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A Darwin Fluid Model

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Abstract

The Darwin model of particle interaction is a second order (in v/c) approximation to the fully relativistic theory of particle interaction in which retardation effects are replaced by modified action-at-a-distance interactions. The approximation has proved most useful in computer simulations of plasmas in which fast waves (with group velocity on the order of c) are neglected due to the small time steps required. Some attention has been paid to the Darwin approximation as a self-consistent particle theory, but little has been said about its applications to continuum theories. We study the Darwin system as a self-consistent continuum theory derived from an action principle. Specifically, the action for particles interacting via fields, which are themselves required to be solutions of Maxwell's equations, is rendered as a continuum action in Lagrangian variables. This is then taken as the *a priori* action for a fluid theory which is studied in both Lagrangian and Eulerian variables.