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Impurity Transport Caused by Blob and Hole Propagations

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It is firstly demonstrated that transport of impurity particles are caused by blob and hole propagations by means of the three dimensional (3D) electrostatic Particle-in-Cell (PIC) simulations. We have shown that (1) the impurity profile in the blob / hole structure becomes biased shape like a dipole and (2) the biased density profile of impurity propagates with the blob / hole. The “blob” and “hole” are the intermittent filamentary coherent structures along the magnetic field line in peripheral plasmas of fusion magnetic confinement devices and the plasma densities in the blob and hole are higher and lower than that of background plasma, respectively. These structures are thought to be created from edge turbulences and play an important role in the radial convective plasma transport in the SOL. Furthermore, it has been pointed out that the blob and hole propagations can induce impurity transport. However, any numerical studies about the impurity transport with the blob and hole have not been conducted because of the difficulty in including minority ions, i.e., impurities in fluid models. Therefore, in this study, we have improved the 3D-PIC code and investigated dynamics between impurity and the blob and hole structures. In the PIC simulation, an external magnetic field is set as it is parallel to the z axis and has grad-B in the x direction. The initial ratio between impurity and background electron densities is given as 0.06 since it is $\sim 5\%$ in experiments for investigation of impurity transports. The impurity ions are uniformly distributed in the whole system at the initial stage. In the simulation, it is shown that impurity ions in the blob / hole are dragged from the higher to the lower potential sides (the dipole potential structure on the poloidal cross-section is created in a blob / hole) by the polarization drift and that the biased density profile of impurity is transported with the blob / hole by trapping impurity ions in the potential well of the blob / hole. The propagation speed of the blob / hole with impurity is nearly equal to that without impurity. Although the blob / hole propagation is hardly influenced by the impurity, the impurity ions in the blob / hole move with the blob / hole. The impurity averaged radial speed in the blob / hole is close to the blob / hole propagation speed.

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