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The radial scalar power potential and its application to quarkonium systems

Abstract

The current study employs the Nikiforov-Uvarov method to solve the Schrödinger equation for quarkonium systems, utilizing the radial scalar power potential. The eigenvalues of energy and their corresponding wave functions are determined by including the spin–spin, spin–orbit, and tensor interactions in the radial scalar power potential. The mass spectra of charmonia, bottomonia, and bottom-charm in their S, P, D, and F states were determined. Our theoretical states for quarkonium systems align with experimental data across a range of spin levels, as evidenced by our comparison. The total percentage error of our work was computed, yielding a high level of accuracy. The cumulative percentage error for the meson masses of charmonia and bottomonia was determined to be 0.324% and 0.333%, respectively. The masses of the bottom-charm mesons had a total percentage error of 0.012%. Consequently, the present potential yields favorable outcomes for the quarkonium masses, surpassing previous theoretical studies and aligning well with experimental data.

Keywords

Mass spectra; Nikiforov-Uvarov method; Quarkonium system; Radial scalar power potential; Schrödinger equation