Recent developments in Hadron Spectroscopy

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Introduction

The hadron spectroscopy is important due to it's light-light, light-heavy and heavy-heavy flavoured quark components and also very interesting to determine their properties, like masses, radiative decays, decay constants, decay rates magnetic moments etc. Many experimental groups have given the masses and decay channels of hadrons in last decade [1]. The baryons, mesons and exotic particles are also determined by many theoretical approaches with their respective models [2]. Here, the hadronic properties of baryons, mesons and molecules (exotic) are discussed.

We calculated the masses of nucleon, N baryons upto 3300 MeV. The radial and orbital excited states are determined using hypercentral constituent quark model with the first-order correction. The Regge trajectories are also determined in (n, M^2) and (J, M^2) planes. Moreover, the magnetic moments with $J^P = \frac{1}{2}^+$, $\frac{1}{2}^-$ are calculated. We also calculates the Nπ decay width of excited nucleons. Our scheme accounts to an average two-body potential for the three quark system over the hyper angle using the relative Jacobi coordinates ($\vec{\rho}$ and $\vec{\lambda}$). The Hamiltonian of the baryonic system in the hCQM is expressed as [3]

$$H = \frac{P_x^2}{2m} + V(x). \quad (1)$$

The potential is in form of,

$$V(x) = V^0(x) + \left(\frac{1}{m_\rho} + \frac{1}{m_\lambda}\right) V^{(1)}(x) + V_{SD}(x). \quad (2)$$

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This interaction potential consists of a central term $V^0(x)$, spin dependant part $V_S D(x)$ and first order correction $V^1(x)$ is also added [3].

We also determined the masses of singly heavy baryons using same formalism and then calculated a strong P-wave couplings among the s-wave baryons, S-wave couplings between the s-wave and p-wave baryons, and the strong couplings of D-wave from p-wave to s-wave baryons using HHCPT scheme. The strong P-wave transitions of isospin partners $\Sigma_c$are found to be in accordance with other model predictions and experimental measurements [4].

In meson sector, we calculate the result of $c\bar{c}$ meson masses by solving the Schrodinger equation numerically considering the Coulomb plus linear potential. The potential is in form of the spin-hyperfine, spin-orbit and tensor components of one-gluonexchange interactions are employed to obtain the mass spectra of $c\bar{c}$ meson. The calculated mass spectra are compared with the latest results of PDG and are found to be in good accordance. The Regge trajectories of the calculated mass spectra have also been constructed. The values of the wave function are extracted and employed to calculate the leptonic decay constant, $\gamma\gamma$, gg, e^+e, light hadron (LH) and $\gamma\gamma\gamma\gamma$ decay widths of S-wave 0^+ and 1 states of $c\bar{c}$ meson, the widths have been calculated by Van Royen-Weisskopf formula and by NRQCD mechanism incorporating relativistic corrections of order ν^2. The $\gamma\gamma$ and gg decay widths of $\chi0$ and $\chi2$ states of $c\bar{c}$ meson have also been calculated. The calculated decay constants and widths have been compared with the experimental results[5].

We study the interesting problem of interaction and identification of the hadronic molecules which seem to be deuteron-like structure. In particular, we propose a binding mechanism in which One Boson Exchange Potential plus Yukawa screen-like potential is applied in their relative s-wave state. We propose the dipole-like interaction between two color neutral states to form a hadronic molecule. For the identification of the hadronic molecules, the Weinbergs compositeness theorem is used to distinguish the molecule from confined (elementary) state. The present formalism predict some di-hadronic molecular states, involving quarks (s,c, b or $\bar{s}, \bar{c}, \bar{b}$) as a constituents, namely, pn with their possible quantum numbers [6].

Here we have discussed the properties of light-heavy flavoured baryons, mesons and exotic states. It is important for the future experimental facility like PANDA which is expected to provide precise data in light- heavy sector [7].

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