PROCEEDINGS OF SCIENCE

Mass spectra of triply beauty Ω_{bbb} baryon

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Ω_{bbb} is triply beauty quarks baryon which makes the system very interesting. We do not have any experimental observed states for Ω_{bbb}; but many lattice calculations as well as theoretical predictions have been performed for ground and excited states of this baryons. We use Hypercentral Constituent Quark model with Couloumb plus power potential by varying potential index value from 0.5 to 2.0. Our Model also identified the radial and orbital excited state masses for the baryon and try to give the range of the resonance it can be found.

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1. Introduction

The Ω baryon is a combination of same three light quarks(s). This baryon is least known according to the summary table of Particle Data Group [1]. In heavy sector of this baryon, very recently, five states of singly charmed Ω baryon is published [2]. We have already determined the masses of ground and excited states of Ω_c, Ω_b, Ω_{cc}, Ω_{bb}, Ω_{bc}, Ω_{ccc}, Ω_{bbb} baryons with their isospin splittings in our previous work [3, 4, 5, 6, 7, 8, 9]. Ω baryon with three heavy beauty quarks is experimentally still unknown [10]. Among four triply heavy baryons, we discussed the Ω_{bbb} baryon in this paper. Many theoretical approaches; regge phenomenology [11], non-relat. quark model [12], constituent quark model approach [13], latiice-QCD [14, 15], di-quark model [16], pNRQCD approach [17], relat. quark model [18], bag model [19] have published their masses for Ω_{bbb} baryon. All of them gave masses for the ground state at $J^P = \frac{3}{2}^+$ and some of them also provided the excited state masses.

We use the Hypercentral Constituent Quark Model(hCQM) and generate the mass spectra for triply beauty baryon. The Hamiltonian of the three-quark system is taken as

$$H = \frac{P_x^2}{2m} + V(x) \tag{1.1}$$

The hyper radius $x = \sqrt{\rho^2 + \lambda^2}$ is a collective co-ordinate and therefore the hypercentral potential contains also the three-body effects. Where, $m = \frac{2m_\rho m_\lambda}{m_\rho + m_\lambda}$, is the reduced mass and x is the six dimensional radial hyper central coordinate of the three body system. In the hyper central approximation, the potential is only depending on hyper radius(x).

The six dimensional hyper radial Schr*ö*dinger equation using reduced hypercentral radial function,

$$\left[\frac{-1}{2m}\frac{d^2}{dx^2} + \frac{\frac{15}{4} + \gamma(\gamma+4)}{2mx^2} + V(x)\right]\phi_\gamma(x) = E\phi_\gamma(x) \tag{1.2}$$

The hypercentral potential $V(x)$ is the hyper color coulomb plus power potential with first order correction [20, 21, 22]

$$V(x) = V^0(x) + \left(\frac{1}{m_\rho} + \frac{1}{m_\lambda}\right)V^{(1)}(x) + V_{SD}(x) \tag{1.3}$$

The detail of above mentioned equations can be found in Ref. [8]] and the refs. theirin.

2. Mass Spectra and Regge trajectories

The masses of Ω_{bbb} baryon is calculated for ground state(1S), radial excited state(2S-5S) and orbital excited states(1P-5P, 1D-4D, 1F-2F) [3]. The radial excited states are calculated by varying the value of ν in Table 1. Taken values of ν are 0.5, 1.0, 1.5 and 2.0. The A and B are masses without first order correction and masses with first order correction, respectively. The graphical representation of masses (from s-wave to f-wave) are shown in f ig.1. The 1S-5S, 1P-5P, 1D-4D, 1F-2F state masses are presented with their respective J^P values at ν = 1.0 in fig.1. Our obtained

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State	(ν)	A	B
	0.5	15.021	15.024
2S	1.0	15.154	15.163
	1.5	15.266	15.276
	2.0	15.365	15.377
	0.5	15.344	15.350
3S	1.0	15.637	15.654
	1.5	15.897	15.918
	2.0	16.132	16.159
	0.5	15.652	15.661
4S	1.0	16.124	16.149
	1.5	16.560	16.592
	2.0	16.963	17.004
	0.5	15.948	15.960
5S	1.0	16.613	16.644
	1.5	17.245	17.289
	2.0	17.845	17.900

Table 1: Radial excited states of Ω^{-}_{bbb} baryon (in GeV).

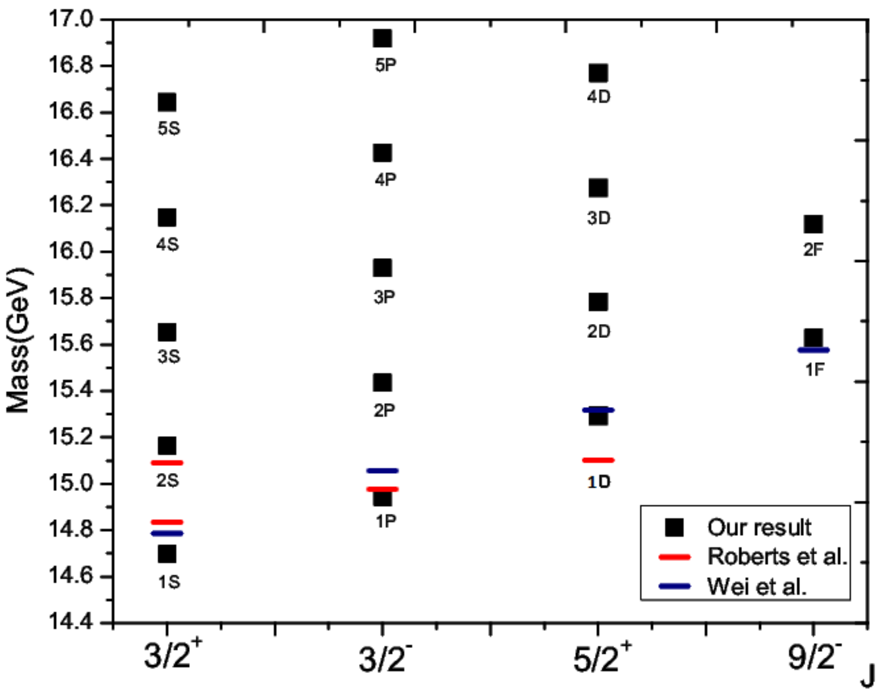

Figure 1: Mass spectra of triply heavy baryons from S state to F state at ν=1.0

results are also compared with Refs. [11, 12].

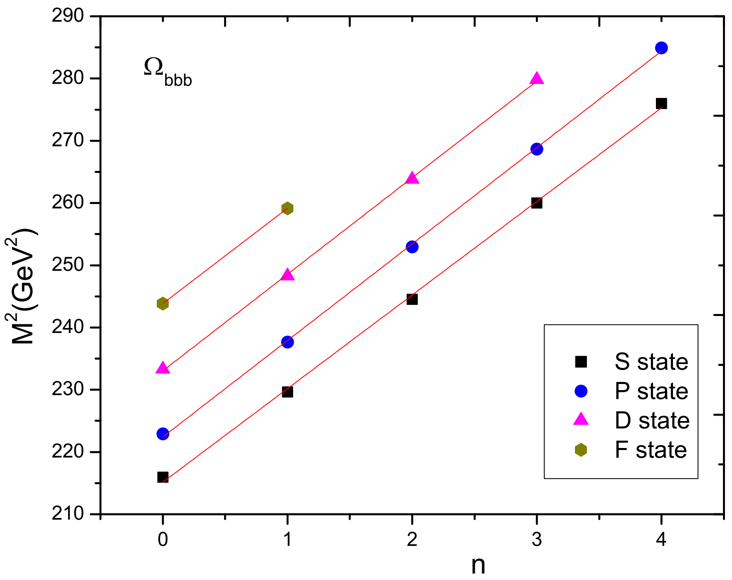

Figure 2: Regge Trajectory in (n, M^2) plane [3].

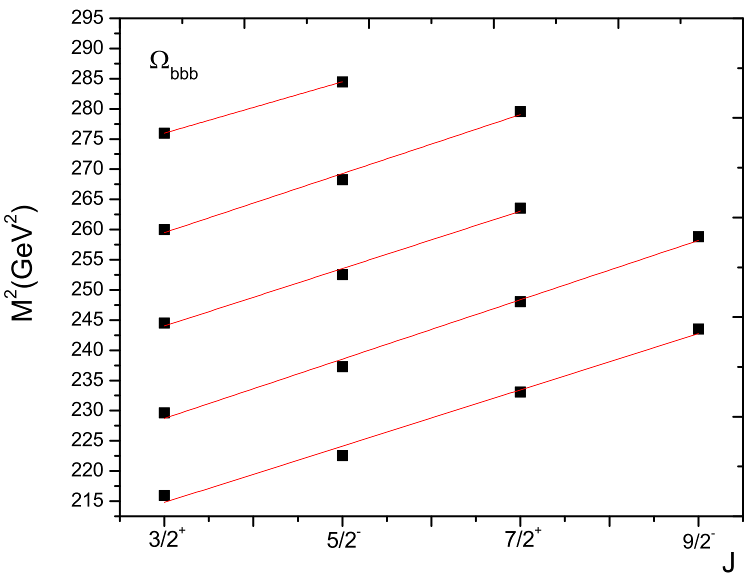

Figure 3: Regge Trajectory in (J, M^2) plane [3].

The regge trajectories are the one of the most important properties of hadrons. Some of the features of these trajectories are: linear, parallel and equidistant. The trajectories of Ω_{bbb} baryon are drawn in two different planes in figs. (2-3). n and J are principal quantum number and total angular momentum respectively. They are drawn against the square of masses to check the mentioned features as well as to assign the particular J^P values.

3. Conclusion

The mass spectra of Ω_{bbb} is presented using hCQM model in this paper. The radial excited states are shown with different ν values while orbital excited states are presented for $\nu = 1.0$. From fig. 1 we observe that masses of Ref. [12] for 2S and 1P state show few MeV difference with our out comes and 1S, 1D and 1F state masses of recent article [11] are near to our results. The unknown quantum numbers can be found using our regge trajectories. They are fulfilled the mentioned features; linear, parallel and equidistant. We are expecting the resonances from future experiments which will decide the mass and J^P values of the particular state.

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