Isotope effect physics, turbulence and long-range correlation studies in the TJ-II stellarator

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There is clear experimental evidence that at comparable plasma parameters deuterium (D) discharges have improved confinement properties as compared with hydrogen (H) ones. The isotope effect has been observed in many different tokamaks under different plasma conditions with a degree of confinement improvement in energy, particle and momentum depending on plasma regimes. Interestingly the isotope effect seems to be weaker in stellarators than in tokamaks [1]. Recent comparative studies in tokamaks and stellarators have shown experimental evidence of the importance of multi-scale physics for unravelling the physics of the isotope effect in fusion plasmas [2, 3].

The goal of this study is to establish the connection between properties of large scale flows, local turbulence and isotope effect physics during the transition from D to H dominated plasmas in the TJ-II stellarator. Different edge plasma parameters were simultaneously characterized in two different toroidal positions approximately 180° apart using two multi-Langmuir probes [4].

Long-range correlation (LRC) has been evaluated for H and D plasmas. The LRC amplitudes are rather similar in H and D dominated plasmas, with a small but systematic tendency of decreasing (in the range of 20%) values in D dominated plasmas in contrast with previous findings from the TEXTOR tokamak [2].

The properties of local turbulence have been characterized for H, D and He plasmas by computing the radial correlation length (Lr) of potential fluctuations. Results show that Lr slightly increases (in the order of 10%) in plasmas dominated by D; increase is more pronounce in He plasmas.

Finally, the evolution of LRC amplitude has been investigated during the transition from ECRH to NBI heated plasmas (deuterium plasmas with H-NBI heating); its value is strongly intermittent and increases significantly in NBI plasmas matching the evolution of $1/\alpha$.