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Isotope effects on confinement and turbulence in ECRH plasma of LHD

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The positive isotope effects have been found in ECRH plasma of LHD. The enhancement factor of global energy confinement time (tauE) to ISS04 scaling in deuterium (D) plasma is about 17% better than in hydrogen (H) plasma. Ion scale density fluctuation level is higher in D plasma. Core fluctuation level in D decreases rapidly with increase of tauE.
Both tokamak scaling (ITER98y2) and helical scaling (ISS04) follow gyro-Bohm (GB) scaling with the exception of ion mass and ion charge number. While GB scaling predicts enhanced transport in D plasma, many experiments show better confinement (in tokamak) in D or comparable confinement (in medium-sized helical devices). In this paper, we report the first results of the improved confinement due to the isotope effects in ECRH plasma of LHD.
In the dataset, the injection power of 77 and 154GHz gyrotron was 0.6-3.9MW in D, 0.8-3.8MW in H, n_{e bar} was 0.6-3.7x10 ¹⁹ m ⁻³ in D, 0.3-3.8x10¹⁹m⁻³ in H. The one path absorption power was 92+-4% of injection power both for H and D plasma. The magnetic axis was 3.6m and Bt was 2.75T. tauE is systematically higher in D. This is more apparent in the high collisionality regime.The enhancement factors are tauE/tauE ISS04 =1.27+-0.12 in D and 1.09+-0.02 in H plasma. Thus, improvement of tauE in D to H is 17%.
For fixed injection power, T_e and T_i profiles are almost identical. However, n_e profile is more hollowed in D plasma. The higher n_e in the edge region results in the higher stored energy and better confinement.
 Ion scale turbulence was measured by two-dimensional phase contrast imaging. The measured normalized wavenumber was around 0.4. Surprisingly, it is found that the fluctuation level is higher in D, while tauE is higher in D plasma. However, the fluctuation level reduces with increase of tauE. This dependence is clearer in D plasma. Recent gyrokinetic study shows stronger collisional stability of TEM in D than in H plasma. Also, hollow density gradient reduces growth rate both of TEM and ITG. The quicker reduction of fluctuation level the core of D qualitatively agrees with collisional dependence of TEM and more hollowed density profiles in D.

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Author: Dr TANAKA, Kenji (National Institute for Fusion Science)

Co-authors: Dr WARMER, Felix (Max Planck Institute for Plasma Physics); Dr TAKAHASHI, Hiromi (National Institute for Fusion Science); Prof. YOKOYAMA, MASAYUKI (National Institute for Fusion Science); Dr NAKATA, Motoki (National Institute for Fusion Science); Dr TSUJIMURA, Toru (National Institute for Fusion Science); Dr OHTANI, Yoshiaki (QST)

Presenter: Dr TANAKA, Kenji (National Institute for Fusion Science)

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