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Locked-mode avoidance and recovery without external momentum input using ICRH

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A simple heating technique has been developed that could provide an actuator to circumvent error-field-induced locked-mode disruptions in tokamak plasmas. New observations of the formation and dynamics of error-field-induced locked-modes at ITER toroidal fields, without fueling and external momentum input have recently been carried out on Alcator C-Mod. Locked-mode excitation is achieved by ramping-up a set of external control "A-coils"capable of producing non-axisymmetric, predominantly n=1, fields with different toroidal phase and a range of poloidal mode, m, spectra. Features of the locked-mode include significant braking of the core toroidal rotation, a strong density pump out due to interaction between the plasma and the resonant magnetic perturbation and a flattening of the temperature profiles at the q=2 rational surface; the saturated island is approximately 6% of the minor radius. The density pump-out can also be the root for a reduction in the mode-locking thresholds, and is the main cause for a strong reduction in stored energy, confinement time and neutron production. Delay of the locked-mode onset and recovery from pre-existing locked-modes has been successfully obtained using Ion Cyclotron Resonance Heating (ICRH). The use of external heating concomitant with the n=1 error-field ramp-up resulted in a delay of the mode-onset avoiding the density pump-out and achieving high-confinement "H-modes". Heating the low-density plasma after the mode-onset was not conducive to an L⟶H transition but resulted in unlocking the plasma without external torque and obtaining co/counter-current flows at the edge/core. This work was performed at Alcator C-Mod, a DOE Office of Science User Facility under US DoE contracts, including DE-FC02-99ER54512 and others at MIT and DE-AC02-09CH11466 at PPPL.

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