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Diffusion of energetic particles due to charge changes and neoclassical tearing modes

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Theoretical calculations and particle simulations are used to show that charge changing processes (i.e. charge exchange) can significantly increase the diffusion of alpha particles in the pedestal-edge-SOL regions. The interaction of the alpha particles with the plasma species, He+ and neutral deuterium (both atomic and molecular) and helium are included. The numerical code calculates the exact alpha particles trajectories and introduces the probability of charge changing events via a Monte Carlo type method, where the probability of each process is taken proportional to the corresponding collision frequency. The cross sections of these processes were obtained from the existing databases. The code runs on a GPU, thus allowing calculations with a large number of particles in a short time using modest computational resources. The effect of neoclassical tearing modes on the confinement of energetic ions produced by NBI is also studied. The experimental information available about the perturbed current density and the displacement are employed. Ampere's law is used to calculate the perturbed poloidal magnetic flux and the resistive Ohm's law to calculate the perturbed electric field. The exact trajectories of the ions in the total fields (equilibrium plus perturbation) are calculated. The results show that the addition of the perturbed electric field produced by the rotation of the mode can greatly increase particle losses.

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