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Simulations of the Sawtooth-Induced Redistribution of Fast Ions in JET and ITER

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Results of simulations of the sawtooth-induced redistribution of fast ions in JET and ITER with the code OFSEF are presented. The dependence of the redistribution on the particle parameters (energy and pitch angle) is studied. The redistribution of the trapped and marginally passing particles is found to exhibit barrier-like behaviour at the separatrix between the trapped and passing particles: the particles with high energies cannot pass the radial coordinate corresponding to the separatrix. The algorithm and structure of the rapid code developed on the basis of the OFSEF calculations are discussed. Simulations of the sawtooth effect on fusion alpha particles in ITER are carried out; they show that when the shape of the q-profile is non-parabolic (which is expected, for example, in the hybrid mode), the post-crash radial profile of the alpha particle distribution function can change significantly. Determining the parameters of a sawtooth crash — the sawtooth mixing radius and the sawtooth crash duration — from observations of the electron cyclotron emission in the equatorial plane of a tokamak is discussed; examples for JET sawtooth crashes are presented. Results of simulations of the sawtooth effect on the neutron emission in several recent JET discharges are presented. In most JET discharges, neutrons are mainly born by deuterons of the NBI (neutral beam injection) beam consisting mainly of passing particles with energies ~100 keV. However, in discharges with the third-harmonic ICRH (ion cyclotron resonance heating), a significant fraction of neutrons is produced by the ICRH tail of trapped deuterons in the MeV energy range, which provides an opportunity to verify the theory predictions.

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