later on the cessation of the EHOs, the broadband intermediate-k turbulence goes into a phase of predator-prey like oscillations between the mean velocity and amplitude of turbulence. The pedestal density and pressure gradient continue to increase with an increase in neutral beam injected power leading up to the first ELM. Approximately 50 msec prior to the ELM onset, the \tilde{n} poloidal flow increases dramatically coincident with a decrease in \tilde{n} amplitude. This may be consistent with a shear flow suppression of turbulence due to an increased pressure gradient driven electric field which in turn leads to a reduction in particle transport and a subsequently further increased density gradient. In stationary wide pedestal QH-mode (ELM free throughout discharge) where the neutral beam injected power is held constant at a lower value, the pedestal density and pressure gradient remain lower than the ELM return case and the limit cycle oscillations continue. These new observations and associated analysis may lead to an interesting picture of ELM onset during QH-mode operation and also may help in understanding the operational space of QH-mode plasmas.

*Work supported in part by the US Department of Energy under DE-FG02-08ER54984¹ and DE-FC02-04ER54698².

Topic area: L-H and L-I transition dynamics, threshold, isotope scaling, pedestal performance