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M1 and E1 transitions of heavy-light quarkonia in Bethe-Salpeter Equation

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Radiative transitions between quarkonium states are interesting and are characterized by $\Delta L = 0$ are the magnetic dipole, M1 transitions, while those characterized by $|\Delta L| = 1$ are the electric dipole, E1 transitions. The M1 transition mode is sensitive to relativistic effects, specially between different spatial multiplets (where $n > n'$), while the E1 transitions are much stronger than M1 transitions, and involve transitions between excited states.

We calculate the radiative decay widths of heavy-light quarkonia for the above mentioned processes in the framework of 4×4 Bethe-Salpeter equation (BSE), which is a fully relativistic approach that incorporates the relativistic effect of quark spins and can also describe internal motion of constituent quarks within the hadron in a relativistically consistent manner, due to its covariant structure. Our wave functions satisfy the 3D BSE, which is in turn obtained from 3D reduction of the 4D BSE under Covariant Instantaneous Ansatz (which is a Lorentz-invariant generalization of Instantaneous Approximation), already have relativistic effects. Further, our transition amplitudes also have relativistically covariant form.

We thus use 4x4 Bethe-Salpeter equation under Covariant Instantaneous Ansatz to calculate the M1 transitions [1-2], $0^{-+} \to 1^{--}\gamma$, $1^{--} \to 0^{-+}\gamma$ and E1 transitions [1-2] involving axial vector mesons such as, $1^{+-} \to 0^{-+}\gamma$, $0^{-+} \to 1^{+-}\gamma$, $1^{++} \to 1^{--}\gamma$, and $1^{--} \to 1^{++}\gamma$, for which very little data is available as of now. We make use of the general structure of the transition amplitude, M_{fi} as a linear superposition of terms involving all possible combinations of $++$, and $--$ components of Salpeter wave functions of final and initial hadrons, expressible in a covariant forms in terms of transition form factors. In the present work, we make use of leading Dirac structures in the hadronic Bethe-Salpeter wave functions of the involved hadrons, which makes the formulation more rigorous. We evaluate the decay widths for both the above mentioned $M1$ and $E1$ transitions. We have used algebraic forms of Salpeter wave functions obtained through analytic solutions of mass spectral equations for ground and excited states of 1^{--},0^{-+} and 1^{+-} heavy-light quarkonia in approximate harmonic oscillator basis to do analytic calculations of their decay widths. We have compared our results with experimental data [3], where ever available, and other models.

References:
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Session

Beyond the Standard Model

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