Particle Transport, Density Peaking and Isotope Scaling in Tokamaks

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Abstract. Particle transport in tokamaks has received much less attention than electron and ion heat transport channels. It is still often not treated self-consistently in transport modelling and predictions for future tokamaks. As a consequence, particle transport and fuelling remain one of the major open questions in understanding ITER physics [1]. The shape of the density profile has a significant influence on fusion performance and impurity transport. The uncertainties in the particle transport limit our predictive capability for future fusion devices.

Particle transport has been extensively studied by performing several dimensionally matched collisionality scans in various plasma scenarios on JET. Gas puff modulation technique has been developed with high quality time-dependent density profile measurements to determine particle transport coefficients [2]. The relative role between turbulent inward convection versus NBI fueling in contributing to density peaking is being intensively studied [3].

The dimensionless isotope mass scaling experiment between pure Deuterium and pure Tritium plasmas with matched ρ^*, ν^*, β_n, q and T_e/T_i has been achieved in JET L-mode with dominant electron heating (NBI+ohmic) conditions. 28% higher scaled energy confinement time $B_t\tau_{E,th}/A$ is found in favour of the Tritium plasma [4]. This can be cast in the form of the dimensionless energy confinement scaling law as $\Omega_i\tau_{E,th} \sim A^{0.48\pm0.16}$. The isotope mass dependence in the particle transport channel is negligible, supported also by the perturbative particle transport analysis with gas puff modulation.

References

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