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Effect of deuterium plasmas on carbon impurity transport in the edge stochastic magnetic field layer of Large Helical Device

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Stochastization of edge magnetic fields has been extensively studied not only for the ELM mitigation but also for the plasma detachment and the impurity transport. The ergodic layer of Large Helical Device (LHD) consists of stochastic magnetic fields with three-dimensional structure intrinsically formed by helical coils. Reduction of the parallel impurity transport in the ergodic layer, so called "impurity screening", has been studied in LHD. The theoretical modelling explains that the parallel momentum balance on impurity ions determines the direction and quantity of the impurity flow driving the impurity screening. Recently, the carbon flow in the ergodic layer was measured in hydrogen (H) plasmas with space-resolved vacuum ultraviolet (VUV) spectroscopy and a close relation between the impurity flow and the impurity screening was experimentally verified for the first time by the comparison between the spectroscopic observations and the impurity transport simulation based on a three-dimensional simulation code, EMC3-EIRENE. In the present report, the VUV spectroscopy for carbon impurities is applied to deuterium (D) plasmas to clarify the effect of the bulk ion mass on the impurity transport in the ergodic layer. Doppler profile measurement at the second order of CIV line emission (2 × 1548.20 Å) is attempted in a flat-top phase of discharges using a 3 m normal incidence VUV spectrometer in the edge plasma at a horizontally-elongated plasma position. The flow velocity becomes the maximum value at the position close to the outermost region of the ergodic layer. The direction of the observed flow is same as the friction force in the parallel momentum balance calculated with EMC3-EIRENE code. The flow velocity increases with the electron density in the H plasmas. The result supports a prediction from the simulation that the friction force becomes more dominant in the force balance in higher density regime. It leads to the increase in the impurity flow which can develop the impurity screening. On the other hand, the flow velocity in the D plasma is smaller than that in the H plasma. The difference of the flow values between D and H plasmas is caused by the mass dependence of the thermal velocity of the bulk ions when the friction force term is dominant in the force balance.

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