# Collisionality scaling in Tore Supra: on the uncertainties of global and local energy confinement analysis

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Collisionality study on L-mode plasma discharges on Tore Supra allows to check the impact of $\nu^*$ on the confinement of the plasma core.

The magnetic field has been varied from 2.4 to 3.9 T across 2 ohmic and 2 ICRF heated discharges at low additional power ($< 1$ MW), leading to a $\nu^*$ scan of a factor $6.8 \pm 2$ in a rather high $\nu^*$ range $> 0.1$. As in [1], to minimize the uncertainties due to radiative losses, the confinement time is defined inside a radius where less than 20% of the power is radiated.

Depending on the assumption set used, the normalized confinement time scaling versus $\nu^*$ changes a lot as detailed in [2, 3]. If no underlying $\rho^*$ nor $\beta$ dependences are assumed, and accounting for uncertainties on the absorbed power of 10% and on the thermal energy of 20% one obtains :

$$B\tau_E \propto \nu^{*-0.3\pm0.2}$$

Now, if one accounts for a realistic underlying gyrobohm scaling including the variability of $\rho^*$ within its 7% uncertainty, one obtains a different scaling law:

$$B\tau_E \propto \nu^{*0\pm0.7}$$

If now, one restricts itself to the subset of the 2 ohmic discharges, where both $Z_{\text{eff}}$ and $T_e/T_i$ are better matched, the following fit is obtained:

$$B\tau_E \propto \nu^{*-0.9\pm0.6}$$

This analysis shows a dependence of the confinement time with respect to $\nu^*$ weaker than $|0.7|$. The ohmic subset of 2 discharges indicates that the tendency is rather a decrease of $B\tau_E$ with higher $\nu^*$.

The local transport analysis is restricted to radii outside which 80% of the power is absorbed to limit the effect of uncertainties on the modelling of power absorption. This limits the local transport analysis to $r/a > 0.6$. To avoid uncertainties due to radiative losses, the radial zone is restricted to radii below which less than 20% of the power is radiated, in this scan $r/a < 0.9$. At $0.6 < r/a < 0.9$, no significant variation of $\chi_{eff}/\chi_B$ with respect to $\nu^*$ is observed.

The limitations of both global and local transport analyses are calling for detailed turbulence measurements to be compared with non-linear gyrokinetic simulations. In this $\nu^*$ scan, the fast-sweeping and the Doppler reflectometers were operating. Effect on the density fluctuations outside error bars is observed only: outside $r/a = 0.8$, for the ohmic pair of discharges and at $k_\theta = 7cm^{-1}$. In this particular case, the fluctuations increase with higher collisionality. The linear gyrokinetic analysis shows that the dominant mode rotates in the ion drift direction (ITG type). Nonetheless, part of the turbulence is carried by trapped electrons since a $\nu^*$ increase leads to a decrease of the turbulent fluxes simulated by GYRO as expected by detrapping effect. This weak trend agrees with the weak dependence of transport and turbulence with respect to $\nu^*$ inside $r/a = 0.8$, but it is opposite to the experimental observation at $r/a > 0.8$.

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