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Relativistic quantum theory for modeling electron scattering

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In this work we present a method for calculating relativistic electron scattering with nuclei, atoms and molecules including the temperature dependence. In particular, we focus on the mean-field approximation of the Dirac equation for many-fermion systems and its self-consistent numerical solutions, which are obtained by using either radial mesh or Gaussian basis sets. The former approach is appropriate for spherical symmetric problems, such as atoms, while the second is more suitable for studying non-spherical non-periodic polycentric systems, e.g. molecules and clusters. We apply our theoretical method to electron scattering with water molecules useful for the study of ionization processes in biological systems, which are fundamental in hadrontherapy. The elastic electron scattering with liquid water, along with inelastic scattering collisions through which secondary electrons release their energy, represents a crucial event of the physico-chemical mechanism caused by the interaction of fast ion beams with a biological medium. In hadrontherapy, the energy lost by the fast ions during their way inside the bio-medium causes the emission of secondary electrons ejected through the ionization of the constituents. The calculation of scattering cross sections for collisional processes, e.g. ionization, excitation or elastic scattering, due to the passage of ion beam whitin the living tissue is key to determine the secondary electrons produced. Moreover, we will discuss and describe the extension of our relativistic computational approach to study weak nuclear decays in nuclei of medical interest.

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