A RELATIVISTIC LANGEVIN APPROACH FOR RUNAWAY ELECTRONS IN TOKAMAK PLASMAS*

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ABSTRACT

The Langevin approach to the kinetics of a collisional plasma is developed for relativistic electrons such as runaway electrons (RE) in tokamak plasmas. In this work, we consider Coulomb collisions between very fast, relativistic electrons and a relatively cool, thermal background plasma. The model is developed using the stochastic equivalence of the Fokker-Planck and Langevin equations [1].

The resulting Langevin model equation for relativistic electrons is an stochastic differential equation (SDE), amenable to numerical simulations by means of Monte-Carlo type codes. The approach will be used to analyze the two-dimensional runaway electron dynamics in momentum space (runaway probability and conditions for runaway, runaway distribution function and generation rate) and the results of the simulations will be compared with those from the non-relativistic Langevin equation for runaway electrons used in the past [2].

Synchrotron radiation losses will be also included which: (1) increase the critical (minimum) electric field for runaway generation; (2) set a limit on the maximum energy that the runaways can reach. The resulting critical field and runaway limiting energy are found to be in agreement with the values provided by a test particle description of the runaway dynamics [3].

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