Fast-Ion Radial Diffusion During High Harmonic ICRF Heating Experiments in DIII-D and NSTX*

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Fast-ion spatial profile measured by the fast ion D_α (FIDA) diagnostic indicates outward radial shifts of fast ions from the primary resonance layers located near the magnetic axis during the DIII-D and NSTX high harmonic ICRF heating experiments. Finite orbit theory suggests that the radial excursion of fast ions may be due to finite drift orbit width effects of fast ions, which can directly affect the ICRF wave propagation and absorption in the plasma. To understand fast-ion transport during ICRF wave heating, finite orbit Monte-Carlo code ORBIT-RF coupled self-consistently with full wave code AORSA was simulated. Most recent simulation results [1] predicted outward radial shift of fast ions qualitatively consistent with FIDA spectroscopic data. This outward shift is validated due to radial diffusion of ICRF heated fast ions across magnetic surfaces, which cannot be reproduced by the conventional zero-orbit Fokker-Planck theory. A noted discrepancy is that ORBIT-RF/AORSA computes further outward shift from magnetic axis than FIDA. This may be due to the fact that simulations are done only for a short period of one or two slowing down times, whereas data measured by FIDA is averaged over a fairly long time window to get better statistics for the steady-state discharge. Interestingly, a larger discrepancy is predicted in NSTX than in DIII-D, which may be due to the larger orbit effect of fast ion and much closer spacing between multiple harmonic layers in relatively low magnetic field NSTX plasma. To understand this discrepancy, more iterations of ORBIT-RF with AORSA are performed until they reach a stationary phase solution. Simulation results will be presented including a detailed comparison with FIDA measurements.

[1] M. Choi, D. Green, W.W. Heidbrink, R. Harvey, D. Liu, V.S. Chan, L.A. Berry, F. Jaeger, L.L. Lao, R.I. Pinsker, M. Podesta, D.N. Smithe, J.M. Park, P. Bonoli, the RF SciDAC and SWIM Team, "Iterated finite-orbit Monte-Carlo simulations with full-wave fields for modeling tokamak ICRF wave heating experiments," to be published in Phys. Plasma (2010).

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Poster Presentation