Regge trajectories in the B_C meson

Virendrasinh H. Kher[1],* Nayneshkumar B. Devlani[1], and Ajay Kumar Rai[2]
[1] *Applied Physics Department, Polytechnic, Faculty of Technology and Enginerring, The M.S. University of Baroda, Vadodara - 390002, INDIA and*
[2] *Deptartment of Applied Physics, Sardar Vallabhbhai National Institute of Technology, Surat - 395007, INDIA*

Introduction

Regge trajectories of mesons play a vital role to identify any new (experimentally) meson excited state as well as to provide the information about quantum number of the particular state. One of the most interesting properties of these trajectories is their linearity, interpreted as an expression of strong forces between quarks at large distances, which lead to color confinement. In this article we investigate the Regge trajectories of the B_C mesons in the potential model framework.

Methodology

To estimate the masses we employ the following Hamiltonian and quark-antiquark potential to study the B_C meson[1];

$$H = \sqrt{\mathbf{p}^2 + m_Q^2} + \sqrt{\mathbf{p}^2 + m_{\bar{Q}}^2} + V(\mathbf{r}), \quad (1)$$

$$V(r) = V^{(0)}(r) + \left(\frac{1}{m_Q} + \frac{1}{m_{\bar{Q}}}\right) V^{(1)}(r) \quad (2)$$

Here, $m_Q(m_{\bar{Q}})$ is the quark(anti-quark) mass. The potentials are [2, 3]

$$V^{(0)}(r) = -\frac{4\alpha_S\left(M^2\right)}{3r} + Ar + V_0, \quad (3)$$

$$V^{(1)}(r) = -C_F C_A \alpha_s^2 / 4r^2, \quad (4)$$

where $\alpha_S\left(M^2\right)$, A, V_0 and $C_F = 4/3$, $C_A = 3$ is the strong running coupling constant, potential parameter, potential constant and the Casimir charges respectively. The estimated masses and details of calculations are outlined in authors' previous work in Ref [4].

*Electronic address: vhkher@yahoo.co.in

Results

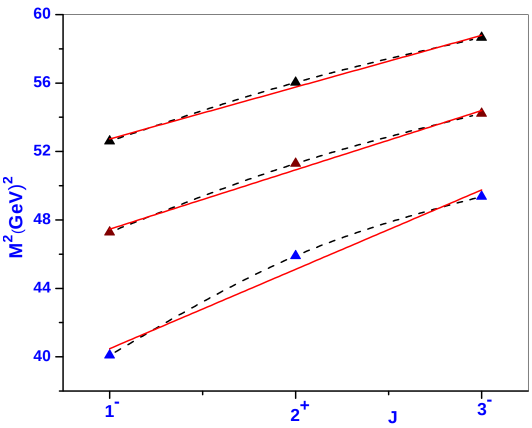

FIG. 1: The ($M^2 \to J$) Regge trajectory for the *Bc* meson with natural parity.

TABLE I: Slopes and intercepts of the (J, M^2) Regge trajectories of B_c meson with unnatural and natural parity.

Parity	Trajectory	$\alpha(GeV^{-2})$	α_0
	Parent	$0.196^{\pm 0.032}$	$-7.797^{\pm 1.446}$
Unnatural	I daughter	$0.274^{\pm 0.027}$	$-12.938^{\pm 1.381}$
	II daughter	$0.316^{\pm 0.027}$	$-16.598^{\pm 1.525}$
	Parent	$0.211^{\pm 0.037}$	$-7.519^{\pm 1.391}$
Natural	I daughter	$0.286^{\pm 0.026}$	$-12.565^{\pm 1.332}$
	II daughter	$0.327^{\pm 0.025}$	$-16.280^{\pm 1.414}$

The Regge trajectories in the (J, M^2) plane with natural and unnatural parity are depicted in Figs. (1-2). In figure, solid triangles are model masses whereas experimentally

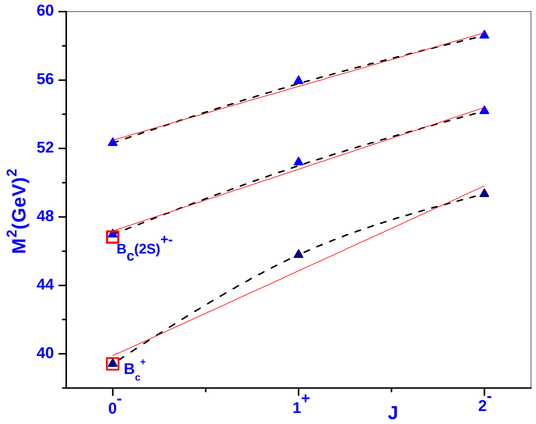

FIG. 2: The $(M^2 \to J)$ Regge trajectory for the Bc meson with unnatural parity.

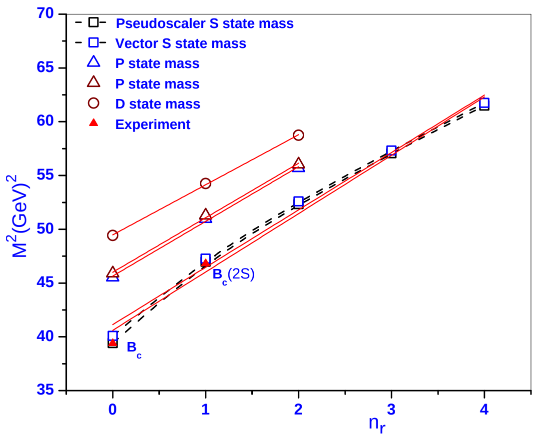

FIG. 3: The $(M^2 \to n_r)$ Regge trajectory for the pseudoscalar and vector S state, excited P and D state masses of the Bc meson.

available masses(taken from PDG[5]) are represented by hollow squares. The Regge trajectories for $n_r = n - 1$ principal quantum number in the (n_r, M^2) plane are describe in Figure (3) and Figure (4). The following definitions are used to calculate the χ^2 fitted slopes (α, β) and the intercepts (α_0, β_0) [6].

$$J = \alpha M^2 + \alpha_0, \tag{5}$$

$$n_r = \beta M^2 + \beta_0 \tag{6}$$

The slopes and intercepts are given in tables

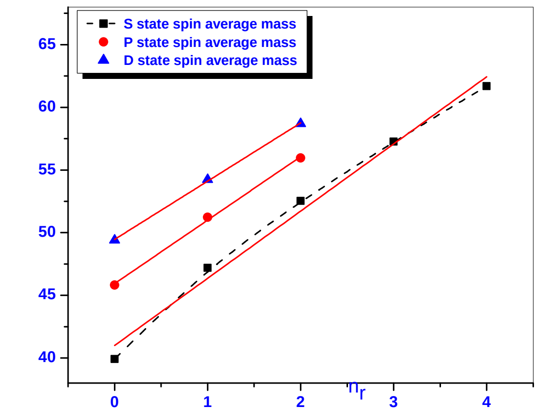

FIG. 4: The $(M^2 \to n_r)$ Regge trajectory for the S-P-D states center of weight mass for the Bc meson.

TABLE II: Slopes and intercepts for the (n_r, M^2) Regge trajectories of B_c meson.

Meson	J^P	$\beta(GeV^{-2})$	β_0
B_c	0^-	0.182 ± 0.012	-7.362 ± 0.617
B_c^*	1^-	0.185 ± 0.011	-7.605 ± 0.569
B_{c0}	0^+	0.196 ± 0.008	-8.961 ± 0.403
B'_{c1}	1^+	0.197 ± 0.008	-9.028 ± 0.386
B_{c1}	1^+	0.197 ± 0.008	-9.060 ± 0.387
B_{c2}	2^+	0.197 ± 0.007	-9.062 ± 0.377
$B_c(^3D_1)$	1^-	0.215 ± 0.005	-10.618 ± 0.247
$B_c(^3D_2)$	2^-	0.215 ± 0.005	-10.642 ± 0.246
$B_c(^1D_2)$	2^-	0.216 ± 0.006	-10.662 ± 0.314
$B_c(^3D_3)$	3^-	0.215 ± 0.005	-10.63 ± 0.289

I and II.

References

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