Effects of radial transport on ICRF heating in tokamak plasmas

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Plasma heating and current drive by RF waves deforms the momentum distribution function of the heated species. The deviation of the distribution functions from the Maxwellian affects the propagation and absorption of the wave itself. Therefore the wave analysis including the effects of distortion of the distribution function is required for quantitative analysis of wave heating and current drive. The deformation is strongly depends on the loss mechanism and radial transport of the energetic ions. In the present analysis, the effect of radial diffusion on ICRF heating and current drive in tokamak plasmas is studied using the integrated tokamak modeling code TASK. In the TASK code, various components collaborate with each other. The full wave component TASK/WM[1] calculates the wave electric field by solving Maxwell's equation including the plasma dielectric tensor as a boundary-value problem. The bounce-averaged Fokker-Planck component TASK/FP[2] analyzes the time evolution of the distribution functions for electrons and ions by solving the Fokker-Planck equation simultaneously including the quasi-linear diffusion terms calculated from the wave electric field. In FP component, Coulomb collision term is based on non-linear collision model which conserves momentum and energy during collision. Radial diffusion due to collision and turbulence is also implemented. The collisional diffusion is caused by the radial shift of the particle orbit due to the collisional change of the parallel momentum under the constraint of canonical angular momentum conservation. The turbulent diffusion is described by a simple mode, no velocity dependence and given radial profile, for the moment. The dielectric tensor component TASK/DP calculates the plasma dielectric tensor by numerically integrating the momentum distribution function, which is calculated by FP component. By repeating this cycle, we can describe the time evolution or the steady state of the wave heating and current drive. The dependence of the power deposition profile and the driven current density profile on the magnitude of radial diffusion will be reported.

[1] FUKUYAMA, A., et al.: Proc. of 20th IAEA FEC (Villamoura, 2004) IAEA-CSP-25/CD/TH/P2-3.

[2] H. Nuga, A. Fukuyama, to be published in Plasma Fusion Research.