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Kinetic Simulation Studies on Multi-ion-species Plasma Transport in Helical Systems

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The first comprehensive analyses of kinetic simulations for anomalous and neoclassical transport of steady state multi-ion-species plasmas including impurity ions in helical systems are performed by gyrokinetic and drift-kinetic approaches.
To design the fusion reactors, the transport phenomena of plasma particles and heat need to be quantitatively predicted, and numerical simulation approaches based on the kinetic frameworks are powerful for that purpose. Recently, it becomes able to validate the kinetic simulation results against the experimental observations for the plasma temperature and density profiles with the experimental errors taken into account. Furthermore, studies on the transport of the multi-ion-species plasma are strongly demanded for predicting the performances of the burning plasma in the ITER, future reactors, and also stellarators such as the Large Helical Device (LHD).
In high ion temperature plasmas with hollow impurity density profiles heated by neutral beam injection (NBI), we find that the turbulent contribution of the carbon impurity particle flux remains to be directed inward radially within the allowable ranges of the plasma temperature and density profiles, while the neoclassical ion fluxes can change due to the generated radial electric field (E_{r}) and the external momentum sources. Even for the case of the negative E_{r}, the neoclassical carbon flux can be directed outward when the inward-directed current is imposed sufficiently by the co-injected heating beam.
These findings contribute deeper understandings of the hollow profiles in the LHD impurity hole plasmas in terms of fully kinetic framework.

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