$B^0$ decay into $D^0$ and $\rho$ or $f_0(500)$, $f_0(980)$, $a_0(980)$ and $\bar{B}_s^0$ decay into $D^0$ and $K^{*0}$ or $\kappa(800)$

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We make predictions for ratios of branching fractions of $B^0$ decays into $D^0$ and the scalar mesons $f_0(500)$, $f_0(980)$, $a_0(980)$, plus $\bar{B}_s^0$ decay into $D^0$ and $\kappa(800)$. We also compare the $\pi^+\pi^-$ production in the scalar channel with that observed in the $\rho$ channel and make predictions for the $B_s^0$ decay into $D^0$ and $K^{*0}(800)$, comparing the strength of this channel with that of $\kappa(800)$ production. The theoretical approach is based on results of chiral unitary theory where the scalar resonances are generated from the pseudoscalar-pseudoscalar interaction. Up to an arbitrary normalization, the mass distributions and rates for decays into the scalar resonances are predicted with no free parameters. Comparison with experimental data is done when available.

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I. INTRODUCTION

The weak decay of $B$ mesons has become an unexpected and most valuable source of information on hadron structure and in particular a powerful instrument to investigate the nature of the scalar mesons, which is a permanent source of debate. The starting point in this line came with the observation in LHCb [1] that in the $B_s^0$ decay into $J/\psi$ and $\pi^+\pi^-$ a pronounced peak for the $f_0(980)$ was observed, while no signal was seen for the $f_0(500)$ ($\sigma$). This finding was corroborated by following experiments in Belle [2], CDF [3] and D0 [4] collaborations. Soon it was also observed in the $B^0$ decay into $J/\psi$ and $\pi^+\pi^-$ [5, 6] a clear signal was seen for $f_0(500)$ production while no signal, or a very small one, was seen for $f_0(980)$.

The low lying scalar mesons have been the subject of study within the unitary extension of chiral perturbation theory, chiral unitary theory, and a coherent picture emerges where these states are generated from the interaction of pseudoscalar mesons provided by the chiral Lagrangians [6, 12]. Some other approaches use different starting points, like assuming a seed of $q\bar{q}$ [12, 14], or a tetraquark component [13, 10], but as soon as these original components are allowed to mix with the unavoidable meson-meson components, the large strength of this interaction "eats up" the original seed and the meson-meson cloud becomes the largest component of the states.

The dynamical picture to generate the scalar mesons from the pseudoscalar-pseudoscalar interaction has been tested successfully in a large number of reactions (see a recent update in Ref. [18]). However, the findings of the $B$ decays have opened a new line of research on this topic, offering new and useful information on the nature of these scalar mesons. Indeed, in Ref. [18] it was shown that the features and ratios obtained from the experiments on $B$ decays could be well reproduced by the dynamical generation picture of the scalars. It was shown there, that although addressing the full complexity of these and related problems can be rather complicated and require many free parameters [19-24], the evaluation of ratios of decay modes for some of these channels is rather simple and, in particular, allows one to get an insight on the nature of the scalar resonances. A related but different path is followed in Ref. [25], looking at the scalars from the point of view of $q\bar{q}$ or tetraquarks.

The work of Ref. [18] on $B^0_s$ and $B^0$ decays in $J/\psi$ and $\pi^+\pi^-$ has followed suit along the same lines and in Ref. [26] the rates for $B_s^0$ and $B^0$ decays in $J/\psi$ and a vector meson were investigated and successfully reproduced, along with predictions for the decays into $J/\psi$ and $\kappa(800)$. Similarly, in Ref. [27] predictions were done for the ratios of branching fractions of $B^0$ and $B_s^0$ decays into $J/\psi$ and the scalar mesons $f_0(1370)$, $f_0(1710)$, or tensor mesons $f_2(1270)$, $f'_2(1525)$, $K_{2}^*(1430)$. Related work, but on weak $D$ decays into $K^{*0}$ and the $f_0(500)$, $f_0(980)$ and $a_0(980)$ has been done in Ref. [28]. One of the interesting things on these weak decays is that isospin is not conserved and then one can obtain states of different isospin, like the $f_0(980)$ and $a_0(980)$, from the same reaction. The prediction for the rates of these two channels from the same reaction is a new test offered by these weak decays.

In the present paper we undertake a related problem. We study the decay of $B^0$ into $D^0$ and $f_0(500)$, $f_0(980)$ and $a_0(980)$. At the same time we study the decay of $B_s^0$ into $D^0$ and $\kappa(800)$. We also relate the rates of production of vector mesons and compare with $f_0(500)$ production and $K^{*0}$ with $\kappa(800)$ production. Experimentally there is information on $\rho$ and $f_0(500)$ production in
for the $\bar{B}^0$ decay into $D^0$ and $\pi^+\pi^-$. There is also information on the ratio of the rates for $B^0 \to D^0 K^+K^-$ and $B^0 \to D^0\pi^+\pi^-$. We investigate all these rates and compare with the experimental information.

II. FORMALISM

Following Refs. [18] and [25] we show in Fig. 1 the dominant diagrams for $\bar{B}^0$ [Fig. 1 (a)] and $B^0$ [Fig. 1 (b)] decays at the quark level. The mechanism has the $b \to c$ transition, needed for the decay, and the $u \to d$ vertex that requires the Cabibbo favored $V_{ud}$ Cabibbo-Kobayashi-Maskawa (CKM) matrix element ($V_{ud} = \cos \theta_c$).

![Diagram of $\bar{B}^0 \to D^0\bar{d}\bar{d}$ and $B^0 \to D^0\bar{s}\bar{s}$ decays](image)

FIG. 1: Diagrammatic representations of $\bar{B}^0 \to D^0\bar{d}\bar{d}$ decay (a) and $B^0 \to D^0\bar{s}\bar{s}$ decay (b).

A. $B^0$ and $\bar{B}^0$ decay into $D^0$ and a vector

Fig. 1 (a) contains $\bar{d}\bar{d}$ from where the $\rho$ and $\omega$ mesons can be formed. Fig. 1 (b) contains $\bar{s}\bar{s}$ from where the $K^{*0}$ emerges. At the quark level, we have

$$|\rho^0> = \frac{1}{\sqrt{2}}(\bar{u}\bar{u} - \bar{d}\bar{d}); \quad |\omega> = \frac{1}{\sqrt{2}}(\bar{u}\bar{u} + \bar{d}\bar{d});$$

$$|K^{*0} > = \bar{d}\bar{s}.$$  

Hence, by taking as reference the amplitude for $\bar{B}^0 \to D^0K^*$ as $V'_{P\rho}p_D$, we can write the rest of the amplitudes as

$$t_{\bar{B}^0\to D^0\rho^0} = -\frac{1}{\sqrt{2}}V'_{P\rho}p_D,$$

$$t_{\bar{B}^0\to D^0\omega} = \frac{1}{\sqrt{2}}V'_{P\rho}p_D,$$

$$t_{\bar{B}^0\to D^0\rho^0} = 0,$$

$$t_{\bar{B}^0\to D^0K^{*0}} = V'_{P\rho}p_D,$$

where $V'_{P\rho}$ is a common factor to all $\bar{B}^0(B^0) \to D^0V_i$ decays, with $V_i$ being a vector meson, and $p_D$ the momentum of the $D^0$ meson in the rest frame of the $\bar{B}^0$ (or $B^0$),

$$p_D = \frac{\lambda^{1/2}(M^2_{B^0}, M^2_D, M^2_{inv})}{2M_{B^0}}.$$  

The factor $p_D$ is included to account for a necessary $p$-wave vertex to allow the transition from $0^- \to 0^-1^-$. Although parity is not conserved, angular momentum is, and this requires the angular momentum $L = 1$. Note that the angular momentum needed here is different than the one in the $B^0 \to J/\psi V_i$, where $L = 0$ [20]. Hence, a mapping from the situation there to the present case is not possible.

The decay width is given by

$$\Gamma_{\bar{B}^0 \to D^0V_i} = \frac{1}{8\pi M_{B^0}}|t_{\bar{B}^0 \to D^0V_i}|^2 p_D.$$  

B. $\bar{B}^0$ and $B^0$ decay into $D^0$ and a pair of pseudoscalar mesons

In order to produce a pair of mesons, the final quark-antiquark pair $\bar{d}\bar{d}$ or $\bar{s}\bar{s}$ in Fig. 1 has to hadronize into two mesons. The flavor content, which is all we need in our study, is easily accounted for in the following way [18, 31]: we must add a $q\bar{q}$ pair with the quantum numbers of the vacuum, $\bar{u}u + d\bar{d} + s\bar{s}$, as shown in Fig. 2.

![Diagram of $q\bar{q}$ pair hadronization](image)

FIG. 2: Schematic representation of the hadronization of a $q\bar{q}$ pair.

The content of the meson-meson components in the hadronized $q\bar{q}$ pair is easily done in the following way [18, 31]:

$$M = \begin{pmatrix} u\bar{u} & u\bar{d} & u\bar{s} \\ d\bar{u} & d\bar{d} & d\bar{s} \\ s\bar{u} & s\bar{d} & s\bar{s} \end{pmatrix} = \begin{pmatrix} u \\ d \\ s \end{pmatrix} \begin{pmatrix} \bar{u} & \bar{d} & \bar{s} \end{pmatrix}$$  

where $M$ is the $q\bar{q}$ matrix; then we have the property

$$M \cdot M = \begin{pmatrix} u & d & s \\ \bar{u} & \bar{d} & \bar{s} \end{pmatrix} \begin{pmatrix} \bar{u} & \bar{d} & \bar{s} \end{pmatrix} (\bar{u}u + \bar{d}d + \bar{s}s) = M(\bar{u}u + \bar{d}d + \bar{s}s).$$
The next step consists in writing the matrix \( M \) in terms of mesons and we have, using the standard \( \eta-\eta' \) mixing\(^{32, 33}\),

\[
\phi = \begin{pmatrix}
\sqrt{2} \pi^0 + \frac{1}{\sqrt{3}} \eta + \frac{1}{\sqrt{6}} \eta' \\
\sqrt{2} \pi^0 + \frac{1}{\sqrt{3}} \eta + \frac{1}{\sqrt{6}} \eta' \\
-\sqrt{2} \pi^0 + \frac{1}{\sqrt{3}} \eta + \frac{1}{\sqrt{6}} \eta' \\
-\frac{1}{\sqrt{3}} \eta + \sqrt{2} \eta'
\end{pmatrix}.
\]

Hence, we can write

\[
d\bar{d}(\bar{u}u + \bar{d}d + \bar{s}s) \to (\phi \cdot \phi)_{22} = \pi^- \pi^+ + \frac{1}{2} \pi^0 \pi^0 + \frac{1}{3} \eta \eta
\]

\[
\bar{s}(\bar{u}u + \bar{d}d + \bar{s}s) \to (\phi \cdot \phi)_{23} = \pi^- K^+ - \frac{1}{\sqrt{2}} \pi^0 K^0
\]

where we have neglected the terms including \( \eta' \) that have too large mass to be relevant in our study.

Eqs. (12) and (13) give us the weight for pairs of two pseudoscalar mesons. The next step consists on letting these mesons interact, which they inevitably will do. This is done in Ref. \[18\] following the mechanism of Fig. 3.

The \( f_0(500) \) and \( f_0(980) \) will be observed in the \( B^0 \rightarrow D^0 \pi^- \pi^+ \) final pairs, the \( a_0(980) \) in \( \pi^0 \eta \) pairs and the \( \kappa(800) \) in the \( B^0_s \rightarrow D^0 \pi^- K^+ \) pairs. Then we have for the corresponding production amplitudes

\[
t(B^0 \rightarrow D^0 \pi^- \pi^+) = V_P \left( 1 + G_{\pi^- \pi^+ \rightarrow \pi^- \pi^+} \right)
\]

\[
+ \frac{1}{2} G_{\pi^0 \pi^0 \rightarrow \pi^- \pi^+} \right)
\]

\[
+ G_{K^0 \bar{K}^0 \rightarrow \pi^- \pi^+} \right)
\]

\[
t(B^0 \rightarrow D^0 \pi^- K^+) = V_P \left( 1 + G_{\pi^- K^+ \rightarrow \pi^- K^+} \right)
\]

\[
- \frac{1}{\sqrt{2}} G_{\pi^0 K^0 \rightarrow \pi^- K^+} \right)
\]

In the same way we can write\(^1\)

\[
t(B^0 \rightarrow D^0 \pi^0 \eta) = V_P \left( \sqrt{\frac{2}{3}} - \sqrt{\frac{2}{3}} G_{\pi^0 \eta \rightarrow \pi^0 \eta} \right)
\]

\[
+ G_{K^0 \bar{K}^0 \rightarrow \pi^0 \bar{K}^0 \rightarrow \pi^0 \eta} \right)
\]

\[
\frac{d\Gamma}{dM_{inv}} = \frac{1}{2} \frac{p_B \bar{p}_\pi}{(2\pi)^3 4M_{B^0}} \left| t(B^0 \rightarrow D^0 \pi^- \pi^+) \right|^2,
\]

where \( \bar{p}_\pi \) is the pion momentum for the \( \pi^+ \) or \( \pi^- \) in the rest frame of the \( \pi^- \pi^+ \) system

\[
\bar{p}_\pi = \frac{\lambda^{1/2}(M_{B^0}^2, m_\pi^2, m_\pi^2)}{2M_{inv}}
\]

and similar formulas for the other decays.

### III. NUMERICAL RESULTS

In the first place we look for the rates of \( B^0 \) and \( B^0_s \) decay into \( D^0 \) and a vector. By looking at Eqs. (93), (94), and (95), we have

\[
\frac{\Gamma(B^0 \rightarrow D^0 \rho^0)}{\Gamma(B^0 \rightarrow D^0 \omega)} = \left( \frac{p_D(\rho^0)}{p_D(\omega)} \right)^3 = 1,
\]

\[
\frac{\Gamma(B^0 \rightarrow D^0 \rho^0)}{\Gamma(B^0 \rightarrow D^0 \rho^0)} = \left( \frac{M_{B^0}}{2} \right)^3 \left( \frac{p_D(\rho^0)}{p_D(\rho^0)} \right)^3 \simeq 1\frac{1}{2}.
\]

\[
\Gamma(B^0 \rightarrow D^0 \phi) = 0.
\]

\(^1\) It is worthy to note that \( \pi^+ \pi^- \), \( \pi^0 \pi^0 \) and \( \eta \eta \) are in isospin \( I = 0 \), while \( \pi^0 \eta \) is in \( I = 1 \).
Experimentally there are no data in the PDG for the branching ratio $Br(B^0 \to D^0 \rho^0)$ and we find the branching ratios for $B^0 \to D^0 \rho^0$ and $B^0 \to D^0 \omega$ and $B^0 \to D^0 K^{*0}$ as the following (note the change $B^0 \to D^0$ and $D^0 \to D^0$, $\bar{B}^0 \to \bar{B}^0$, $K^{*0} \to K^{*0}$)

$$Br(B^0 \to D^0 \rho^0) = (3.2 \pm 0.5) \times 10^{-4},$$

$$Br(B^0 \to D^0 \omega) = (2.53 \pm 0.16) \times 10^{-4},$$

$$Br(B^0 \to D^0 K^{*0}) = (3.5 \pm 0.6) \times 10^{-4}.$$  \(2\)

The ratio $\frac{\Gamma_{B^0 \to D^0 \rho^0}}{\Gamma_{B^0 \to D^0 \omega}}$ is fulfilled, while the ratio $\frac{\Gamma_{B^0 \to D^0 K^{*0}}}{\Gamma_{B^0 \to D^0 \rho^0}}$ is barely in agreement with data. The branching ratio $\Gamma_{B^0 \to D^0 \rho^0}$ is clearly different from phase space. 

It is instructive to show the $\pi^+\pi^-$ production and compare with the results from experiment. We show this in Fig. 5. To make this plot we need to convert the total rate for vector production into a mass distribution. This we do following the steps of Ref. 26 and then we write

$$\frac{d\Gamma_{B^0 \to D^0 \rho^0 \to D^0 \pi^+\pi^-}}{dM_{\text{inv}}} = -\frac{2m_{\rho}}{\pi} \times \text{Im} \left[ \frac{1}{M_{\text{inv}}^2 - m_{\rho}^2 + im_{\rho}\Gamma_{\rho}(M_{\text{inv}})} \right] \tilde{\Gamma}_{B^0 \to D^0 \rho^0},$$  \(27\)

where

$$\Gamma_{\rho}(M_{\text{inv}}) = \Gamma_{\rho} \left( \frac{p^{\text{off}}}{p^{\text{on}}} \right)^3 \frac{m_{\rho}^2}{M_{\text{inv}}^2},$$  \(28\)

$$p^{\text{off}} = \frac{\lambda^{1/2}(M_{\text{inv}}^2, m_{\pi}^2, m_{\rho}^2)}{2M_{\text{inv}}} \theta(M_{\text{inv}} - 2m_{\pi}),$$  \(29\)

$$p^{\text{on}} = \frac{\lambda^{1/2}(m_{\rho}^2, m_{\pi}^2, m_{\rho}^2)}{2m_{\rho}},$$  \(30\)

$$\tilde{\Gamma}_{B^0 \to D^0 \rho^0}(M_{\text{inv}}) = \Gamma_{B^0 \to D^0 \rho^0} \left( \frac{p^{\text{off}}}{p^{\text{on}}} \right)^3$$  \(31\)

with $p^{\text{off}}$ the $D^0$ momentum for $\pi^+\pi^-$ invariant mass $M_{\text{inv}}$ and $p^{\text{on}}$ for $M_{\text{inv}} = m_{\rho}$.

The formulae are easily generalized for the other decays.

From Fig. 3 we see a large contribution from the $f_0(500)$ and a larger contribution from the $\rho^0 \to \pi^+\pi^-$ production. Since $V_{\pi}^p$ and $V_{\pi}^p$ are unknown normalization constants in the theory, we have adjusted the strength of $V_{\pi}^p$ to that of $V_{\pi}^p$ in order to fit the experimental numbers of Ref. 29. We can see that the $f_0(500)$ is clearly visible in the distribution of $\pi^+\pi^-$ invariant mass in the region of $400 \sim 600$ MeV.

The relative weight of $V_{\pi}^p$ to $V_{\pi}^p$ obtained to fit the data in Fig. 3 can be used to obtain the strength of $K^{*0}$ production versus $\kappa(800)$ production in the $B^0 \to D^0\pi^-K^+$ decay. For this we use Eqs. (3) to (6) and recall that the rate for $K^{*0} \to \pi^-K^+$ is $\frac{2}{3}$ of the total $K^{*0}$ production. The results for $K^{*0} \to \pi^-K^+$ and $\kappa(800) \to \pi^-K^+$ production are shown in Fig. 4 with the same normalization.

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2 Private communication from Tim Gershon of the LHCb collaboration
FIG. 4: (Color online) Invariant mass distributions for $\pi^+\pi^-, K^+K^-$, and $\pi^0\eta$ in $\bar{B}^0$ decays and $\pi^-K$ in $\bar{B}_s^0$ decay.

as in Fig. 5, from there we see a clear peak for $K^{*0}$ production, with strength bigger than for $\rho^0$ in Fig. 5 due in part to the factor of two bigger strength in Eq. (21) and the smaller $K^{*0}$ width. The $\kappa(800)$ is clearly visible in the lower part of the spectrum where the $K^{*0}$ has no strength.

There is some experimental information to test some of the prediction of our results. Indeed in Ref. [29] (see Table II of that paper) one can find the rates of production for $f_0(500)$ (it is called $f_0(600)$ there) and $f_0(980)$. Concretely,

$$ Br[\bar{B}^0 \rightarrow D^0 f_0(500)] \cdot Br[f_0(500) \rightarrow \pi^+\pi^-] = (0.68 \pm 0.08) \times 10^{-4}, \quad (32) $$

$$ Br[\bar{B}^0 \rightarrow D^0 f_0(980)] \cdot Br[f_0(980) \rightarrow \pi^+\pi^-] = (0.08 \pm 0.04) \times 10^{-4}, \quad (33) $$
where the errors are only statistical. This gives
\[
\frac{Br[\bar{B}^0 \to D^0 f_0(980)] \cdot Br[f_0(980) \to \pi^+ \pi^-]}{Br[B^0 \to D^0 f_0(500)] \cdot Br[f_0(500) \to \pi^+ \pi^-]} \bigg|_{\text{Exp.}} = 0.12 \pm 0.06.
\]

(34)

From Fig. 1 it is easy to estimate our theoretical results for this ratio by integrating over the peaks of the \(f_0(500)\) and \(f_0(980)\). We find
\[
\frac{Br[\bar{B}^0 \to D^0 f_0(980)] \cdot Br[f_0(980) \to \pi^+ \pi^-]}{Br[B^0 \to D^0 f_0(500)] \cdot Br[f_0(500) \to \pi^+ \pi^-]} \bigg|_{\text{Theo.}} = 0.08,
\]
with about an estimate error of 10%. As we can see, the agreement of the theory with experiment is good within errors.

Finally, although with more uncertainty, we can also estimate the ratio
\[
\frac{\Gamma(B^0 \to \bar{D}^0 K^+ K^-)}{\Gamma(B^0 \to D^0 \pi^+ \pi^-)} = 0.056 \pm 0.011 \pm 0.007
\]
(36)
of Ref. 30. This requires an extrapolation of our results to higher invariant masses where our results would not be accurate, but, assuming that most of the strength for both reactions comes from the region close to the \(K^+ K^-\) threshold and from the \(\rho^0\) peak, respectively, we obtain a ratio of the order of 0.03 \(\sim\) 0.06 which agrees qualitatively with the ratio of Eq. 36.

We have selected \(B^0\) decay into \(D^0\) and \(\pi^+ \pi^-\), or \(\pi^0 \eta\) and \(B_s^0\) into \(D^0\) and \(\pi^- K^+\) which are Cabibbo favored. In this case one does not find competitive mechanisms corresponding to different topologies of the diagrams 11. Similarly as done in Ref. 18, one could also consider \(B_s^0\) into \(D^0\) and \(\pi^+ \pi^-\). In this case we can have this reaction using the mechanism of Fig. 1(b), replacing the final \(d\) quark by an \(s\) quark. Upon hadronization the \(s\bar{s}\) pair will give \(K \bar{K}\) which upon rescattering can produce \(\pi^+ \pi^-\). The \(udW\) transition is substituted by \(usW\) transition and hence the \(\cos \theta_c\) into \(\sin \theta_c\). The evaluation of this diagram is straightforward, but there is a competing diagram of the type of external emission (see Fig. 5A of Ref. 28) where the \(W\) directly converts into \(s\bar{u}(K^-)\) and the final quark is a \(c\) quark. Upon hadronization of the \(c\bar{s}\) pair we can get \(D^0\) and \(K^+\). In both mechanisms we have \(K \bar{K} D^0\) in the final state, which through rescattering will give \(D^0 \pi^+ \pi^-\), and the two mechanisms interfere. We thus cannot be as predictive as in the other cases where there is only one dominant mechanism and unknown dynamical factors cancel in ratios. However, we can already say that these two mechanisms are both Cabibbo suppressed, so, the ratio of \(f_0(980)\) production in this case would be suppressed with respect to the \(B^0\) case by \((\sin \theta_c / \cos \theta_c)^2\) with respect to the \(B^0\) case. This is in contrast to the \(B^0\) and \(B_s^0\) decays into \(J/\psi\) and \(f_0(980)\), where the second decay was favored with respect to the first one 14, 18. On the other hand, we see also here that the \(\pi^+ \pi^-\) in the \(B^0\) decay into \(D^0\) and \(\pi^+ \pi^-\) proceeds via rescattering of the primary produced \(K \bar{K}\) pair. This is similar to the case of \(B^0\) decay into \(J/\psi\) and \(\pi^+ \pi^-\) in Ref. 18 and thus we can also predict that in the \(B^0 \to D^0 \pi^+ \pi^-\) the \(f_0(980)\) would be seen and there would be practically no trace of the \(f_0(500)\) excitation.

IV. CONCLUSIONS

In this paper we have addressed the study of the \(\bar{B}^0\) decay into \(D^0\) and \(\rho\) or \(f_0(500)\), \(f_0(980)\), \(a_0(980)\), and \(B^0_s\) decay into \(D^0\) and \(K^0(800)\) or \(\kappa(800)\). The theoretical framework is simple to interpret and allows us to get relative strengths of the different reactions. The Cabibbo favored dominant mechanism at the quark level is identified and then the rates for production of vector mesons are trivially obtained assuming a \(q \bar{q}\) nature for the vector mesons. The relative rates obtained are in good agreement with experimental data. This in itself is already a good finding, supporting that nature for the vector mesons, which has been advocated from the large \(N_c\) behaviour of the amplitudes 12 and from the compositeness sum rule 43, 44. As to the production of the scalar mesons we could predict the invariant mass distributions with the same normalization for the \(B^0\) decay into \(D^0\rho^0(\rho^0 \to \pi^+ \pi^-)\), \(D^0 f_0(\rho^0 \to \pi^+ \pi^-)\), and \(D^0 a_0(980)(a_0(980) \to \pi^0 \eta)\). With the same normalization we could predict the invariant mass distribution for \(B^0\) decay into \(D^0 K^{*0}(K^{*0} \to \pi^- K^+)\) or \(D^0 \kappa(800)(\kappa(800) \to \pi^- K^+)\). All this could be done with no free parameters under the assumption that these resonances are generated dynamically from the meson-meson interactions and constitute solid predictions for future experiments, which are most likely to be performed at LHCb or other facilities.

The comparison of these results with vector production required some experimental data that we could find in the literature, where the \(f_0(500)\) and \(\rho^0\) production were measured simultaneously. A fit to these data allowed us to see the relative contribution of the \(f_0(500)\) to the \(\pi^+ \pi^-\) distribution, which is large and clearly visible at low invariant masses. With this information we could make predictions for the strength of \(K^{*0}\) production in \(B^0\) decay into \(D^0\) and \(K^{*0}\) and compare it with the \(\kappa(800)\) contribution. These are again solid predictions for future experiments, relative to the production of the \(\rho^0\) in the \(B^0\) decay into \(D^0\) and \(\rho\).

The large amount of information predicted in decays which are Cabibbo favored, and the relevance that this information has on the nature of the scalar mesons, should be a clear motivation for the implementation of these experiments in the near future.

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