The Canonical Proper-Time Quantum Theory

Abstract

In this talk, I begin by reconsidering the hydrogen atom problem and discuss the extent that we may believe in the validity of the use of perturbation analysis to compute the hyperfine splitting separation. I show explicitly that the Pauli equation is not completely valid for the study of the Dirac hydrogen atom problem in s-states. (Recall that, when Lamb and Retherford confirmed suspicions that the $2s_{1/2}$ state hydrogen was shifted above the $2p_{1/2}$ state, the Pauli approximation to the Dirac equation was used to (essentially) decide that the Dirac equation was not sufficient.) Thus, we conclude that there are some open physical and mathematical problems with any attempt to explicitly show that the Dirac equation is insufficient to explain the full hydrogen spectrum.

Using a new method, I show how to effect separation of variables for full coupling, solve the radial equation, provide graphs of the probability density function, for the 2p and 2s states and compare them with those of the Dirac Coulomb case.

I then return to the canonical proper-time formulation of relativistic mechanics, and the corresponding Maxwell theory, and show that this theory allows for a natural progression to a proper-time relativistic quantum theory. I show how our approach allows us to handle non-conservation of particle number, even in the classical case.

Finally, I show that the canonical proper-time theory leads to three new relativistic wave equations, one associated with the Dirac equation, one associated with the square-root equation, which is related to the Dirac equation via the Foldy-Wouthuysen transformation, and one associated with the square-root equation, which is analytically related to the Dirac equation. Finally, I briefly compare the three equations, suggest their domain of application, discuss current problems and give some indication of future research directions.