Non-leptonic decay properties of B_c meson using potential model

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Introduction

The investigation of weak decays of mesons composed of a heavy quark and antiquark gives a very important insight in the heavy quark dynamics. The ground state of B_c meson is discovered by the Collider Detector at Fermilab (CDF) in the $p\overline{p}$ collisions [1]. The B_c meson has some special properties among all the heavy flavor mesons, because it is the only meson consisting of the two quarks with different flavors. This difference of quark flavors forbids annihilation into gluons. The decay $b \rightarrow c$ plays a significant role as it led to the charmonia final states in the B_c decays [2]. Though the semileptonic decay mode $B_c \rightarrow J/\psi l^+ \nu_l$ is a significant mode in this channel, the uncertainties in the neutrino momentum measurements make the non-leptonic decay mode, $B_c \rightarrow J/\psi(\pi^+/\rho^+)$ important. The specially designed B-Physics programmes at Tevatron (in Run II),LHC, LHCb etc., are expected to record numerous $B_c^{\pm}$ events ($> 10^8 \sim 10^{10}$ per year) [3, 4]. Theoretical studies are motivated as many decay channels of B_c will be recorded experimentally, and certain rare processes will become accessible.

Methodology

In this paper we calculate the decay width for the channel $B_c \longrightarrow c\bar{c}[^{2s+1}L_J]\pi^+$ based on the hard-soft factorization method given by [5]. The basic parameters like the masses of the decaying and recoiling meson states and the properties of the radial wave functions are employed from the Coulomb plus power potential (CPP_ν) model [6]. Decay width for $B_c \rightarrow c\bar{c}[^{2S+1}L_J]\pi^+$ channel for different $c\bar{c}$ final states are computed in terms of a correction factor $a_1^2(\approx 1)$ comes from the hard gluon contrbution to the four fermion effective weak lagrangian given by [5].

Results and Discussion

The decay widths for the channel $B_c \rightarrow c\bar{c}[^{2S+1}L_J]\pi^+$ for different ν by using CPP_ν model are presented here (Table I). The computed results are in agreement with that predicted by [5] within the potential range given by $\nu = 0.6 - 0.9$. The agreement occurs for the index ν that shifts from 0.9 to 0.6 as the decay occurs through the final state of S-wave charmonium to D-wave charmonium.

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TABLE I: The decay width for various $B_c \longrightarrow c\bar{c}[^{2S+1}L_J]\pi^+$ states in $a_1^2 \times 10^{-15} GeV$

ν	J/ψ	η_c	h$_c$	χ_{c0}	χ_{c1}	χ_{c2}	^{1}D$_2$	^{3}D$_1$	^{3}D$_2$	^{3}D$_3$
0.1	0.46	0.57	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01
0.5	3.28	3.94	6.13	3.28	0.02	3.25	11.30	5.83	0.05	5.32
0.7	5.14	6.08	16.00	8.27	0.05	8.57	56.26	29.12	0.20	26.61
0.8	6.09	7.15	23.37	11.90	0.07	12.59	108.85	56.40	0.35	51.39
0.9	7.06	8.23	32.47	16.32	0.09	17.59	198.80	103.65	0.57	93.61
1.0	8.00	9.28	43.67	21.64	0.12	23.74	338.71	178.30	0.88	158.92
1.1	8.93	10.30	56.76	27.70	0.15	30.96	558.79	298.16	1.31	260.30
1.3	10.73	12.27	89.30	42.47	0.21	49.01	1362.16	747.99	2.62	621.70
1.5	12.40	14.06	129.71	60.28	0.28	71.70	2954.37	1694.63	4.72	1310.89
2.0	16.04	17.87	262.55	115.79	0.49	146.47	14630.74	9764.97	15.43	5865.51
Kiselev [5]	6.5	8.40	18.00	11.00	0.10	8.90	35.00	19.00	0.34	16.00
Chang[7, 8]	2.10	2.00	0.57	0.32	0.082	0.28	-	-	-	-

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