Validation of Quasilinear Theory of Resonant Diffusion in the Ion Cyclotron Range of Frequencies by Comparison with Exact Integration Results*

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The validity of ICRF quasilinear (QL) diffusion theory is examined in the context of the C-Mod ICRF experiment by comparison of coefficients calculated with Lorentz orbits in AORSA full-wave fields, with and without finite-orbit-width effects, using the DC (Diffusion Coefficient) code. From a zero-banana-orbit-width modified Lorentz equation, overall conclusions are that approximation of the excited RF by a single toroidal mode leads, in the Lorentz calculation, to strong correlation pitch angle modification of the RF diffusion; this thereby modifies self-consistent radial power absorption calculated with the CQL3D Fokker-Planck code. However, inclusion of a full toroidal mode spectrum results in most, but not all, correlations ceasing to exist. Hence, modeling of ICRF power absorption using a correlation-less QL theory is reasonably accurate, even with a suitably chosen single toroidal mode. Multi-mode correlations remain, particularly for neighboring resonances such as when the trapped particles pass successively through resonance. Code accuracy is supported by power calculations from diffusion coefficients which show increases by only a small amount (0.6%) per turn for coefficients calculated after 1, 2, or 4 poloidal turns. Nonlinear effects appear as a 1% power absorption effect as a function of increasing input power up to 4 times the nominal 2.65 MW to the 10 % hydrogen minority; at 8 times nominal power, absorbed power is enhanced ~10%. Finite-banana-width Lorentz orbits give additional radial smoothing of the power deposition. *Work supported by USDOE.