

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

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A remarkable achievement of $T_{i0} = 10$ keV with $Z_{\text{eff}} = 2$ 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) ($n_{\text{D}}/n_e > 0.85$) and pure hydrogen (H) ($n_{\text{H}}/n_e > 0.85$) 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_e/T_i) and normalized T_i -gradient ($R/L_{T_i} = -(R/T_i)(dT_i/dr)$) was investigated in the core region, in which gyrokinetic simulations with GKV code predicts the destabilization of ITG modes [1]. The T_e/T_i dependence shows ITG-like property, while a significant deviation from the ITG-like property is found in the R/L_{T_i} dependence. Moreover, the density fluctuation is well correlated with the heat transport dependence on T_e/T_i and R/L_{T_i} , indicating suppression of ITG mode in large R/L_{T_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 ($T_{i0} \sim 10$ keV) with multiple-ion conditions.

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