Exotic mesons with hidden bottom near thresholds

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The plethora of exotic hadrons found recently inspire many theoretical estimations into new forms of matter such as quark-gluon hybrids, meson molecules and tetraquarks. Especially, $Z_b(10610)$ and $Z_b(10650)$ reported by Belle [1] are noticeable. Since they are electrically charged in their observed quantum numbers $I^G(J^P) = 1^+(1^+)$, their minimal constituents must be four quarks. The reported masses and widths of the two resonances are $M(\mathrm{Z_b}(10610)) = 10607.2 \pm 2.0$ MeV, $\Gamma(\mathrm{Z_b}(10610)) = 18.4 \pm 2.4$ MeV and $M(\mathrm{Z_b}(10650)) = 10652.2 \pm 1.5$ MeV, $\Gamma(\mathrm{Z_b}(10650)) = 11.5 \pm 2.2$ MeV. Since their masses are very close to the respective thresholds of $B\bar{B}^*$ and $B^*\bar{B}^*$, we can expect that Z_b's have molecular type structures of $B^{(*)}\bar{B}^{(*)}$. In this report, we study the exotic heavy hadron spectroscopy near open bottom thresholds to explain the structures of the Z_b's and predict the additional candidates of molecules which have not been found yet [2].

Assuming the exotic mesons as $B^{(*)}\bar{B}^{(*)}$ molecular states, we study the interaction among two heavy mesons in terms of the one boson exchange potential model. All possible composite states which can be constructed from the B and B* mesons are studied up to the total angular momentum $J \leq 2$. We consider, as exotic states, isosinglet states with exotic J^{PC} quantum numbers and isotriplet states. We solve numerically the Schrödinger equation with channel-couplings for each state. It is shown that masses of $Z_b(10610)$ and $Z_b(10650)$ are reproduced as $B^{(*)}\bar{B}^{(*)}$ bound and resonance states. Besides, we predict several possible bound and/or resonant states in other channels for future experiments. Results are shown in Fig. 1.

We also discuss decays and productions for the possible molecular states formed by bottom mesons $B^{(*)}$ and $\bar{B}^{(*)}$. The spin wave functions of the molecular states are rearranged into those of heavy and light spin degrees of freedom by using the re-coupling formulae of angular momentum. By applying the heavy quark symmetry we derive model independent relations among various decay and production rates, which can be tested in experiments [3].

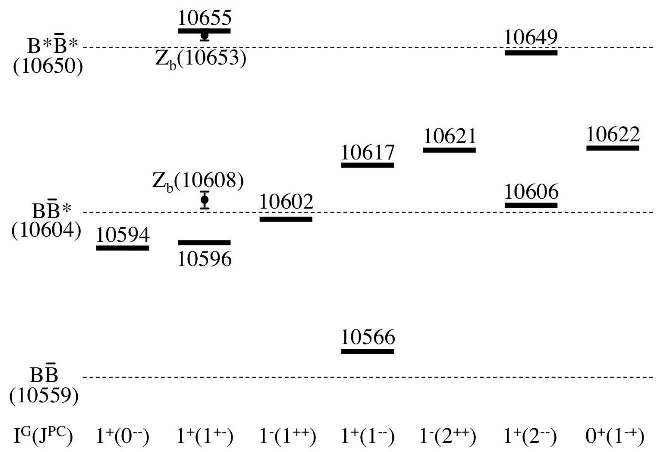

Figure 1: The $\mathrm{B}^{(*)}\bar{\mathrm{B}}^{(*)}$ bound and resonant states with exotic $I^G(J^{PC})$. The dots with error bars denote the position of the experimentaly observed $\mathrm{Z_b}$'s where $M(\mathrm{Z_b}(10610)) = 10607.2$ MeV and $M(\mathrm{Z_b}(10650)) = 10652.2$ MeV. Solid lines are for our predictions for the energies of the bound and resonant states when the $\pi\rho\omega$ potential is employed. Mass values are shown in units of MeV.

References

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