Pedestal structure and stability in H and D isotope experiments on JET-ILW

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Understanding the isotope effects of plasma confinement and transport is crucial for the preparation of the non-nuclear phase of ITER (Hydrogen or Helium) and for its subsequent phase of Deuterium-Tritium operations. On the other hand, the positive scaling of energy confinement time with isotope mass (A) observed in experiments has not yet been understood theoretically. Experiments in Hydrogen (H) and Deuterium (D) have recently been executed on JET-ILW in preparation for the upcoming D-T campaign, providing stringent tests to plasma transport models.

This contribution investigates the isotope effects of the pedestal structure and ELM losses in H and D Type I ELMy H-modes. Comparative type I ELMy H-modes were obtained with both isotopes by means of systematic power and gas scans, revealing a doubling of the power threshold for type I/type III ELMs from D to H and a reduction of the thermal energy confinement in H. The ELM frequency is higher in H than in D at the same net input power, as observed in previous experiments [1], [2]. The pedestal stability of H type I ELMy H-modes at the lowest gas rates is largely consistent with the ELMs being triggered by intermediate-n Peeling–Ballooning modes. H-modes in H and D at the same pedestal stored energy do not have matched density and temperature profiles: in H the lower density is compensated by higher temperature. This is in contrast to JT-60U experiments, where density and temperature profiles were matched in H and D when the stored energy was matched by raising the H-NBI heating [1].

An isotope identity experiment in JET-C had shown that the plasma transport properties could be described in terms of the basic dimensionless plasma physics parameters ρ^*, β, ν^* and q [3]. This technique was also adopted in the new JET-ILW isotope experiments. Although the ρ^*, β, ν^*, q profiles and Z_{eff} were well matched in the two species, the scaled energy confinement time, $B \cdot \tau_E/A$, and scaled ELM frequency, $A \cdot f_{ELM}/B$, deviated by up to a factor of two depending on the gas fuelling rate.

[1] H. Urano et al., NF 48, 045008 (2008); [2] J.G. Cordey et al., NF 39, 301 (1999); [3] J.G. Cordey et al., PPCF 42, A127 (2000)