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Favorable Core and Pedestal Transport Properties of the Wide Pedestal QH-Mode Regime[1]

D. R. ERNST[2], Massachusetts Institute of Technology

The high confinement Wide Pedestal Quiescent H-Mode regime (H_{98y2} up to 1.6) is promising for steady burning plasma operation without ELMs and associated divertor damage, at ITER collisionalities, with nearly equal ion and electron temperatures and no net torque injected. In recent DIII-D experiments, unlike other H-Modes, confinement improves when electron cyclotron heating (ECH) replaces neutral beam power, promising for burning plasma operation. We have sustained Wide Pedestal QH-Mode for several confinement times with up to 77% ECH power (23% NBI) with $T_{e0} > 12$ keV.[3] Fourier analysis of the ECE T_e response to modulated ECH separates diffusion and convection in the electron power balance, revealing an inward core electron thermal pinch, forming an internal transport barrier (ITB) in T_e as the ECH is moved on-axis. The pinch is being explored using GENE simulations (now with the first exact gyrokinetic collision operator[4]). TEM turbulence dominates, driving significant magnetic flutter transport. Even without the ITB, ion channel confinement improves in the core and pedestal as the fraction of off-axis electron heating increases. The pedestal E_r well broadens and deepens, while the intensities of low and intermediate wavenumber density fluctuations respond oppositely. Wide Pedestal QH-Mode has been separately demonstrated with zero net injected NBI torque throughout. We have measured the effective intrinsic torque profile as a function of ECH power fraction (0%, 32%, 52%), while simultaneously measuring electron thermal transport. The intrinsic torque density balances that from edge beam orbit loss to produce near-zero total torque density across the profile. The edge beam orbit loss torque diminishes as the fraction of ECH power increases, yet confinement improves.

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[2]With C. C. Petty, K. H. Burrell, A. Bortolon, C. Chrystal, S. Haskey, Q. Pan, T. Rhodes, M. Austin, K. Barada, L. Bardoczi, T. Carlstrom, Xi Chen, B. Grierson, D. Hatch, G. McKee, T. Osborne, C. Paz-Soldan, G. Wang, T. Wilks, Z. Yan, L. Zeng

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[4]Q. Pan, D. R. Ernst, and P. Crandall, Phys. Plasmas **27**, 042307 (2020).