Turbulence and Transport Reduction with Negative Triangularity : Correlation ECE Measurements in TCV

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Due to turbulence, core energy transport in fusion devices such as tokamaks generally exceeds collisional transport by at least an order of magnitude. It is therefore crucial to understand the instabilities driving the turbulent state and to find ways to control them.

Plasma shape is one of these fundamental tools. In low collisionality plasmas, such as in a reactor, changing the plasma shape from Dee-shape to inverse Dee-shape (from positive to negative triangularity δ) reduces the energy transport by a factor two: the heat flux necessary to sustain the same profiles and stored energy in a discharge with δ=-0.4 is only half of that at δ=+0.4. This is significant, since it opens the possibility of having H-mode-like confinement time within an L-mode edge; or at least with smaller ELMs.

Recent correlation ECE measurements show that this reduction of transport at negative δ is reflected in a reduction by a factor of two of both 1) the amplitude of temperature fluctuations in the broadband frequency range 30-150 kHz, and 2) the fluctuation correlation length, measured at mid-radius (ρ_v~0.6). In addition, the fluctuations amplitude is reduced with increasing collisionality, consistent with theoretical estimates of the collisionality effect on Trapped Electron Modes (TEM).

The correlation ECE results are compared to gyrokinetic code results: 1) global linear gyrokinetic simulations (LORB) have predicted shorter radial TEM wavelength $\lambda_\perp$ for negative triangularity plasmas, consistent with the shorter radial turbulence correlation length λ_c observed. 2) At least close to the strongly shaped plasma boundary, local nonlinear gyrokinetic simulations with the GS2 code predict that the TEM induced transport decreases with decreasing triangularity and increasing collisionality, in fair agreement with the experimental observations. 3) Calculations are now extended to global nonlinear simulations (ORB5).

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