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Iterated Finite Orbit Monte Carlo Simulation with Full Wave Fields for Tokamak ICRF Wave Heating Experiments[1]

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A predictive understanding of ICRF wave heating is important for tokamak experiments and ITER. Finite-orbit effects due to drift motion of non-Maxwellian species may significantly modify the ICRF wave propagation and absorption in the plasma. To self-consistently obtain wave heating and fast-ion velocity space information, the 5D finite-orbit Monte-Carlo plasma distribution solver ORBIT-RF is integrated with the 2D full-wave code AORSA. To evaluate the finite-orbit effects on wave heating, the ORBIT-RF wave absorption model has been validated against linear full-wave zero orbit-width predictions from CQL3D/AORSA and measurements in Alcator C-Mod and DIII-D experiments for various ion cyclotron harmonics. Systematic comparison performed with an initial Maxwellian distribution largely reproduces linear absorption directly evaluated by AORSA dielectric tensor. An inward shift of ORBIT-RF absorption peak for high harmonics compared with that of AORSA has been observed. This inward shift may be indicative of finite orbit effects, which can produce a noticeable change in the radial absorption profile. DIII-D simulations based on combined ray-tracing zero orbit-width calculations using GENRAY/CQL3D show discrepancies with the measured FIDA spectroscopic data. To assess the finite-orbit effects on this difference, the non-Maxwellian plasma distribution evolution calculated by ORBIT-RF is iterated with wave fields computed from AORSA including quasilinear and collisional orbit diffusion. To accurately start the ORBIT-RF/AORSA iterations, beam-ion distributions computed from PTRANSP from experimental profiles are used as initial conditions. Comparison of ORBIT-RF/AORSA results against FIDA measurements of fast-ion distribution and results from CQL3D/AORSA with zero orbit assumption will be presented.

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