
Preface

The aim of this volume is twofold. First, it is an attempt to simplify and clarify the relativistic theory of the hydrogen-like atoms. For this purpose we have used the mathematical formalism, introduced in the Dirac theory of the electron by David Hestenes, based on the use of the real Clifford algebra $Cl(M)$ associated with the Minkowski space-time M , that is, the euclidean R^4 space of signature (1,3). This algebra may be considered as the extension to this space of the theory of the Hamilton quaternions (which occupies an important place in the resolution of the Dirac equation for the central potential problem).

The clarity comes from the real form given by D. Hestenes to the electron wave function that replaces, in a strict equivalence, the Dirac spinor. This form is directly inscribed in the frame of the geometry of the Minkowski space in which the experiments are necessarily placed. The simplicity derives from the unification of the language used to describe the mathematical objects of the theory and the data of the experiments.

The mathematics concerning the definition and the use of the algebra $Cl(M)$ are not very complicated. Anyone who knows what a vector space is will be able to understand the geometrical implications of this algebra. The lecture will be perhaps more difficult for the readers already acquainted with the complex formalism of the matrices and spinors, to the extent that the new language will appear different from the one that they have used. But the correspondence between the two formalisms is ensured in the text at each stage of the theory.

The second aim concerns a presentation of the theory of one-electron atoms starting from its relativistic foundation, the Dirac equation. The nonrelativistic Pauli and Schrödinger theories are introduced as approximations of this equation. One of the major purpose, about these approximations, has been to display, on the one side, the enough good concordance between the Dirac and the Pauli–Schrödinger theories for the bound states of the electron furthermore, but to a weaker extent, for the states of the continuum close to the freedom energy, and, on the other side, the considerable discordances for

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the high values of the continuum. A special attention has been drawn to the verification of the numerical relativistic results by the comparison with those obtained by means of the nonrelativistic approximations, when the comparison is acceptable, and also to the recourse to different mathematical methods for the resolution of a same problem.

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