Studies of H–mode Plasmas Produced Directly by Pellet Injection in DIII–D*

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A key issue for the physics of H–mode plasmas is to determine which plasma quantities are critical for the formation of the edge transport barrier. One approach is to directly perturb the edge plasma and observe the subsequent changes. In DIII–D, pellet injection has been used to directly change the edge plasma conditions and produce H–mode transitions. H–mode transitions were produced by injecting frozen deuterium pellets of diameter 2.7 mm from the inner wall of the DIII–D vessel into the high toroidal field side (HFS) and also into the low field side (LFS) of the plasma. Both the HFS and LFS pellets produced significant increases in the edge electron density, which led to substantial reductions in the edge electron and ion temperatures. However, H–mode transitions were still produced with the lowered edge temperatures, implying that a critical edge temperature is not necessary for H–mode transitions. The pellet induced H–mode plasma exhibited clear pedestals in electron density and electron and ion temperatures at the plasma edge and persisted for the duration of the applied neutral beam power. The HFS pellet's penetration and deposition profiles were substantially deeper (up to $\rho \approx 0.2$) than that of the LFS pellet (up to $\rho \approx 0.8$). However, since both HFS and LFS pellets produced H–mode transitions, this implies that pellet penetration depth is not important; the important factor is the large increase in the electron density right at the plasma edge produced by both these types of pellets. The values of the edge plasma quantities at the H–mode transition were expressed in the parametric terms described in several theories and models of the H–mode transitions. On comparison, the experimentally determined parameters at the H–mode transition were well below those required by several theoretical models. Changes in the edge profiles of n_e, T_e, T_i, and E_r across the transition will be presented. Finally, pellet injection reduced the H–mode power threshold by about 33%, from 7.3 MW to 4.9 MW in plasmas which and the ∇B drift away from the X–point.

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