The relativistic feature of Hydrogen-like atoms in the Heisenberg picture

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October 26, 2021

Abstract

The relativistic properties of Hydrogen-like atoms (HLAs) are here investigated in the Heisenberg picture for the first time. The relativistic vibrational Hamiltonian (RVH) is first defined as a power series of harmonic oscillator Hamiltonian by using the relativistic energy eigenvalue . By applying the first-order RVH (proportional to) to the Heisenberg equation, a pair of coupled equations is turned out for the relativistic motion of the electron's position and linear momentum. A simple comparison of the first-order relativistic and nonrelativistic equations reveals this reality that the natural (fundamental) frequency of HLA (like entropy) is slowly raised by increasing the atomic number from . The second-order RVH (proportional to) has then been implemented to determine an exact expression for the electron relativistic frequency in the different atomic energy levels. In general, the physical role of RVH is fundamental because it not only specifies the temporal relativistic variations of position, velocity, and linear momentum of the oscillating electron, but also identifies the corresponding relativistic potential, kinetic, and mechanical energies. The results will finally be testified by demonstrating energy conservation.

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