

Spectroscopy and decay widths of pseudoscalar and vector charmonium and bottomonium within the applications of Bethe - Salpeter equation

In this study, we calculate the mass spectrum, weak decay constants, two photon decay widths, and two gluon decay widths of ground (1S), and radially excited (2S, 3S, 4S) states of pseudoscalar charmonium and bottomonium such as η_c and η_b , as well as the mass spectrum, leptonic decay constants and radiative decay widths of ground state (1S) and excited (2S, 1D, 3S, 2D, 4S, 3D, 5S, 5D) states of vector charmonium and bottomonium such as J/ψ , and Υ using the formulation of Bethe-Salpeter equation under covariant Instantaneous Ansatz (CIA). Our results are in good agreement with data (where ever available) and other models. In this framework, from the beginning, we employ a 4×4 representation for two-body ($Q\bar{Q}$) BS amplitude for calculating both the mass spectra as well as the transition amplitudes. However, the price we have to pay is to solve a coupled set of equations for both pseudoscalar and vector quarkonia, which we have explicitly shown get decoupled in the heavy-quark approximation, leading to mass spectral equation with analytical solutions for both masses, as well as eigenfunctions for all the above states, in an approximate harmonic oscillator basis. The analytical forms of eigenfunctions for ground and excited states so obtained are used to evaluate the transition amplitudes for different processes in contrast purely numerical approaches used for solving the coupled Salpeter equations found in the literatures so far.

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