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On the origin of quantum mechanics

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Abstract

Action at distance in Newtonian physics is replaced by finite propagation speeds in classical post-Newtonian physics. As a result, the differential equations of motion in Newtonian physics are replaced by functional differential equations, where the delay associated with the finite propagation speed is taken into account. Newtonian equations of motion, with post-Newtonian corrections, are often used to approximate the functional differential equations. Is the finite propagation speed the origin of the quantum mechanics? In the present work a simple atomic model based on a functional differential equation which reproduces the quantized Bohr atomic model is presented. As straightforward application of the result the fine structure of the hydrogen atom is tackled.

1. Introduction

Newtonian forces (for example, the inverse square law for gravitation) imply "action at distance". This absurd, but singularly successful, premises of the Newtonian theory predicts that signals propagate instantaneously. In classical physics, relativity theory postulates that signals propagate with a velocity that does not exceed that of light. Thus, the forces of Newtonian physics must be replaced by force laws that take into account the finite propagation speed of the classical fields which determine the forces acting on a moving body. In turn, the ordinary or partial differential equations of Newtonian physics, which are derived from the second law of motion $m\ddot{r} = F$, must be replaced by corresponding functional differential equations where the force F is no longer a function of just position, time, and velocity; but must take into account the time delays due to the finite propagation speed.

The functional differential equations of motion for classical field theory are generally difficult, often impossible, to express in a form that is amenable to analysis. Thus, in order to obtain useful dynamical predictions from realistic models, it is frequently to replace the functional differential equations of motion by approximations that are ordinary or partial differential equations [3]. The purpose in these works is to discuss some of the mathematical issues that must be addressed to obtain a rigorous foundation for the post-Newtonian dynamics, i.e., Newtonian dynamics with relativistic corrections (see for instance [3] and the references therein). For the electromagnetic classical field, in the ideal case of a point-charge particle, the resulting retarded potentials are the Liénard–Wiechert potentials. For the gravitational classical field we must use the Einstein's field equation. Simple models of these equations are the subject of current research. The basic idea of post-Newtonian approximation, from a mathematical point of view, is the expansion of

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