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Simulation study of electrostatic potential generated by NBI and its effect on the neoclassical transport of carbon impurity ions in LHD

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Electrostatic potential $\Phi_{\rm NBI}$ generated by the neutral-beam-injection (NBI) to the plasma, and its effect on the neoclassical transport of carbon impurity ions in the Large Helical Device (LHD) are investigated for the first time by means of the global drift-kinetic simulations. The ripple-trapped beam ions of the perpendicular NBI (40keV) have been found to generate $\Phi_{\rm NBI}$ in the order of 0.01-0.02$T_{\rm e}$ when $n_{\rm e} = 3 \times 10^{19}{\rm m}^{-3}$, $T_{\rm e} = T_{\rm i} = 3$keV, and the injection power is 5MW. The global neoclassical transport simulations taking into account $\Phi_{\rm NBI}$ have shown that the diffusion coefficient of C^{6+} impurity ions decreased by 14% and the radially inward convection velocity decreased by 22% in the presence of $\Phi_{\rm NBI}$ of the 5MW injection. These new findings suggest that $\Phi_{\rm NBI}$ may have a non-negligible impact on the neoclassical impurity transport in LHD, especially in the impurity-hole plasma with high-power NBI heating.

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