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P4.1102 Isotope effect on energy confinement time and thermal transport in NBI-heated plasmas on LHD

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Energy confinement time and thermal transport has been investigated in NBI heated hydrogen (H), deuterium (D) and mixture (H&D) plasmas in a large-scale stellarator-heliotron LHD. Regression analysis of thermal energy confinement time has indicated no significant dependence on the isotope mass (A) in the expression of operational parameters such as $\tau^{(scl)}(E,th)$ ⊠ $A^{(-0.01+-0.02)} B^{(0.85+-0.02)} n_e^{(0.78+-0.01)} P_{abs}^{(-0.87+-0.01)}$, *where B, n_e and P_{abs} are magnetic field, line-averaged density and absorbed heating power, respectively. An isotope effect on energy confinement time seems degenerate like an MHD model. This expression can be rephrased into the expression of non-dimensional parameters such as* $\tau^{(scl)}(E,th)\Omega_i \propto A^{(1.01)}\rho^{(-3.03)}\upsilon^{(0.19)}\beta^{(-0.28)}$ where ρ, υ and β are normalized gyro radius, normalized
collisionality and normalized pressure, respectively. This expression suggests co-existence of gyro-Bohm nature ($\tau_{(E,th)}\ \Omega_i \propto \rho^{(-3)}$) *and clear but un-known mass dependence, or this could be consequence of violation of gyro-Bohm nature. H and D plasmas with the same non-dimensional parameters such as* ρ, υ^* and β have been compared in order to assess these two contrasting conjectures. These plasmas which are non-dimensionally similar but have different mass have been obtained by adjusting magnetic field, density and heating power to realize density ratio of nD/nH=2 and temperature ratio of T_D/T_H=sqrt(2) at $B_D/B_H=2^{(3/4)}$. Gyro-Bohm model as well as neoclassical transport predicts the same thermal diffusivity normalized by Ω_i for these pairs of non-dimensionally similar plasmas. However, significant improvement of thermal diffusivity has been identified in deuterium plasmas compared with hydrogen plasmas in particular electron loss channel. Since it should be noted that electron heating is predominant for these plasmas, typically P_e/P_i~4, this local thermal transport characteristics is consistent with a conjecture from energy confinement time $\tau_{(E,th)}\ \Omega_i \propto A$. Effects of heating channel in other words T_e/T_i ratio and isotope mixture as well as configurational effect due to enhanced neo-classical helical ripple transport are also discussed.

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