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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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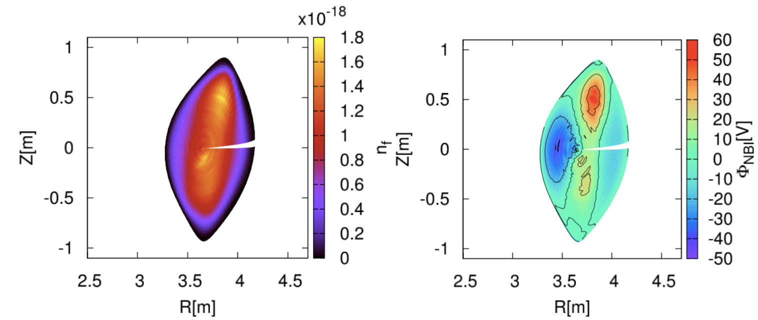
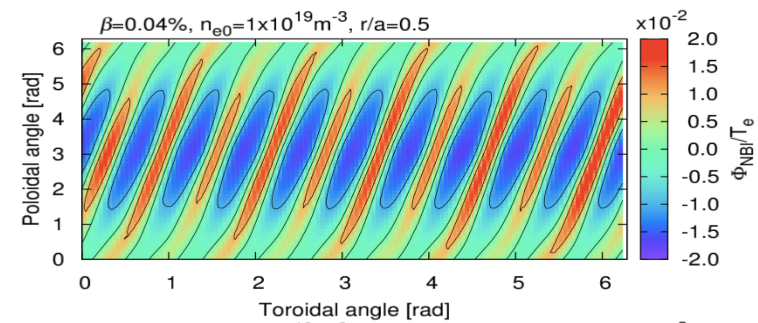
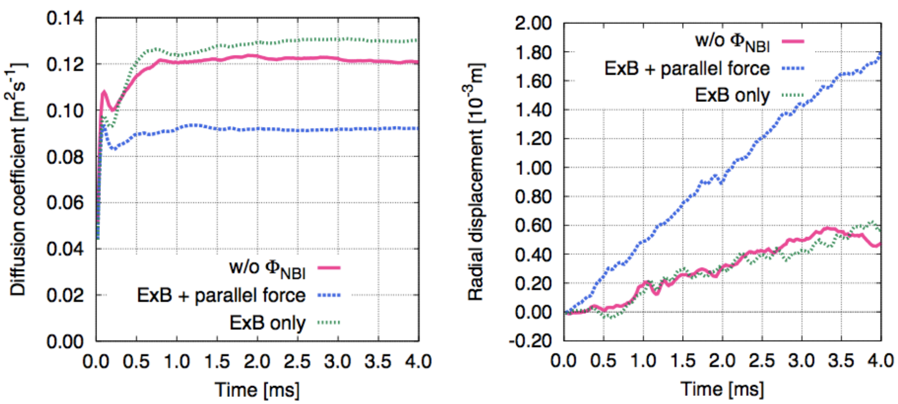
Abstract
The electrostatic potential, Φ_{NBI}, generated by non-uniform density distribution of fast ions produced by a perpendicular neutral beam (NBI) injection (40keV hydrogen beam) in the helical plasma of the Large Helical Device (LHD) are numerically investigated. It is shown that the fast ions trapped in one of the helical ripples create the helical structure of electrostatic potential with the order of several % of the background temperature for 5MW injection. The effect of the generated electrostatic potentials on the neoclassical transport of carbon impurity ions is investigated by means of Monte Carlo simulations. The diffusion coefficient in the region of $r/a<0.6$ is decreased in the presence of Φ_{NBI}, while the outward advection is increased especially for lower electron density cases of $1\text{-}3\times10^{19}m^{-3}$. These changes are in a qualitatively favorable direction for C^{6+} to create a hollow density profile called 'impurity hole', which has been observed in the LHD experiments with high-power NBI heating. The main mechanism of these changes is found to come from the parallel electrostatic force rather than $E\times B$ drifts.



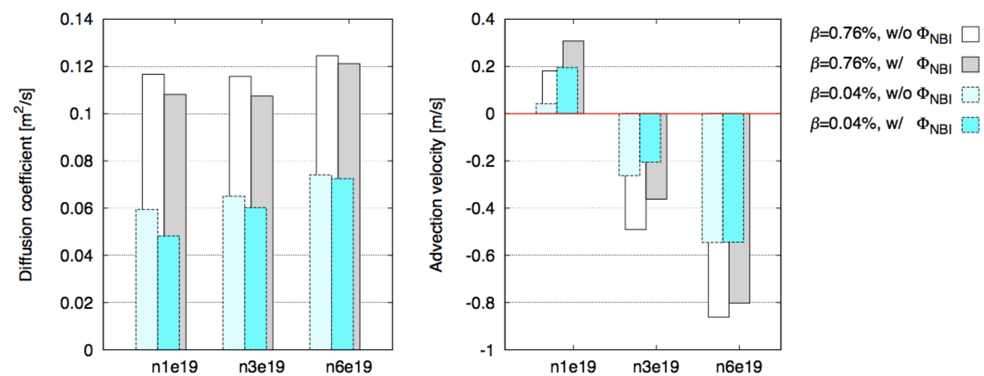
Spatial distribution of fast ion density (left) and Φ_{NBI} (right) on a poloidal cross section. ($n_{e0}=1\times10^{19}m^{-3}$, $T_{e0}=T_{i0}=3keV$)



Φ_{NBI} on the flux surface of r/a=0.5.



Time evolution of diffusion coefficient (left) and ensemble-averaged radial displacement (right) of C^{6+} test particles with/without Φ_{NBI}. 'ExB only' means parallel electrostatic force by Φ_{NBI} is artificially neglected for comparison.



Diffusion coefficient (left) and advection velocity (right) of C^{6+} at the flux surface of r/a=0.5 for different density and beta values.