Simulation of Fast Alfvén Wave Interactions with Neutral-Beam and Minority Ions in Tokamaks

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The Monte-Carlo rf simulation code ORBIT-RF coupled with TORIC full wave solutions using a single dominant toroidal and poloidal wave number has demonstrated the consistency of simulations with previous DIII-D fast wave (FW) experimental results for interaction between injected neutral-beam ions and FW, including the measured neutron enhancement and enhanced high energy tail. Comparison with C-Mod fundamental heating discharges also yielded reasonable agreement. Predicted power absorption from ORBIT-RF falls within a range of TORIC calculations, which assumed high temperature Maxwellian distributions to model the beam ions. This suggests that ORBIT-RF may be used to quantitatively model the non-Maxwellian ion distribution produced during FW heating. Such information is useful for studying the role of fast ions on stability and transport in tokamaks. ORBIT-RF solves the Hamiltonian guiding center drift equations to follow trajectories of test ions in 2-D axisymmetric numerical magnetic equilibrium under Coulomb collisions and ICRF quasi-linear heating. Monte-Carlo operators for pitch-angle scattering and drag calculate the changes of test ions in velocity and pitch angle due to Coulomb collisions between test ions and background plasma. A rf-induced random walk model describing the fast ion stochastic interaction with the FW reproduces quasi-linear diffusion in velocity space. 2-D profiles of FW fields and its wave numbers from TORIC are passed on to ORBIT-RF to calculate perpendicular rf kicks of resonant ions with a generalized arbitrary harmonic. Further improvements to the rf quasilinear operator will be reported.

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