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A Long-Pulse H-Mode Regime with a New Coherent Mode Providing Continuous Transport across Pedestal in EAST

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A long-pulse H-mode regime with a record pulse length over 30 s has been achieved in the EAST superconducting tokamak, sustained by RF heating and current drive with advanced lithium wall coating, exhibiting a good global confinement quality with H_98y2 ˜ 0.9. The H-mode plasmas are either ELM-free or mixed with irregular small ELMs. A new electrostatic edge coherent mode (ECM) is present continuously throughout the long-pulse H-mode discharges in the steep-gradient pedestal region, near the local electron diamagnetic frequency (20-90 kHz), propagating in the electron diamagnetic drift direction in the plasma frame. A significant fraction of the particle and heat exhaust across the pedestal is driven by the ECM, as demonstrated, for the first time, by direct probing the ECM-driven radial fluxes inside the separatrix using a new diamond-coated reciprocating probe array, which is essential for achieving steady state without large ELMs. In addition, the 2D structures of the ECM were examined with a unique, newly developed dual gas puff imaging (GPI) system, which has two view areas, up-down symmetrically about the midplane, showing strongly tilted ballooning mode structure and a poloidal wavelength of ˜ 8 cm, corresponding to a poloidal mode number m > 50 and a toroidal mode number n = 16-19. The ECM is a predominantly electrostatic mode with rather small magnetic component, deltaB/B_p ˜ 1*10ˆ-4, as detected by small magnetic coils mounted on the reciprocating probe at the ECM location. Simulations have been performed using GYRO eigenvalue solver and GS2 initial value code in a flux tube domain near the peak gradient region of the EAST pedestal, which indicate that the dissipative trapped electron mode (DTEM) is the dominant mode with characteristics consistent with those of the ECM. Preliminary results from GTC simulation also indicate that TEM is the most unstable mode under these circumstances. In addition, the ECM has been observed with the central-line-averaged density, n_e = 1.9-5*10ˆ19 mˆ-3 (n_e/n_GW = 0.28-0.7) in the experiments, corresponding to a collisionality, nu*_e = 0.5-5, evaluated at the top of pedestal, which is the same collisionality range where DTEM is active. These results may open a new avenue towards steady-state H-mode operations with a stationary pedestal as maintained by benign electrostatic microinstabilities rather than large ELMs.

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