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# Measurement of the branching fractions for inclusive $B^-$ and $\overline{B}^0$ decays to flavor-tagged $D$, $D_s$, and $\Lambda_c$

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We report on the inclusive branching fractions of $B^-$ and of $\overline{B}^0$ mesons decaying to $D^0X$, $\overline{D}^0X$, $D^+X$, $D^-X$, $D_s^+X$, $D_s^-X$, $\Lambda_c^+X$, $\overline{\Lambda}_c^-X$, based on a sample of $88.9\times10^6$ $B\overline{B}$ events recorded with the *BABAR* detector at the $\Upsilon(4S)$ resonance. Events are selected by completely reconstructing one $B$ and searching for a reconstructed charmed particle in the rest of the event. We measure the number of charmed and of anticharmed particles per $B$ decay and derive the total charm yield per $B^-$ decay $n_c^- = 1.313 \pm 0.037 \pm 0.062^{+0.063}_{-0.042}$ and per $\overline{B}^0$ decay $n_c^0 = 1.276 \pm 0.062 \pm 0.058^{+0.066}_{-0.046}$, where the first uncertainty is statistical, the second is systematic, and the third reflects the charm branching-fraction uncertainties.

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The dominant process for the decay of a $b$ quark is $b \to cW^{*-}$ [1], resulting in a (flavor) correlated $c$ quark and a virtual $W$. In the decay of the $W$, the production of a $\overline{u}d$ or a $\overline{c}s$ pair are both Cabibbo-allowed and should be equal, the latter being suppressed only by a phase-space factor. The first process dominates hadronic $b$ decays, while the second can be easily distinguished as it will produce a (flavor) anticorrelated $\overline{c}$ quark. Experimentally, correlated and anticorrelated charm production can be investigated through the measurement of the inclusive $B$-decay rates to flavor-tagged charmed mesons or baryons. Current measurements [2–4] of these rates have statistically limited precision and do not distinguish among the different $B$ parent states.

Most of the charged and neutral $D$ mesons produced in $\overline{B}$ decays come from correlated production $\overline{B} \to DX$. However, a significant number of $\overline{B} \to \overline{D}X$ decays are expected through $b \to c\overline{c}s$ transitions, such as $\overline{B} \to D^{(*)}\overline{D}^{(*)}\overline{K}^{(*)}(n\pi)$. Although the branching fractions of the three-body decays $\overline{B} \to D^{(*)}\overline{D}^{(*)}\overline{K}$ have been measured [5,6], it is not clear whether they saturate $\overline{B} \to \overline{D}X$ transitions. It is therefore important to improve the precision on the branching fraction $\mathcal{B}(\overline{B} \to \overline{D}X)$.

By contrast, the anticorrelated $D_s^-$ production $\overline{B} \to D_s^- D(n\pi)$ is expected to dominate $\overline{B}$ decays to $D_s$ mesons, since correlated production needs an extra $s\overline{s}$ pair created from the vacuum to give $\overline{B} \to D_s^+K^-(n\pi)$. There is no prior published measurement of $\mathcal{B}(\overline{B} \to D_s^+X)$.

All strangeless charmed baryons decay to $\Lambda_c$. Correlated $\Lambda_c$ are produced in decays such as $B^- \to \Lambda_c^+\overline{p}\pi^-(\pi)$, while anticorrelated $\overline{\Lambda}_c^-$ should originate from $B^- \to \Xi_c\overline{\Lambda}_c^-(\pi)$. Another possibility is $B^- \to \Lambda_c^+\overline{\Lambda}_c^-K^-$, the baryonic analogue of the $D\overline{D}K$ decay. The rates for $\Xi_c$ production in $B$ decays [7] are unknown, because there is no absolute measurement of $\Xi_c$ decay branching fractions.

This analysis uses $\Upsilon(4S) \to B\overline{B}$ events in which either a $B^+$ or a $B^0$ meson (hereafter denoted $B_{\rm reco}$) decays into a hadronic final state and is fully reconstructed. We then reconstruct $D$, $D_s$, and $\Lambda_c$ from the recoiling $B^-$ ($\overline{B}^0$) meson and compare the flavor of the charm hadron with that of the $B_{\rm reco}$, thus allowing separate measurements of the $B^-$ ($\overline{B}^0$) $\to D^0X$, $D^+X$, $D_s^+X$, $\Lambda_c^+X$ and $B^-$ ($\overline{B}^0$) $\to$ $\overline{D}^0X$, $D^-X$, $D_s^-X$, $\overline{\Lambda}_c^-X$ branching fractions. We extract $\mathcal{B}(B^- \to \Lambda_c^+\overline{\Lambda}_c^-K^-)$ from the missing-mass spectra of the $\Lambda_c^+K^-$ or $\overline{\Lambda}_c^-K^-$ systems recoiling against the $B_{\rm reco}$. We can then evaluate indirectly $\mathcal{B}(B^- \to \Xi_cX) = \mathcal{B}(B^- \to \overline{\Lambda}_c^-X) - \mathcal{B}(B^- \to \Lambda_c^+\overline{\Lambda}_c^-K^-)$ and compute the average number of charm (anticharm) particles per $B^-$ decay, $N_c^-$ ($N_{\overline{c}}^-$):

$$N_c^- = \sum_{X_c}\mathcal{B}(B^- \to X_cX), \quad (1)$$

$$N_{\overline{c}}^- = \sum_{\overline{X}_c}\mathcal{B}(B^- \to \overline{X}_cX), \quad (2)$$

where the sum is performed over $X_c = D^+, D^0, D_s^+, \Lambda_c^+, \Xi_c, (c\overline{c})$ or $\overline{X}_c = D^-, \overline{D}^0, D_s^-, \overline{\Lambda}_c^-, (c\overline{c})$, and $(c\overline{c})$ refers to all charmonium states collectively. We neglect $\overline{\Xi}_c$ production, as it requires both a $\overline{c}s$ and an $s\overline{s}$ pair in the decay to give $\overline{\Xi}_c\Omega_c$. We can sum $N_c^-$ and $N_{\overline{c}}^-$ to obtain the average number of charm plus anticharm quarks per $B^-$ decay, $n_c^- = N_c^- + N_{\overline{c}}^-$ (and similarly for $\overline{B}^0$ decays). In addition to the theoretical interest [8–11], the fact that anticorrelated charmed particles are a background for many studies also motivates a more precise measurement of their production rates in $B$ decays.

The measurements presented here are based on a sample of $88.9\times10^6$ $B\overline{B}$ pairs ($81.9\ \text{fb}^{-1}$) recorded at the $\Upsilon(4S)$ resonance with the *BABAR* detector at the PEP-II asymmetric-energy $B$-meson factory at the Stanford Linear Accelerator Center (SLAC). The *BABAR* detector is described in detail elsewhere [12]. Charged-particle trajectories are measured by a 5-layer double-sided silicon vertex tracker and a 40-layer drift chamber, both operating in a 1.5-T solenoidal magnetic field. Charged-particle identification is provided by the average energy loss ($dE/dx$) in the tracking devices and by an internally reflecting ring-imaging Cherenkov detector. Photons are detected by a CsI(Tl) electromagnetic calorimeter. We use Monte Carlo simulations of the *BABAR* detector based on GEANT4 [13] to optimize selection criteria and determine selection efficiencies.

We reconstruct $B^+$ and $B^0$ decays ($B_{\rm reco}$) in the modes $B^+ \to \overline{D}^{(*)0}\pi^+$, $\overline{D}^{(*)0}\rho^+$, $\overline{D}^{(*)0}a_1^+$ and $B^0 \to D^{(*)-}\pi^+$,

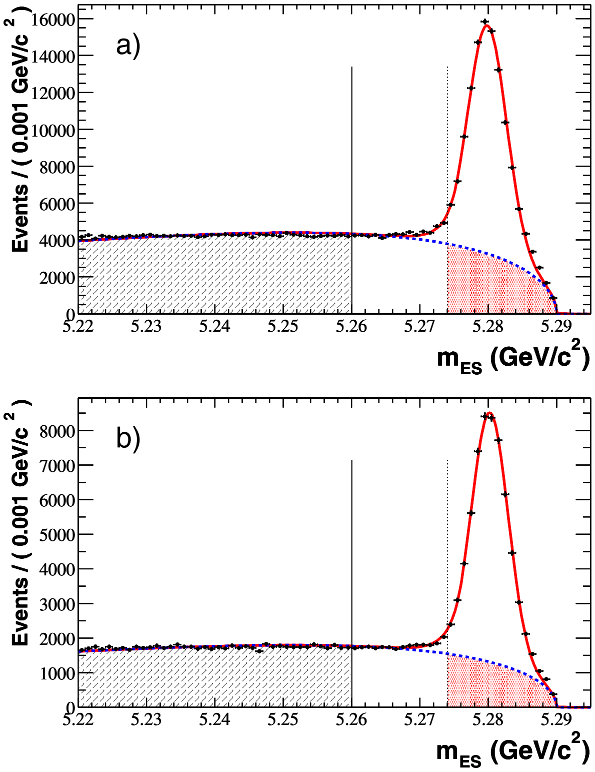


FIG. 1 (color online). $m_{\mathrm{ES}}$ spectra of reconstructed (a) $B^+$ and (b) $B^0$ candidates. The solid vertical line shows the upper limit of the background control region (hatched), the dotted vertical line the lower limit of the $B$ signal region. The crossed area shows the background under the $B$ signal. The solid curve is the sum of the fitted signal and background; the dashed curve is the background component only.

$D^{(*)-}\rho^+$, $D^{(*)-}a_1^+$. $\overline{D}^0$ candidates are reconstructed in the $K^+\pi^-$, $K^+\pi^-\pi^0$, $K^+\pi^-\pi^+\pi^-$, and $K_S^0\pi^+\pi^-(K_S^0 \to \pi^+\pi^-)$ decay channels, while $D^-$ are reconstructed in the $K^+\pi^-\pi^-$ and $K_S^0\pi^-$ modes. $D^*$ candidates are reconstructed in the $D^{*-} \to \overline{D}^0\pi^-$ and $\overline{D}^{*0} \to \overline{D}^0\pi^0, \overline{D}^0\gamma$ decay modes. The first kinematic variable used to identify fully reconstructed $B$ decays is the beam-energy substituted mass, $\mathrm{m_{ES}} = \sqrt{(s/2 + \mathbf{p}_i \cdot \mathbf{p}_B)^2/E_i^2 - \mathbf{p}_B^2}$, where $\mathbf{p}_B$ is the $B_{\mathrm{reco}}$ momentum and $(E_i, \mathbf{p}_i)$ is the four-momentum of the initial $e^+e^-$ system, both measured in the laboratory frame. The invariant mass of the initial $e^+e^-$ system is $\sqrt{s}$. The second variable is $\Delta E = E_B^* - \sqrt{s}/2$, where $E_B^*$ is the $B_{\mathrm{reco}}$ candidate energy in the center-of-mass frame. We require $|\Delta E| < n\sigma_{\Delta E}$ with $n = 2$ or 3, depending on the decay mode, and using the measured resolution $\sigma_{\Delta E}$ for each decay mode.

In the $m_{\mathrm{ES}}$ spectra (Fig. 1), we define a signal region with $5.274 < \mathrm{m_{ES}} < 5.290\ \mathrm{GeV}/c^2$ and a background control region with $5.220 < \mathrm{m_{ES}} < 5.260\ \mathrm{GeV}/c^2$. For each of the $B$-decay modes, the combinatorial background in the signal region is derived from a fit to the $m_{\mathrm{ES}}$ distribution that uses an empirical phase-space threshold function [14] for the background, together with a signal function [15] peaked at the $B$ meson mass. The numbers of reconstructed $B^+$ and $B^0$ candidates, $N_{B^+} = 85840 \pm 1910(\mathrm{syst})$ and $N_{B^0} = 48322 \pm 590(\mathrm{syst})$, are then obtained by subtracting this background from the total number of events found in the signal region. These measured $B$ meson yields provide the normalization of all branching-fraction measurements reported below. The systematic uncertainties quoted above are computed by varying the boundaries of the signal and background regions and by comparing the shapes of the threshold function [14] in the data and in the simulation.

The contamination of $B^0$ events in the $B^+$ signal induces a background which peaks near the $B$ mass. From the Monte Carlo simulation, the fraction of $B^0$ events in the reconstructed $B^+$ signal sample is found to be $c_0 = 0.034$ and the fraction of $B^+$ events in the reconstructed $B^0$ signal sample to be $c_+ = 0.019$. A 100% systematic uncertainty is conservatively assigned to these numbers but they will have a small effect on the final results.

We now turn to the analysis of inclusive $D$, $D_s$, and $\Lambda_c$ production in the decays of the $\overline{B}$'s that recoil against the reconstructed $B$. Charmed particles $X_c$ (correlated production) are distinguished from anticharmed particles $\overline{X}_c$ (anticorrelated production). They are reconstructed from charged tracks that do not belong to the $B_{\mathrm{reco}}$. The decay modes considered are listed in Table I.

For charged $B$ decays, Fig. 2 shows the $D$, $D_s$, and $\Lambda_c$ mass spectra of correlated and anticorrelated candidates

TABLE I. Charmed-particle signal yields and $B$ branching fractions per decay mode. The first uncertainty is statistical, the second is systematic (but does not include the charm branching-fraction uncertainties).

| | | $B^- \to X_cX$ | | $B^- \to \overline{X}_cX$ | | $\overline{B}^0 \to X_cX$ | | $\overline{B}^0 \to \overline{X}_cX$ | |
|---|---|---|---|---|---|---|---|---|---|
| $X_c$ decay mode | | Yield | $\mathcal{B}(\%)$ | Yield | $\mathcal{B}(\%)$ | Yield | $\mathcal{B}(\%)$ | Yield | $\mathcal{B}(\%)$ |
| $D^0$ [16] | $\to K^-\pi^+$ | $1273 \pm 42$ | $79.2 \pm 2.6 \pm 3.9$ | $160 \pm 16$ | $9.3 \pm 1.0 \pm 0.5$ | $397 \pm 24$ | $50.3 \pm 3.4 \pm 2.4$ | $139 \pm 14$ | $7.3 \pm 2.2 \pm 0.5$ |
| | $\to K^-\pi^+\pi^-\pi^+$ | $998 \pm 65$ | $80.6 \pm 5.3 \pm 7.5$ | $173 \pm 30$ | $13.4 \pm 2.4 \pm 1.3$ | $332 \pm 36$ | $56.2 \pm 6.8 \pm 5.4$ | $83 \pm 23$ | $1.8 \pm 4.4 \pm 0.5$ |
| $D^+$ | $\to K^-\pi^+\pi^+$ | $262 \pm 29$ | $9.8 \pm 1.2 \pm 1.2$ | $98 \pm 20$ | $3.8 \pm 0.9 \pm 0.4$ | $452 \pm 31$ | $39.7 \pm 3.0 \pm 2.8$ | $125 \pm 18$ | $2.3 \pm 1.8 \pm 0.3$ |
| $D_s^+$ | $\to \phi\pi^+$ | $11 \pm 5$ | $2.2 \pm 1.1 \pm 0.3$ | $82 \pm 11$ | $16.5 \pm 2.3 \pm 1.7$ | $24 \pm 6$ | $8.3 \pm 2.8 \pm 0.8$ | $28 \pm 6$ | $9.9 \pm 2.9 \pm 1.0$ |
| | $\to \overline{K}^{*0}K^+$ | $0 \pm 3$ | $0.0 \pm 1.1 \pm 0.2$ | $55 \pm 11$ | $18.0 \pm 3.5 \pm 1.7$ | $3 \pm 4$ | $0.0 \pm 2.8 \pm 0.1$ | $14 \pm 5$ | $9.9 \pm 4.1 \pm 1.2$ |
| | $\to K_S^0K^+$ | $0 \pm 3$ | $0.0 \pm 0.9 \pm 0.2$ | $31 \pm 9$ | $9.2 \pm 2.7 \pm 0.8$ | $12 \pm 5$ | $5.0 \pm 3.4 \pm 0.4$ | $23 \pm 6$ | $13.3 \pm 4.3 \pm 1.0$ |
| $\Lambda_c^+$ | $\to pK^-\pi^+$ | $41 \pm 9$ | $3.5 \pm 0.8 \pm 0.3$ | $33 \pm 9$ | $2.9 \pm 0.8 \pm 0.3$ | $28 \pm 8$ | $4.9 \pm 1.7 \pm 0.4$ | $16 \pm 6$ | $2.0 \pm 1.2 \pm 0.2$ |

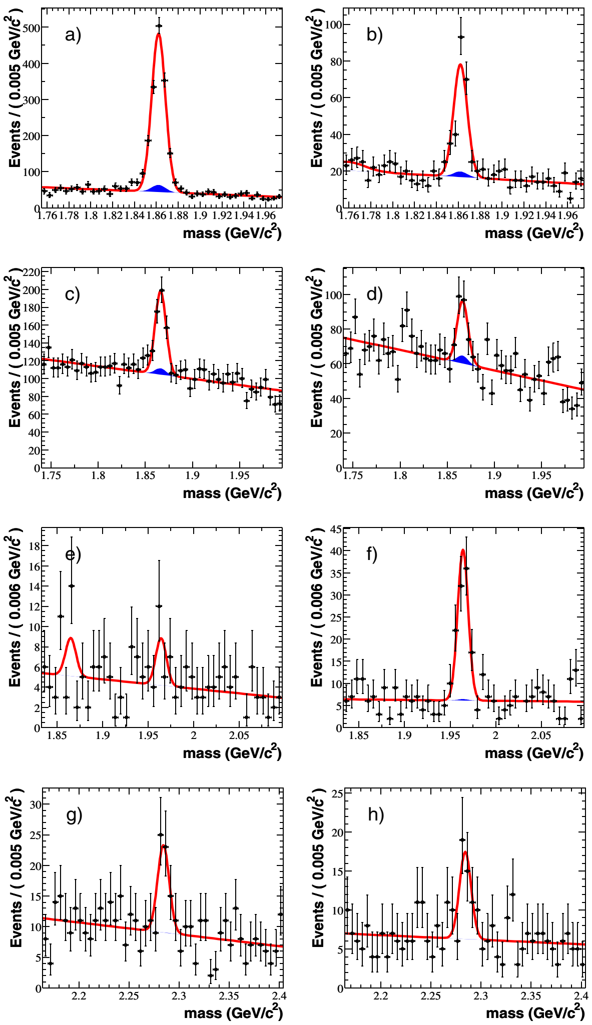


FIG. 2 (color online). Correlated (left) and anticorrelated (right) charmed-particle mass spectra in the recoil of $B^+$ events, for (a),(b) $D^0 \to K^-\pi^+$; (c),(d) $D^+ \to K^-\pi^+\pi^+$; (e),(f) $D_s^+ \to \phi\pi^+$; and (g),(h) $\Lambda_c^+ \to pK^-\pi^+$. The solid curve is the sum of a Gaussian signal and of a linear background plus mode-dependent satellite contributions [17]. The shaded areas show the contribution of well reconstructed $D$, $D_s$, or $\Lambda_c$ in the $B^+$ combinatorial background.

recoiling against $B$'s reconstructed in the $m_{\rm ES}$ signal region, for some selected decay modes. These spectra are fitted with the sum of a Gaussian signal and a linear background (including a satellite peak for some channels [17]). The shaded areas correspond to well reconstructed $D$, $D_s$, or $\Lambda_c$ from the combinatorial $B_{\rm reco}$ background. They are obtained from data in the $m_{\rm ES}$ background control region, normalized to the number of combinatorial background events expected under the $B_{\rm reco}$ peak. The background-subtracted reconstructed signal yields are listed in Table I. The reconstruction efficiencies for each charmed (anticharmed) final state $X_c \to f$ ($\overline{X}_c \to \overline{f}$) are computed from the simulation as a function of the charmed-particle momentum in the $B^-$ center-of-mass frame and are applied event by event to obtain the efficiency-corrected charm signal yields $N(X_c \to f)$ [$N(\overline{X}_c \to \overline{f})$]. The final branching fractions are computed from these yields, the number of $B_{\rm reco}$, and the intermediate branching fractions $\mathcal{B}(X_c \to f)$ taken from Ref. [18]. They are given by

$$\mathcal{B}(B^- \to X_c X) = \frac{N(X_c \to f)}{N_{B^+} \times \mathcal{B}(X_c \to f)} - c_0 \mathcal{B}_0. \qquad (3)$$

Here the raw branching fraction for $B^- \to X_c X$ is modified by a small corrective term $c_0 \mathcal{B}_0$ that accounts for the $B^0$ contamination in the reconstructed $B^+$ sample. The factor $\mathcal{B}_0$ depends on the measured $\overline{B}^0 \to X_c X$ and $B^0 \to X_c X$ branching fractions and on the $B^0 - \overline{B}^0$ mixing parameter $\chi_d$ [18]. It ranges from less than 3% for $\Lambda_c$ to as much as 50% for correlated $D^0$ and $D^+$. Doubly Cabibbo-suppressed $D^0$ decays are also taken into account. The branching fractions and their errors are given in Table I. The statistical and systematic uncertainties are computed separately for each channel. For example, the 3.9% absolute systematic uncertainty on $\mathcal{B}[B^- \to D^0(K^-\pi^+)X]$ reflects the quadratic sum of 1.8% attributed to $N_{B^+}$, 1.3% to the error on the rate of true $D$'s in the $B$ combinatorial background, 0.8% to the Monte Carlo statistics, 1.2% to the track-finding efficiency, 2.5% to the particle identification, 1.2% to $c_0$, and 0.1% to $\mathcal{B}_0$. We combine the results from the different $D^0$ and $D_s$ decay modes to extract the final branching fractions listed in Table II.

To extract $N_c$ from these numbers, we need to evaluate the contribution of $B^- \to \Lambda_c^+ \overline{\Lambda}_c^- K^-$. Combining the four-momenta of the recoiling $B^-$, of a $K^-$, and of the reconstructed $\Lambda_c^+$ or $\overline{\Lambda}_c^-$ candidate, we compute the missing mass: the absence of signal at the $\Lambda_c$ mass excludes a significant contribution of this process. We therefore take $\mathcal{B}(B^- \to \Xi_c X) = \mathcal{B}(B^- \to \overline{\Lambda}_c^- X)$ in the computation of $N_c$. Using Eqs. (1) and (2) and taking $\mathcal{B}[B^- \to (c\overline{c})X] = (2.3 \pm 0.3)\%$ [19,20], one obtains:

$$N_c^- = 0.983 \pm 0.030 \pm 0.046^{+0.028}_{-0.023},$$
$$N_{\overline{c}}^- = 0.330 \pm 0.022 \pm 0.020^{+0.051}_{-0.031},$$
$$n_c^- = 1.313 \pm 0.037 \pm 0.062^{+0.063}_{-0.042}.$$

TABLE II. Combined $B^-$ branching fractions. The first uncertainty is statistical, the second is systematic, and the third reflects charm branching-fraction uncertainties [18].

| $X_c$ | Correlated $\mathcal{B}(B^- \to X_c X)(\%)$ | Anticorrelated $\mathcal{B}(B^- \to \overline{X}_c X)(\%)$ |
|---|---|---|
| $D^0$ | $79.3 \pm 2.5 \pm 4.0^{+2.0}_{-1.9}$ | $9.8 \pm 0.9 \pm 0.5^{+0.3}_{-0.3}$ |
| $D^+$ | $9.8 \pm 1.2 \pm 1.2^{+0.8}_{-0.7}$ | $3.8 \pm 0.9 \pm 0.4^{+0.3}_{-0.3}$ |
| $D_s^+$ | $0.5 \pm 0.6 \pm 0.2^{+0.2}_{-0.1}$ | $14.3 \pm 1.6 \pm 1.5^{+4.9}_{-3.0}$ |
| | $<2.2$ at 90% C.L. | |
| $\Lambda_c^+$ | $3.5 \pm 0.8 \pm 0.3^{+1.3}_{-0.8}$ | $2.9 \pm 0.8 \pm 0.3^{+1.1}_{-0.6}$ |

TABLE III. Combined $\overline{B}^0$ branching fractions. The first uncertainty is statistical, the second is systematic, and the third reflects charm branching-fraction uncertainties [18].

| $X_c$ | Correlated $\mathcal{B}(\overline{B}^0 \to X_c X)(\%)$ | Anticorrelated $\mathcal{B}(\overline{B}^0 \to \overline{X}_c X)(\%)$ |
|---|---|---|
| $D^0$ | $51.1 \pm 3.1 \pm 2.5^{+1.3}_{-1.3}$ | $6.3 \pm 1.9 \pm 0.5^{+0.2}_{-0.2}$ |
| $D^+$ | $39.7 \pm 3.0 \pm 2.8^{+2.8}_{-2.5}$ | $2.3 \pm 1.8 \pm 0.3^{+0.2}_{-0.2}$ <br> $<5.1$ at 90% C.L. |
| $D_s^+$ | $3.9 \pm 1.7 \pm 0.4^{+1.3}_{-0.8}$ <br> $<8.7$ at 90% C.L. | $10.9 \pm 2.1 \pm 0.8^{+3.8}_{-2.3}$ |
| $\Lambda_c^+$ | $4.9 \pm 1.7 \pm 0.4^{+1.8}_{-1.0}$ | $2.0 \pm 1.2 \pm 0.2^{+0.7}_{-0.4}$ <br> $<3.8$ at 90% C.L. |

The reconstruction of $D$, $D_s$, and $\Lambda_c$ from $\overline{B}^0$ decays is performed in the same way as that in the $B^-$ analysis. The corresponding yields are listed in Table I. We then compute for each decay channel $X_c \to f$ the efficiency-corrected signal yields $N(X_c \to f)$ $[N(\overline{X}_c \to \overline{f})]$ and define the raw branching fractions $\mathcal{B}_c$ and $\bar{\mathcal{B}}_c$ as

$$\mathcal{B}_c = N(X_c \to f)/[N_{B^0} \times \mathcal{B}(X_c \to f)], \qquad (4)$$

$$\overline{\mathcal{B}}_c = N(\overline{X}_c \to \overline{f})/[N_{B^0} \times \mathcal{B}(X_c \to f)]. \qquad (5)$$

After correcting these numbers for $B^0\overline{B}^0$ mixing, we obtain the final branching fraction for $\overline{B}^0 \to X_c X$:

$$\mathcal{B}(\overline{B}^0 \to X_c X) = \frac{\mathcal{B}_c - \chi_d(\mathcal{B}_c + \overline{\mathcal{B}}_c) - c_+\mathcal{B}_+}{1 - 2\chi_d}, \qquad (6)$$

where $\chi_d = 0.181 \pm 0.004$ is the $B^0 - \overline{B}^0$ mixing parameter [18]. The correcting factor $\mathcal{B}_+$ accounts for $B^+$ contamination in the $B^0$ sample and depends on $\mathcal{B}(B^- \to X_c X)$ and $\mathcal{B}(B^+ \to X_c X)$. The results are given in Table I. Combining the different $D^0$ or $D_s$ modes, we obtain the final branching fractions listed in Table III.

To compute $N_c$, we neglect $\overline{B}^0 \to \Lambda_c^+ \overline{\Lambda}_c^- K^0$ production and assume that $\mathcal{B}(\overline{B}^0 \to \Xi_c X) = \mathcal{B}(\overline{B}^0 \to \overline{\Lambda}_c^- X)$. Substituting $\overline{B}^0$ for $B^-$ in Eqs. (1) and (2) and taking $\mathcal{B}[B^0 \to (c\overline{c})X] = (2.3 \pm 0.3)\%$ [19,20], we obtain:

$$N_c^0 = 1.039 \pm 0.051 \pm 0.049^{+0.039}_{-0.031},$$
$$N_{\overline{c}}^0 = 0.237 \pm 0.036 \pm 0.012^{+0.039}_{-0.024},$$
$$n_c^0 = 1.276 \pm 0.062 \pm 0.058^{+0.066}_{-0.046}.$$

TABLE IV. Fraction $w$ of anticorrelated charm.

| Mode | $B^-$ decays | $\overline{B}^0$ decays |
|---|---|---|
| $\overline{D}^0 X$ | $0.110 \pm 0.010 \pm 0.003$ | $0.110 \pm 0.031 \pm 0.008$ |
| $D^- X$ | $0.278 \pm 0.052 \pm 0.009$ | $0.055 \pm 0.040 \pm 0.006$ |
| $D_s^- X$ | $0.966 \pm 0.039 \pm 0.012$ | $0.733 \pm 0.092 \pm 0.010$ |
| $\overline{\Lambda}_c^- X$ | $0.452 \pm 0.090 \pm 0.003$ | $0.286 \pm 0.142 \pm 0.007$ |

We also compute the fraction of anticorrelated charm production in $B$ decays, $w(\overline{X}_c) = \mathcal{B}(\overline{B} \to \overline{X}_c X)/[\mathcal{B}(\overline{B} \to X_c X) + \mathcal{B}(\overline{B} \to \overline{X}_c X)]$. Here, many systematic uncertainties cancel (tracking, $K$ identification, $D$ branching fractions, $B$ counting). The results are given in Table IV. We obtain an upper limit on the correlated $D_s^+$ fraction in $B^-$ decays: $\mathcal{B}(B^- \to D_s^+ X)/\mathcal{B}(B^- \to D_s^\pm X) < 0.126$ at 90% C.L.

In conclusion, we have measured for the first time the branching fractions for inclusive decays of $B$ mesons to flavor-tagged $D$, $D_s$, and $\Lambda_c$, separately for $B^-$ and $\overline{B}^0$. We observe significant production of anticorrelated $D^0$ and $D^+$ mesons in $B$ decays (Table IV), with the branching fractions detailed in Tables II and III. The correlated $D_s$ production in $B^-$ decays is measured to be small.

As expected, the sum of all correlated charm branching fractions $N_c$ is compatible with 1, for charged as well as for neutral $B$'s. The numbers of charmed particles per $B^-$ decay ($n_c^- = 1.313 \pm 0.037 \pm 0.062^{+0.063}_{-0.042}$) and per $\overline{B}^0$ decay ($n_c^0 = 1.276 \pm 0.062 \pm 0.058^{+0.066}_{-0.046}$) are consistent with previous measurements [2,19,21] and with theoretical expectations [8–10].

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[1] Throughout this paper, the named reaction refers also to its complex conjugate.
[2] CLEO Collaboration, T. E. Coan *et al.*, Phys. Rev. Lett. **80**, 1150 (1998).
[3] DELPHI Collaboration, J. Abdallah *et al.*, Phys. Lett. B **561**, 26 (2003).
[4] CLEO Collaboration, R. Ammar *et al.*, Phys. Rev. D **55**, 13 (1997).
[5] ALEPH Collaboration, R. Barate *et al.*, Eur. Phys. J. C **4**, 387 (1998).
[6] *BABAR* Collaboration, B. Aubert *et al.*, Phys. Rev. D **68**, 092001 (2003).

[7] CLEO Collaboration, B. Barish *et al.*, Phys. Rev. Lett. **79**, 3599 (1997).

[8] E. Bagan *et al.*, Phys. Lett. B **351**, 546 (1995).

[9] G. Buchalla *et al.*, Phys. Lett. B **364**, 188 (1995).

[10] M. Neubert, in *Proceedings of the 17th International Symposium on Lepton-Photon Interactions, Beijing, China* (World Scientific, Singapore, 1995), p. 298.

[11] A. L. Kagan, in *Proceedings of the 7th International Symposium on Heavy Flavour Physics, Santa Barbara, CA* (World Scientific, Singapore, 1997).

[12] *BABAR* Collaboration, B. Aubert *et al.*, Nucl. Instrum. Methods Phys. Res., Sect. A **479**, 1 (2002).

[13] GEANT4 Collaboration, S. Agostinelli *et al.*, Nucl. Instrum. Methods Phys. Res., Sect. A **506**, 250 (2003).

[14] ARGUS Collaboration, H. Albrecht *et al.*, Z. Phys. C **48**, 543 (1990).

[15] CRYSTAL BALL Collaboration, T. Skwarnicki *et al.*, Report No. DESY F31-86-02.

[16] Only $D^0 \to K^- \pi^+$ and $D^0 \to K^- \pi^+ \pi^+ \pi^-$ are used for the charm counting because $D^0 \to K^- \pi^+ \pi^0$ has a lower significance and $D^0 \to K^0_S \pi^+ \pi^-$ is not self-tagging (one cannot distinguish between $D^0$ and $\overline{D}^0$).

[17] Satellite contributions include a reflection from $D^0 \to K^- K^+$ in the $D^0 \to K^- \pi^+$ mass spectrum and a signal at the $D^+$ mass (from $D^+ \to \phi \pi^+$ decays) in the $D_s^+ \to \phi \pi^+$ mass spectrum.

[18] Particle Data Group, S. Eidelman *et al.*, Phys. Lett. B **592**, 1 (2004).

[19] ALEPH Collaboration, CDF Collaboration, DELPHI Collaboration, L3 Collaboration, OPAL Collaboration, and SLD Collaboration, hep-ex/0112028.

[20] M. Beneke *et al.*, Phys. Rev. D **59**, 054003 (1999).

[21] CLEO Collaboration, L. Gibbons *et al.*, Phys. Rev. D **56**, 3783 (1997).