1D particle simulation of plasma transport in Scrape-off layer

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The SOL (Scrape-off layer) physics is very important for controlling the heat flux to the divertor target in tokamak devices. Numerical simulations using the comprehensive divertor codes (SOLPS, EMC3, etc) based on the plasma fluid modeling are indispensable, however, further improvement of the modeling is required, and the kinetic effect is one of key issues for improving the modeling. In this work, a 1D3V Particle code is used to simulate the simplified 1D SOL. The Particle model includes Coulomb collisions, electron-impact excitation and ionization collisions and ion-neutral charge exchange collisions. The coulomb collision frequency is artificially increased to simulate the collisional plasma in the SOL.

The particle simulation gives the plasma sheath formation and the profiles of plasma density, temperature and velocity, self-consistently. One of the important advantages of particle simulation is that the non-Maxwellian velocity distribution can be simulated. The ion velocity distribution can deviate from the Maxwellian distribution near the plasma sheath. With particle simulation, the plasma surface interactions, like target physical sputtering, can be modelled more precisely. The parameters at the sheath entry can be used to verify and improve the boundary conditions for fluid model. Besides, this work simulates the effects of Carbon atom injection and Deuterium recycling on the plasma and heat flux to the target. Carbon and Deuterium atoms are traced as particles. The simulation results show that the presence of neutral atoms reduces the plasma temperature, the sheath potential drop and the heat flux to the target, which are desired.