ISHW Abstract

Study on impurity hole plasmas by global neoclassical simulation

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An impurity hole observed in the Large Helical Device (LHD) is a hollow density profile of an impurity ion species, typically carbon, spontaneously formed in the core plasma in which a negative (inward pointing) ambipolar radial electric field exists. Local neoclassical models have predicted the carbon impurity flux flows inwardly under such a condition. Further, the local models have predicted that the sign of the radial electric field in impurity hole plasmas is negative for the entire region. This contradicts an experimental observation of an impurity hole plasma that the radial electric field changes its sign from negative to positive along the minor radius.

In the present work, we investigate neoclassical impurity transport in an impurity hole plasma by global simulation using a global neoclassical simulation code FORTEC-3D. By the global simulation, we show that an ambipolar radial electric field that changes its sign along the radius is obtained as a solution of the ambipolar condition and with such a radial electric field profile, the impurity carbon flux can be outwardly directed even where the radial electric field is negative and the carbon density profile is hollow. Furthermore, the particle balance between neoclassical and modeled turbulent fluxes are obtained with good accuracy. This consistency is another outcome of the global simulation that has not been achieved by the local neoclassical simulations. Our result indicates that we have moved one step closer to reproducing the impurity transport in impurity hole plasmas by kinetic simulation.