Impact of negative triangularity on turbulent transport: From validated simulations to basic understanding

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Negative triangularity tokamak discharges lie beyond the standard operating regimes but have been experimentally found to potentially lead to significant improvements in the plasma confinement. The physical mechanism leading to this improvement and in particular how edge triangularity, which is rapidly diminishing towards the magnetic axis, can influence the behavior of the plasma at all radial positions still remains unclear.

We will discuss high realism gyrokinetic GENE simulations used to reproduce transport and fluctuation levels experimentally measured in different tokamaks and providing the basis for understanding the underlying stabilizing mechanisms.

We have considered L-mode (ECH heated) DIII-D plasmas for which, making use of flux-tube simulations we have addressed the impact of critical gradients and profile stiffness of shape. We have also considered DIII-D NBI heated plasmas and characterized the differences between $\delta>0$, which is found to transition to H-mode, and $\delta<0$ which although remains in L-mode regime has a similar high confinement. Previous investigations of TCV discharges aiming at addressing similar questions have been complemented here with corresponding global GENE runs. Such runs are found to be necessary to reproduce the actual transport level and allowed us to measure the impact of finite machine size effects.

Furthermore, the impact and beneficial effects of $\delta<0$ in turbulent regimes other than TEM dominated plasmas and its interplay with other plasma parameters will be presented, addressing the universality of confinement improvement due to negative triangularity.