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How Good is a Quasilinear ICRH Operator? A New Method for ICRH Simulation in a Guiding Center Code[1]

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The widely used form of conventional quasilinear cyclotron resonance heating operator was derived in a homogeneous system, and then extended to an inhomogeneous system assuming that the resonance layer is thin enough to ignore the inhomogeneity effects and the resonance time is short enough to neglect the nonlinear interactions. It is also assumed that the Coulomb collisions are weak enough not to interfere with the quasilinear wave-particle interaction process within a resonance layer, but strong enough to decorrelate the consecutive resonance layers (in addition to the multi-mode decorrelation). However, a six dimensional numerical Lorentz-force simulation reveals that these assumptions break down in many physical situations and can yield incorrect estimate of quasilinear heating rate. Detailed description on the validity of the quasilinear theory will be presented, in comparison with the six dimensional numerical results, under assumed rf field profiles of practical interest. Based upon the six dimensional study, we also report a new reduced method to evaluate the ion cyclotron resonance interaction in a guiding center kinetic code, which can accurately include the effects of nonlinear orbit distortion, wave inhomogeneity, magnetic field inhomogeneity (trapped-passing particles), multiple wave numbers, and Coulomb collisions.

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