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Hamiltonian Theory and Stochastic Simulation Methods for Radiation Belt Dynamics XIN TAO, ANTHONY CHAN, Rice University, ALAIN BRIZARD, Saint Michael's College, JAY ALBERT, JAMES MILLER — A general Hamiltonian theory for the adiabatic motion of relativistic charged particles in the radiation belts and numerical modeling of multi-dimensional diffusion due to interactions between electrons and waves are presented in this work. By using Lie-transform perturbation analysis with the Hamiltonian theory, three invariants of the adiabatic relativistic motion and the guiding center equations of motion of charged particles are obtained. Interactions with small amplitude waves are described using quasi-linear diffusion theory, and we note that in previous work numerical problems arise when solving the resulting multi-dimensional diffusion equations using standard finite difference methods. In this work we introduce two new methods based on stochastic differential equation theory to solve the multi-dimensional radiation belt diffusion equations. We use our new codes to assess the importance of cross diffusion, which is often ignored in previous work, and effects of ignoring oblique waves, which are omitted in the parallel-propagation approximation of calculating diffusion coefficients. Using an established wave model we show that ignoring cross diffusion or oblique waves may produce large errors at small pitch angels and high energies. Results of this work are useful for understanding radiation belt dynamics, which is crucial for predictability of radiation in space.

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