Quiescent H–mode Plasmas in the DIII–D Tokamak*

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Stabilization of edge localized modes (ELMs) in H–mode plasmas in divertor tokamaks has several beneficial effects. Stabilization breaks the coupling between edge and global MHD modes which limits the performance of advanced tokamak plasmas. In addition, stabilization prevents the large pulsed divertor heat load that can be caused by ELMs. The key problem in the past with ELM-free discharges has been monotonic, uncontrolled density and radiated power increase. By utilizing cyropumping to control the edge plasma density, ELM-free and sawtooth-free H–mode plasmas have been produced using neutral beam counter-injection in single-null divertor plasmas in DIII–D. These shots exhibit constant density and radiated power throughout the ELM-free phase. This quiescent state lasts for up to 3500 ms, limited only by the neutral beam durations chosen. A critical input power above about 2.8 MW and critical line averaged density below about 3×10^{19} m^{-3} are required to reach this state. The presence of substantial edge pedestals and steep edge gradients in electron density and temperature and in ion temperature and rotation clearly demonstrates that these discharges are in H–mode. The good particle control in the absence of ELMs is due to a continuous, low frequency, edge MHD mode called the edge harmonic oscillation (EHO). This nonsinusoidal electromagnetic oscillation has been detected on Mirnov loops, beam emission spectroscopy, reflectometry, phase contrast imaging and electron cyclotron emission. Fourier analysis of the oscillation shows multiple frequency harmonics/toroidal mode numbers. The n=1 toroidal component of the mode has a frequency typically between 5 and 10 kHz. The density fluctuation associated with the EHO peaks on or slightly outside the separatrix. The edge pressure gradient is the same in ELMing and quiescent dischanges. MHD stability calculations are in progress to try to understand why the ELMs cease in these discharges.

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