Formation of a Staircase Pedestal with Suppressed Edge-Localized-Modes (ELMs) in the DIII-D Tokamak

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We observe the formation of a high-pressure staircase pedestal (≈16-20 kPa) in high $\beta_p$ plasmas ($\beta_p>1.5$) in the DIII-D tokamak when large amplitude ELMs are suppressed using resonant magnetic perturbations (RMP). The pedestal cyclically transitions from a one-step structure to a wider two-step staircase structure, with a period of ≈40-60 ms (upper right figs.). In the wide pedestal phase a strong flattening of the electron density and temperature develops in mid-pedestal, producing the staircase pedestal structure[1]. Also, localized bursting fluctuations are seen in the this flat region ($\rho\approx0.95$) (lower right fig.). Fluctuations at the pedestal top ($\rho\approx0.8$) are periodically enhanced by RMP[1], and drive the narrowing of the pedestal width (left fig.). Gyrokinetic analysis using the newly developed CGYRO[3] code and experimental fluctuation measurements (BES diagnostic) reveal that the feedback effect of reduced ExB shear in mid-pedestal on the enhancement of transport by trapped electron modes results in transport bifurcation which eventually leads to local flattening of profiles and staircase pedestal formation[3]. By enhancing the confinement and drastically reducing the peak of heat flux to diverter, formation of the staircase pedestal opens a path for optimizing the steady-state operation in ITER and future reactors.

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