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Rotation Profile Hollowing in DIII-D Low-Torque Electron-Heated H-mode Plasmas

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Recent experiments in the DIII-D tokamak obtained low torque MHD-free H-mode discharges approaching ITER baseline conditions revealing mid-radius rotation profile hollowing associated with turbulent transport. This indicates that hollowing of toroidal rotation profiles that occurs prior to onset of large-scale MHD observed in low torque ITER Baseline conditions is not due to pre-existing MHD mode drag, but a natural consequence of the turbulent momentum flux. Low torque (T~0.6Nm) plasmas in the ITER similar shape with q95~4.3, βN~1.2-1.6 and electron cyclotron heating (ECH) power between 0-3.4 MW deposited between ρ=0.3-0.7 are studied for ion and electron heating effects on momentum transport. Turbulent density fluctuations are measured with Doppler backscattering (DBS) for intermediate-k (kθρs 1-5) and beam emission spectroscopy (BES) for low-k (kθρs < 1). Contrasting times in a discharge with a core tearing mode with a later phase after the tearing mode has disappeared, the role of the mode on rotation profile hollowing can be determined. In the presence of the mode, the rotation profile is flat or moderately peaked. However, after the tearing mode disappears, the profile takes on a non-monotonic, localized "well"or hollowness, with a positive local rotation gradient. We interpret this phenomenon as the tearing mode reducing the turbulent transport near the island by shunting the thermal flux, flattening the profiles and reducing the turbulent residual stress. When the tearing mode disappears, turbulence increases and the turbulent residual stress is able to drive the non-monotonic rotation profile. Fluctuations in the region of the non-monotonic rotation reveal both low-k ion temperature gradient (ITG) as well as intermediate-k trapped electron mode (TEM) scale fluctuations. The theoretical impact of the linearly unstable modes and turbulent transport mechanisms on the rotation hollowing is still being investigated. This work was supported in part by the US Department of Energy under DE-FC02- 04ER54698, DE-SC0014264 and DE-AC02-09CH11466, and carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under Grant Agreement No. 633053

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