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Impact of H, D, T and D-T Hydrogenic Isotopes on Detachment in JET ITER-like Wall Low-Confinement Mode Plasmas

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Measurements in JET ITER-like Wall low-confinement mode plasmas showed that the scrape-off layer at the low-field side midplane was 30% broader and the low-field side divertor plasma a factor of $2-3$ more strongly detached in pure-tritium than in pure-protium plasmas for otherwise similar core plasma conditions. The conditions in pure-deuterium and in a $40\%-60\%$ deuterium-tritium plasmas were found to be between those in protium and tritium plasmas. These results are statistically significant and consistent with the lower triton than proton velocities and shorter ionisation mean free path for tritium than for protium atoms, as predicted by the EDGE2D-EIRENE code. For all four isotope species and mixes, the onset of detachment was observed within 10% of the same electron density at the edge of the core plasma. The formation of detachment with increasing edge density is identical between the isotope species and mixes: the electron temperature at and adjacent to the low-field side target plate decreased from 20 eV to 1 eV in non-linear fashion over a narrow edge density range, and the onset of detachment was achieved when the electron temperature at the low-field side plate reached 2 eV. The high electron density (pressure) region, formed at the low-field side plate in the near-separatrix SOL when the electron temperature was $0.7-1.0$ eV, was observed to transition non-linearly from the target plate to the low-field side X-point region. The formation of the high-density/pressure region in the low-field side divertor was independent of the molecular gas pressure in the sub-divertor, and thus the fuelling and pumping rates of the experimental setup. The density limit was 30% lower in tritium than in protium plasmas. The potential impact of hydrogenic collisional-radiative models including the isotope mass and Lyman-alpha opacity will be discussed.

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