Nonleptonic decay widths of B^0 mesons into $D^+\pi^-$

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Introduction

In recent years, the non-leptonic decay of $B^0 \to D^+\pi^-$ has been obtained by BaBar [1]. The $B^0 \to D^+\pi^-$ processes provide very good opportunities to test the standard model of hadronic B-meson decays due to their clean and dominant hadronic decay channels.

Theory

The matrix element for $B^0 \to D^+\pi^-$ can be parametrized into model dependant form factors as [2],

$$\langle D(p^{'})|V^\mu|\bar{B}(p)\rangle = f_+(q^2)(p+p^{'})^\mu + f_-(q^2)(p-p^{'})^\mu \quad (1)$$

The form factors $f_\pm(q^2)$ can be written in terms of universal Isgur-Wise function as

$$f_\pm(q^2) = \frac{M_D \pm M_B}{2\sqrt{M_B M_D}}\xi(\omega) \quad (2)$$

Here, $\omega = v\cdot v^{'} = (M_B^2 + M_D^2 - q^2)/(2M_B M_D)$ with v and $v^{'}$ as the velocities of B and D mesons respectively. $\xi(\omega)$ is given by [3],

$$\xi(\omega) = \frac{2}{\omega+1}\left\langle j_0\left(2E_q\sqrt{\frac{\omega-1}{\omega+1}}r\right)\right\rangle \quad (3)$$

The decay width $\Gamma(B^0 \to D^+\pi^-)$ then becomes,

$$\Gamma(B^0 \to D^+\pi^-) = \frac{a_1^2 G_F^2 |V_{cb}V_{ud}^*|^2}{32\pi} M_B^3 f_\pi^2 \times \left(1 - \frac{M_D^2}{M_B^2}\right)^3 |f_+(0)|^2 \quad (4)$$

TABLE I: Form factors $f_+(0)$ and $Br(B^0 \to D^+\pi^-)$ (in $\times 10^{-3}$)

ν	$f_+(0)$	$Br(B^0 \to D^+\pi^-)$ $\times 10^{-3}$
0.1	0.30	0.92
0.3	0.41	1.75
0.5	0.47	2.29
0.7	0.51	2.71
0.8	0.53	2.90
0.9	0.55	3.07
1.0	0.56	3.23
1.1	0.57	3.37
1.3	0.59	3.61
1.5	0.61	3.79
Expt [5]		2.69 ± 0.13
[8]	~ 0.60	$3.2^{+0.4}_{-0.8}$
[9]		2.5
[10]		$2.69^{+0.75}_{-0.66}$

Here, a_1 is the nonrelativistic factorization coefficient and for present study it is taken as $a_1 = 1.08$ [4]

Phenomenology

For the description of the mass spectra and nature of wave function of bound state of B and D mesons we employ coulomb plus power type of the potential of the form $V(r) = -\alpha_s/r + Ar^\nu$ with A and ν as potential strength and exponent respectively [6]. For the present study we vary potential exponent ν as $0.1 \le \nu \le 1.5$. Mass spectra and wave function for different choices of exponent ν are obtained by solving schrödinger equation using mathematica notebook [7]. The potential strength is fixed using known experimental values of spin average mass (M_{SA}) for B and D mesons. The masses of the $J = 0$, B and D mesons are then obtained by invoking the usual hyperfine interaction of the one gluon exchange potential [6]. The wave func-

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tion and the masses then employed to compute the form factors given by Eqn. 2.

Results and Discussion

Our result for the form factor at zero recoil ($f_+(0)$) and the branching ratio, $Br(B^0 \to D^+\pi^-)$ against exponent ν are listed in Table I. Our results agree with the experiment for $\nu \sim 0.7$ as against the expected value for $\nu = 1.0$. It indicates the weakening of the confinement strength.

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