The role of turbulence in ECH pump-out process in DIII-D H-mode Plasmas

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In recent H-mode experiments on DIII-D, the ECH power is modulated with a period of 500 ms on top of steady neutral beam heating to study how particle transport evolves. By fitting the density and temperature evolution during the ECH pulse, we find that strongest density reduction occurs outside mid-radius (ρ=0.6-0.8), while the initial increase in electron temperature occurs in the plasma core. So while, the ECH is added to the plasma core, the density pump-out originates at the plasma edge. Linear gyro-kinetic analysis using TGLF [1] shows that the onset of the density pump-out is not the result of a change in turbulence regime, which is what has been assumed in previous research [2]. So the pump-out is not the result of a change in the sign of the thermo-diffusive pinch from inward to outward, but the result of an increase in turbulence drive, in the Ion Temperature Gradient (ITG) regime. The turbulence regime only switches to the Trapped Electron Mode (TEM), after 150ms. While the pump-out is driven by changes at the plasma edge, close to mid-radius, we find that the local density gradient follows the theoretical gyro-kinetic predictions [3]. Gyro-kinetics predict that when the absolute frequency of the dominant unstable mode decreases in the ITG regime, local density peaking increases. Once the dominant mode then switches over to the TEM regime, the local peaking of the density decreases again, which means that R/Ln reaches a maximum right where the turbulence regime switches over from ITG to TEM. For the first time in DIII-D, we observe a correlation between the changes in R/Ln and this change in frequency, in agreement with theoretical prediction [3] and experimental results on AUG [4]. On top of this, we also find that the experimental particle flux (which is independent of the local gradients), shows a similar correlation. This is another indication that particle transport is dominated by changes in turbulence.

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