Gyrokinetic studies of the isotope effect in JET-ILW H-mode discharges

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The upcoming tritium and DT experiments in the JET tokamak with the ITER-like wall have led to renewed interest in the dependence of turbulent transport on the main ion isotope mass. In particular, a difference between the experimentally observed worse energy confinement in H and the theoretically expected gyro-Bohm scaling of transport with $\sqrt{m_i}$, known as the so-called isotope effect, is found.

We use the gyrokinetic code GENE[1] to analyse the core transport of two JET-ILW H-mode discharges in hydrogen (#91554) and deuterium (#84796) at same engineering parameters (Ip/Bt, Pin, injected gas rate)[2] at the radial positions $\rho_{tor} = 0.5$ and $\rho_{tor} = 0.8$. Both linear and nonlinear simulations with the experimental parameters are performed, as well as studies with artificially changed mass (e.g. #91554 with D as main ion species). Additionally, we consider the impact of other plasma parameters such as collisionality, external $\mathbf{E} \times \mathbf{B}$ shear or the presence of a fast ion species.

Quasilinear simulations at $\rho_{tor} = 0.5$ show that only ITG modes are unstable unless collisions are neglected. At $\rho_{tor} = 0.8$ a subdominant trapped electron mode can be found. The amplitude and position of the peak in the growth rate spectrum follow the gyro-Bohm scaling both when changing the isotope for a single discharge as well as between the two discharges. In first nonlinear simulations transport of particles and heat at $\rho_{tor} = 0.5$ also follows the gyro-Bohm scaling when the ion mass is modified and if collisions are neglected. This supports the notion that the isotope effect in these cases originates in the edge

References

[1] genecode.org

[2] C.F. Maggi, H. Weisen et al., Plasma Phys. Control. Fusion 60 (2018) 014045