Non Uniqueness of Non Runaway Solutions of the Abraham-Lorentz-Dirac Equation in an External Laser Pulse

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As it is well known, the Abraham-Lorentz-Dirac equation, which describes a radiating point-like electron, is plagued by the non-physical runaway solutions, i.e., solutions whose acceleration diverges exponentially. Following Dirac, one considers as "physical solutions" only the ones for which the acceleration vanishes for $t \to +\infty$. One problem is to understand if the physical solutions of the equation are determined just by the "mechanical state" of position and velocity, or the knowledge of the initial acceleration is required too. In this latter case, one speaks of non-uniqueness because for a given mechanical state there exist several physical trajectories.

Considering just the simplest model, *i.e.*, the case of an electron interacting with an electromagnetic plane pulse, one founds that the non uniqueness phenomenon occurs if, at a given frequency of the incoming wave, the field intensity is sufficiently large.

While this phenomenon, from the mathematical point of view, is well understood in the non relativistic case, in the full relativistic case, which is the one of physical interest, the reasons of such a behaviour remain unclear.