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Transport characteristics of deuterium and hydrogen plasmas with ion internal transport barrier in LHD

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A remarkable achievement of $T_{\mathrm{i}0} = 10$ keV with $Z_{\mathrm{eff}} = 2$ was obtained in Large Helical Device (LHD). In order to clarify transport characteristics in ion internal transport barrier (ion ITB) formation with isotope effect, a dataset of pure deuterium (D) ($n_{\mathrm{D}}/n_{\mathrm{e}} > 0.85$) and pure hydrogen (H) ($n_{\mathrm{H}}/n_{\mathrm{e}} > 0.85$) plasmas for high-ion-temperature (high-T_{i}) regime were analyzed, and two mechanisms of transport improvement were characterized. A significant reduction of ion heat transport in D plasmas was observed in comparison between D and H plasmas, indicating non-gyroBohm mass dependence. The dependence of the heat transport on temperature ratio ($T_{\mathrm{e}}/T_{\mathrm{i}}$) and normalized T_{i}-gradient ($R/L_{\mathrm{T}\mathrm{i}} = -(R/T_{\mathrm{i}})(dT_{\mathrm{i}}/dr)$) was investigated in the core region, in which gyrokinetic simulations with GKV code predicts the destabilization of ITG modes [1]. The $T_{\mathrm{e}}/T_{\mathrm{i}}$ dependence shows ITG-like property, while a significant deviation from the ITG-like property is found in the $R/L_{\mathrm{T}\mathrm{i}}$ dependence. Moreover, the density fluctuation is well correlated with the heat transport dependence on $T_{\mathrm{e}}/T_{\mathrm{i}}$ and $R/L_{\mathrm{T}\mathrm{i}}$, indicating suppression of ITG mode in large $R/L_{\mathrm{T}\mathrm{i}}$ regime and resultant ion ITB formation. The similarity of instabilities found by GKV indicates that both ITG suppression and isotope effect contribute to production of high-T_{i} plasmas ($T_{\mathrm{i}0} \sim 10$ keV) with multiple-ion conditions.

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