Isotope Identity Experiments in JET with ITER-like Wall

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Dimensionless experiments test the invariance of plasma physics to changes in the dimensional plasma parameters, when the canonical dimensionless parameters, such as ρ^*, ν^*, β, q, ... are conserved. In particular, isotope identity experiments exploit the change in hydrogen isotope ion mass $A = m_i/m_p$ to obtain plasmas with identical dimensionless profiles in the same tokamak. With this technique, NBI-heated L-mode and type I ELMy H-mode plasmas at moderate beta have been obtained in JET with the Be/W ITER-like wall in H and D, with similar profiles of the dimensionless plasma parameters ρ_i^*, ν^*, β_{th}, q, as well as similar Z_{eff}, T_i/T_e and Mach-number profiles. In the core confinement region of these plasmas the dominant instabilities are ITG modes both in H and in D.

The dimensionless thermal energy confinement time $\Omega i\ \tau_{E,th}$ is identical in the L-mode isotope identity pair, indicating lack of isotope mass dependence of the dimensionless $\tau_{E,th.}$, and the invariance principle is satisfied in the core confinement region. In the type I ELMy H-mode pair, similarity in H and D is found for both core and pedestal regions for the ELM-averaged profiles, but not for the pre-ELM profiles. $\Omega_i\ \tau_{E,th}$ is not identical in the H-mode pair and yields an isotope mass dependence $\Omega_i\ \tau_{E,th} \sim A^{0.51}$, consistent with the favourable isotope mass scaling of the dimensional $\tau_{E,th}$ observed in JET-ILW. Predictive flux driven simulations of core plasma transport with JETTO-TGLF (L-mode pair) and TRANSP-TGLF (H-mode pair) are in agreement with experiment for both isotopes: the stiff core heat transport, typical of JET-ILW NBI L-modes and NBI H-modes at moderate beta values, overcomes the local gyro-Bohm scaling of gradient-driven TGLF, explaining the lack of isotope mass dependence in the core confinement region of the L-mode plasmas and the increase of confinement with isotope mass in the H-mode plasmas, which originates in the pedestal region. The effect of *ExB* shearing from sheared toroidal rotation on the predicted core heat and particle transport channels is found to be negligible in the low beta and low momentum input L-mode plasmas, while it becomes apparent in the H-mode identity pair at moderate beta.