Reduced fluctuations in high confinement plasmas at negative triangularity on DIII-D*

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Plasmas with negative triangularity (δ_n) shape on the DIII-D tokamak are characterized by high confinement and normalized beta ($H_{98,y2}$ = 1.2, β_N = 2.6), despite featuring edge pressure profiles typical of an L-mode plasma without Edge Localized Modes.

This work was inspired by previous results from the TCV tokamak [1], where the energy confinement time of collisionless ($\nu_{\rm eff} \sim 0.2$) L-mode plasmas subject to pure Electron Cyclotron Heating (ECH) was shown to double when reversing δ, with other parameters held fixed. The experiments on DIII-D investigated δ_n plasmas at moderate collisionalities ($\nu_{\rm eff} \simeq 0.5$) in both pure ECH and mixed ion-electron (ECH/NBI) heating regimes, thus exploring for the first time a more reactor relevant regime where $T_e \sim T_i$. For both heating schemes, plasmas at δ_n show up to 30% increase in stored energy compared to discharges with matched actuators but positive δ (δ_p). In the high power phase, during which δ_p plasmas develop an H-mode pedestal, the δ_n matched discharges produced 30% more neutrons than the δ_p counterpart, which a TRANSP analysis shows to be due to a reduced main ion dilution owing to lower impurity content. The intensity of density fluctuations measured by the Phase Contrast Imaging (PCI) diagnostic [2] is seen to decrease by 50% and 30%, respectively, in the two heating phases at δ_n. The relative intensity of fluctuations at positive and negative wavenumbers is seen by the PCI to depend on the shape. A linear gyro-kinetic analysis indicates that, in both heating schemes, discharges are dominated by Trapped Electron Modes at ion scale but, unlike the TCV discharges, strong electron scale fluctuations are present in the core. Growth rates are seen to decrease at δ_n in the spectral region $k_\theta \rho_s < 2$, with the largest decrease seen in the ECH-only phase.

References

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