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Positronium structure: an illustration of nonperturbative renormalization in a basis light-front approach

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We solve for the mass spectrum and structure of the positronium, the bound state formed by an electron and a positron, from the first-principles of QED. We adopt a nonperturbative approach based on light-front Hamiltonian formalism, named Basis Light-front Quantization. In this calculation we include the lowest two Fock sectors, $|e^+e^-\rangle$ and $|e^+e^-\gamma\rangle$, in the basis. We perform the nonperturbative fermion mass renormalization on the single-electron level. After solving the eigenvalue problem of the positronium, we obtain the mass spectrum and wave functions of the low-lying eigenstates, which are then compared with those obtained from a light-front one-photon-exchange effective interaction approach. Finally we present the probability of finding a photon in these low-lying states.

Authors: ZHAO, Xingbo (Institute of Modern Physics, Chinese Academy of Sciences); FU, Kaiyu (Institute of Modern Physics, Chinese Academy of Sciences); ZHAO, Hengfei (Institute of Modern Physics, Chinese Academy of Sciences); LI, Yang (USTC); VARY, James (Iowa State University)

Presenter: ZHAO, Xingbo (Institute of Modern Physics, Chinese Academy of Sciences)

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