# Heavy FLavor AVeraging group (HFLAV) - December 2017

## $B^+$ Branching Fractions (decays with strange mesons part 1) ($\times 10^{-6}$) - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | *BABAR* | | Belle | | CLEO | | CDF | LHCb | Our Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 327 | $K^0\pi^+$ | $23.7 \pm 0.8$ | $23.9 \pm 1.1 \pm 1.0$ | [1] | $23.97 \pm 0.53 \pm 0.71$ | [2] | $18.8^{+3.7+2.1}_{-3.3-1.8}$ | [3] | | | $23.79 \pm 0.75$ |
| 328 | $K^+\pi^0$ | $12.9 \pm 0.5$ | $13.6 \pm 0.6 \pm 0.7$ | [4] | $12.62 \pm 0.31 \pm 0.56$ | [2] | $12.9^{+2.4+1.2}_{-2.2-1.1}$ | [3] | | | $12.94^{+0.52}_{-0.51}$ |
| 329 | $\eta' K^+$ | $70.6 \pm 2.5$ | $71.5 \pm 1.3 \pm 3.2$ | [5] | $69.2 \pm 2.2 \pm 3.7$ | [6] | | | | | $70.6 \pm 2.7$ |
| 330 | $\eta' K^{*+}$ | $4.8^{+1.8}_{-1.6}$ | $4.8^{+1.6}_{-1.4} \pm 0.8$ | [7] | $< 2.9$ | [8] | | | | | $4.8^{+1.8}_{-1.6}$ |
| 331 | $\eta' K_0^*(1430)^+$ | $5.2 \pm 2.1$ | $5.2 \pm 1.9 \pm 1.0$ | [7] | | | | | | | $5.2 \pm 2.1$ |
| 332 | $\eta' K_2^*(1430)^+$ | $28 \pm 5$ | $28.0^{+4.6}_{-4.3} \pm 2.6$ | [7] | | | | | | | $28.0^{+5.3}_{-5.0}$ |
| 333 | $\eta K^+$ | $2.4 \pm 0.4$ | $2.94^{+0.39}_{-0.34} \pm 0.21$ | [5] | $2.12 \pm 0.23 \pm 0.11$ | [9] | $2.2^{+2.8}_{-2.2}$ | [10] | | | $2.36^{+0.22}_{-0.21}$ |
| 334 | $\eta K^{*+}$ | $19.3 \pm 1.6$ | $18.9 \pm 1.8 \pm 1.3$ | [11] | $19.3^{+2.0}_{-1.9} \pm 1.5$ | [12] | $26.4^{+9.6}_{-8.2} \pm 3.3$ | [10] | | | $19.3 \pm 1.6$ |
| 335 | $\eta K_0^*(1430)^+$ | $18 \pm 4$ | $18.2 \pm 2.6 \pm 2.6$ | [11] | | | | | | | $18.2 \pm 3.7$ |
| 336 | $\eta K_2^*(1430)^+$ | $9.1 \pm 3.0$ | $9.1 \pm 2.7 \pm 1.4$ | [11] | | | | | | | $9.1 \pm 3.0$ |
| 337 | $\eta(1295) K^+$ † | $2.9^{+0.8}_{-0.7}$ | $2.9^{+0.8}_{-0.7} \pm 0.2$ ‡ | [13] | | | | | | | $2.9^{+0.8}_{-0.7}$ |
| 339 | $\eta(1405) K^+$ † | $< 1.2$ | $< 1.2$ | [13] | | | | | | | $< 1.2$ |
| 340 | $\eta(1475) K^+$ † | $13.8^{+2.1}_{-1.8}$ | $13.8^{+1.8+1.0}_{-1.7-0.6}$ | [13] | | | | | | | $13.8^{+2.1}_{-1.8}$ |
| 341 | $f_1(1285) K^+$ | $< 2.0$ | $< 2.0$ | [13] | | | | | | | $< 2.0$ |
| 342 | $f_1(1420) K^+$ † | $< 2.9$ | $< 2.9$ | [13] | | | | | | | $< 2.9$ |
| 344 | $\phi(1680) K^+$ † | $< 3.4$ | $< 3.4$ | [13] | | | | | | | $< 3.4$ |
| 345 | $f_0(1500) K^+$ | $3.7 \pm 2.2$ | $3.7 \pm 2.2$ § | [14, 15] | | | | | | | $3.7 \pm 2.2$ |
| 346 | $\omega K^+$ | $6.5 \pm 0.4$ | $6.3 \pm 0.5 \pm 0.3$ | [16] | $6.8 \pm 0.4 \pm 0.4$ | [17] | $3.2^{+2.4}_{-1.9} \pm 0.8$ | [18] | | | $6.5 \pm 0.4$ |
| 347 | $\omega K^{*+}$ | $< 7.4$ | $< 7.4$ | [19] | | | | | | | $< 7.4$ |
| 348 | $\omega(K\pi)_0^{*+}$ | $28 \pm 4$ | $27.5^{+3.0}_{-2.6}$ | [19] | | | | | | | $27.5^{+3.0}_{-2.6}$ |
| 349 | $\omega K_0^*(1430)^+$ | $24 \pm 5$ | $24.0 \pm 2.6 \pm 4.4$ | [19] | | | | | | | $24.0 \pm 5.1$ |
| 350 | $\omega K_2^*(1430)^+$ | $21 \pm 4$ | $21.5 \pm 3.6 \pm 2.4$ | [19] | | | | | | | $21.5 \pm 4.3$ |
| 351 | $a_0(980)^+ K^0$ † | $< 3.9$ | $< 3.9$ | [20] | | | | | | | $< 3.9$ |
| 352 | $a_0(980)^0 K^+$ † | $< 2.5$ | $< 2.5$ | [20] | | | | | | | $< 2.5$ |
| 353 | $K^{*0}\pi^+$ | $10.1 \pm 0.9$ | $10.8 \pm 0.6^{+1.2}_{-1.4}$ | [14] | $9.7 \pm 0.6^{+0.8}_{-0.9}$ | [21] | | | | | $10.1^{+0.8}_{-0.9}$ |
| 354 | $K^{*+}\pi^0$ | $8.2 \pm 1.9$ | $8.2 \pm 1.5 \pm 1.1$ | [22] | | | $7.1^{+11.4}_{-7.1} \pm 1.0$ | [18] | | | $8.2 \pm 1.8$ |
| 355 | $K^+\pi^+\pi^-$ | $51 \pm 2.9$ | $54.4 \pm 1.1 \pm 4.6$ | [14] | $48.8 \pm 1.1 \pm 3.6$ | [21] | | | | | $51.0 \pm 3.0$ |
| 356 | $K^+\pi^+\pi^-$ $(NR)$ | $16.3^{+2.1}_{-1.5}$ | $9.3 \pm 1.0^{+6.9}_{-1.7}$ | [14] | $16.9 \pm 1.3^{+1.7}_{-1.6}$ | [21] | | | | | $16.3 \pm 2.0$ |
| 357 | $\omega(782) K^+$ $(K^+\pi^+\pi^-)$ | $6 \pm 9$ | $5.9^{+8.8+0.5}_{-9.0-0.4}$ | [14] | | | | | | | $5.9^{+8.8}_{-9.0}$ |
| 358 | $f_0(980) K^+$ $(K^+\pi^+\pi^-)$ † | $9.4^{+1.0}_{-1.2}$ | $10.3 \pm 0.5^{+2.0}_{-1.4}$ | [14] | $8.8 \pm 0.8^{+0.9}_{-1.8}$ | [21] | | | | | $9.4^{+0.9}_{-1.0}$ |
| 359 | $f_2(1270)^0 K^+$ $(K^+\pi^+\pi^-)$ | $1.07 \pm 0.27$ | $0.88^{+0.38+0.01}_{-0.33-0.03}$ | [14] | $1.33 \pm 0.30^{+0.23}_{-0.34}$ | [21] | | | | | $1.07 \pm 0.29$ |
| 360 | $f_0(1370)^0 K^+$ $(K^+\pi^+\pi^-)$ † | $< 10.7$ | $< 10.7$ | [23] | | | | | | | $< 10.7$ |
| 361 | $\rho(1450)^0 K^+$ $(K^+\pi^+\pi^-)$ | $< 11.7$ | $< 11.7$ | [23] | | | | | | | $< 11.7$ |
| 362 | $f_2'(1525) K^+$ $(K^+\pi^+\pi^-)$ | $< 3.4$ | $< 3.4$ | [23] | | | | | | | $< 3.4$ |
| 363 | $\rho^0 K^+$ $(K^+\pi^+\pi^-)$ | $3.7 \pm 0.5$ | $3.56 \pm 0.45^{+0.57}_{-0.46}$ | [14] | $3.89 \pm 0.47^{+0.43}_{-0.41}$ | [21] | | | | | $3.74^{+0.49}_{-0.45}$ |

Results for LHCb are relative BFs converted to absolute BFs.
CLEO upper limits that have been greatly superseded are not shown.
† In this product of BFs, all daughter BFs not shown are set to 100%.
‡ The value quoted is $\mathcal{B}(B^+ \to \eta(1295)K^+) \times \mathcal{B}(\eta(1295) \to \eta\pi\pi)$.
§ Average of results in $K_S^0 K^+ K^-$, $K_S^0 K_S^0 K^+$ [15] and $K^+\pi^+\pi^-$ [14]. Includes an $f_X$ resonance with parameters that are compatible with $f_0(1500)$.

# Heavy FLavor AVeraging group (HFLAV) - December 2017

## $B^+$ Branching Fractions (decays with strange mesons part 2) ($\times 10^{-6}$) - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | *BABAR* | Belle | CLEO | CDF | LHCb | Our Avg. |
|---|---|---|---|---|---|---|---|---|
| 364 | $K_0^*(1430)^0\pi^+$ $(K^+\pi^+\pi^-)$ | $45^{+9}_{-7}$ | $32.0 \pm 1.2^{+10.8}_{-6.0}$ [14] | $51.6 \pm 1.7^{+7.0}_{-7.5}$ [21] | | | | $45.1 \pm 6.3$ |
| 365 | $K_2^*(1430)^0\pi^+$ $(K^+\pi^+\pi^-)$ | $5.6^{+2.2}_{-1.5}$ | $5.6 \pm 1.2^{+1.8}_{-0.8}$ [14] | $< 6.9$ [24] | | | | $5.6^{+2.2}_{-1.4}$ |
| 366 | $K^*(1410)^0\pi^+$ $(K^+\pi^+\pi^-)$ | $< 45$ | | $< 45$ [24] | | | | $< 45$ |
| 367 | $K^*(1680)^0\pi^+$ $(K^+\pi^+\pi^-)$ | $< 12$ | $< 15$ [23] | $< 12$ [24] | | | | $< 12$ |
| 368 | $K^+\pi^0\pi^0$ | $16.2 \pm 1.9$ | $16.2 \pm 1.2 \pm 1.5$ [22] | | | | | $16.2 \pm 1.9$ |
| 369 | $f_0(980)K^+$ $(K^+\pi^0\pi^0)$ | $2.8 \pm 0.8$ | $2.8 \pm 0.6 \pm 0.5$ [22] | | | | | $2.8 \pm 0.8$ |
| 370 | $K^-\pi^+\pi^+$ | $< 0.046$ | $< 0.95$ [25] | $< 4.5$ [26] | | | $< 0.046$ [27] | $< 0.046$ |
| 371 | $K^-\pi^+\pi^+$ $(NR)$ | $< 56$ | | | $< 56$ [28] | | | $< 56$ |
| 372 | $K_1(1270)^0\pi^+$ | $< 40$ | $< 40$ [29] | | | | | $< 40$ |
| 373 | $K_1(1400)^0\pi^+$ | $< 39$ | $< 39$ [29] | | | | | $< 39$ |
| 374 | $K^0\pi^+\pi^0$ | $< 66$ | | | $< 66$ [30] | | | $< 66$ |
| 375 | $\rho^+K^0(K^0\pi^+\pi^0)$ | $8.0 \pm 1.5$ | $8.0^{+1.4}_{-1.3} \pm 0.6$ [31] | | | | | $8.0^{+1.5}_{-1.4}$ |
| 376 | $K^{*+}\pi^+\pi^-$ | $75 \pm 10$ | $75.3 \pm 6.0 \pm 8.1$ [32] | | | | | $75.3 \pm 10.1$ |
| 377 | $K^{*+}\rho^0$ | $4.6 \pm 1.1$ | $4.6 \pm 1.0 \pm 0.4$ [33] | | | | | $4.6 \pm 1.1$ |
| 378 | $f_0(980)K^{*+}$ † | $4.2 \pm 0.7$ | $4.2 \pm 0.6 \pm 0.3$ [33] | | | | | $4.2 \pm 0.7$ |
| 379 | $a_1^+K^0$ | $35 \pm 7$ | $34.9 \pm 5.0 \pm 4.4$ [34] | | | | | $34.9 \pm 6.7$ |
| 380 | $b_1^+K^0$ † | $9.6 \pm 1.9$ | $9.6 \pm 1.7 \pm 0.9$ [35] | | | | | $9.6 \pm 1.9$ |
| 381 | $K^{*0}\rho^+$ | $9.2 \pm 1.5$ | $9.6 \pm 1.7 \pm 1.5$ [36] | $8.9 \pm 1.7 \pm 1.2$ [37] | | | | $9.2 \pm 1.5$ |
| 382 | $K_1(1400)^+\rho^0$ | $< 780$ | $< 780$ ¶ [38] | | | | | $< 780$ ¶ |
| 383 | $K_2(1430)^+\rho^0$ | $< 1500$ | $< 1500$ ¶ [38] | | | | | $< 1500$ ¶ |
| 384 | $b_1^0K^+$ † | $9.1 \pm 2.0$ | $9.1 \pm 1.7 \pm 1.0$ [39] | | | | | $9.1 \pm 2.0$ |
| 385 | $b_1^+K^{*0}$ † | $< 5.9$ | $< 5.9$ [40] | | | | | $< 5.9$ |
| 386 | $b_1^0K^{*+}$ † | $< 6.7$ | $< 6.7$ [40] | | | | | $< 6.7$ |
| 387 | $K^+\overline{K}^0$ | $1.31 \pm 0.17$ | $1.61 \pm 0.44 \pm 0.09$ [1] | $1.11 \pm 0.19 \pm 0.05$ [2] | | | $1.52 \pm 0.21 \pm 0.05$ [41] | $1.32 \pm 0.14$ |
| 388 | $\overline{K}^0K^+\pi^0$ | $< 24$ | | | $< 24$ [30] | | | $< 24$ |
| 389 | $K^+K_SK_S$ | $10.8 \pm 0.6$ | $10.6 \pm 0.5 \pm 0.3$ [15] | $13.4 \pm 1.9 \pm 1.5$ [26] | | | | $10.8 \pm 0.6$ |
| 390 | $f_0(980)K^+$ $(K^+K_SK_S)$ | $14.7 \pm 3.3$ | $14.7 \pm 2.8 \pm 1.8$ [15] | | | | | $14.7 \pm 3.3$ |
| 391 | $f_0(1710)K^+$ $(K^+K_SK_S)$ | $0.48^{+0.40}_{-0.26}$ | $0.48^{+0.40}_{-0.24} \pm 0.11$ [15] | | | | | $0.48^{+0.41}_{-0.26}$ |
| 392 | $K^+K_SK_S$ $(NR)$ | $20 \pm 4$ | $19.8 \pm 3.7 \pm 2.5$ [15] | | | | | $19.8 \pm 4.5$ |
| 393 | $K_SK_S\pi^+$ | $< 0.51$ | $< 0.51$ [42] | $< 3.2$ [26] | | | | $< 0.51$ |
| 394 | $K^+K^-\pi^+$ | $5.0 \pm 0.7$ | $5.0 \pm 0.5 \pm 0.5$ [43] | $5.38 \pm 0.40 \pm 0.35$ [44] | | | | $5.24 \pm 0.42$ |
| 395 | $K^+K^-\pi^+$ $(NR)$ | $< 75$ | | | $< 75$ [28] | | | $< 75$ |
| 396 | $\overline{K}^{*0}K^+$ $(K^+K^-\pi^+)$ | $< 1.1$ | $< 1.1$ [45] | | | | | $< 1.1$ |
| 397 | $\overline{K}_0^*(1430)^0K^+$ $(K^+K^-\pi^+)$ | $< 2.2$ | $< 2.2$ [45] | | | | | $< 2.2$ |
| 398 | $K^+K^+\pi^-$ | $< 0.011$ | $< 0.16$ [25] | $< 2.4$ [26] | | | $< 0.011$ [27] | $< 0.011$ |
| 399 | $K^+K^+\pi^-$ $(NR)$ | $< 87.9$ | | | | | | $< 87.9$ |

Results for CDF and LHCb are relative BFs converted to absolute BFs.
CLEO upper limits that have been greatly superseded are not shown.
† In this product of BFs, all daughter BFs not shown are set to 100%.
¶ Result from ARGUS. Cited in the *BABAR* column to avoid adding a column to the table.

# Heavy FLavor AVeraging group (HFLAV) - December 2017

## $B^+$ Branching Fractions (decays with strange mesons part 3) ($\times 10^{-6}$) - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | *BABAR* | | Belle | | CLEO | CDF | LHCb | Our Avg. |
|---|---|---|---|---|---|---|---|---|---|---|
| 400 | $f_2'(1525)K^+$ | $1.8 \pm 0.5$ | $1.8 \pm 0.5$ ‡ | [15] | $< 8$ | [24] | | | | $1.8 \pm 0.5$ |
| 401 | $f_J(2220)K^+$ | $< 1.2$ | | | $< 1.2$ | [46] | | | | $< 1.2$ |
| 402 | $K^{*+}\pi^+K^-$ | $< 11.8$ | $< 11.8$ | [32] | | | | | | $< 11.8$ |
| 403 | $K^{*+}\overline{K}^{*0}$ | $0.91 \pm 0.29$ | $1.2 \pm 0.5 \pm 0.1$ | [47] | $0.77^{+0.35}_{-0.30} \pm 0.12$ | [48] | | | | $0.91^{+0.31}_{-0.28}$ |
| 404 | $K^{*+}K^+\pi^-$ | $< 6.1$ | $< 6.1$ | [32] | | | | | | $< 6.1$ |
| 405 | $K^+K^-K^+$ | $34.0 \pm 1.4$ | $34.6 \pm 0.6 \pm 0.9$ | [15] | $30.6 \pm 1.2 \pm 2.3$ | [24] | | | | $34.0 \pm 1.0$ |
| 406 | $\phi K^+$ $(K^+K^-K^+)$ | $8.8^{+0.7}_{-0.6}$ | $9.2 \pm 0.4^{+0.7}_{-0.5}$ | [15] | $9.6 \pm 0.9^{+1.1}_{-0.8}$ | [24] | $5.5^{+2.1}_{-1.8} \pm 0.6$ | $7.6 \pm 1.3 \pm 0.6$ [50] | | $8.8 \pm 0.5$ |
| 407 | $f_0(980)K^+$ $(K^+K^-K^+)$ | $9.4 \pm 3.2$ | $9.4^{+1.6}_{-2.8}$ | [15] | | | [49] | | | $9.4^{+1.6}_{-2.8}$ |
| 408 | $a_2(1320)K^+$ $(K^+K^-K^+)$ † | $< 1.1$ | | | $< 1.1$ | [24] | | | | $< 1.1$ |
| 409 | $X_0(1550)K^+$ $(K^+K^-K^+)$ | $4.3 \pm 0.7$ | $4.3 \pm 0.60 \pm 0.30$ | [51] | | | | | | $4.30 \pm 0.67$ |
| 410 | $\phi(1680)K^+$ $(K^+K^-K^+)$ † | $< 0.8$ | | | $< 0.8$ | [24] | | | | $< 0.8$ |
| 411 | $f_0(1710)K^+$ $(K^+K^-K^+)$ † | $1.1 \pm 0.6$ | $1.12 \pm 0.25 \pm 0.50$ | [15] | | | | | | $1.12 \pm 0.56$ |
| 412 | $K^+K^-K^+$ $(NR)$ | $23.8^{+2.8}_{-5.0}$ | $22.8 \pm 2.7 \pm 7.6$ | [15] | $24.0 \pm 1.5^{+2.6}_{-6.0}$ | [24] | | | | $23.8^{+2.9}_{-5.1}$ |
| 413 | $K^{*+}K^+K^-$ | $36 \pm 5$ | $36.2 \pm 3.3 \pm 3.6$ | [32] | | | | | | $36.2 \pm 4.9$ |
| 414 | $\phi K^{*+}$ | $10.0 \pm 2.0$ | $11.2 \pm 1.0 \pm 0.9$ | [52] | $6.7^{+2.1+0.7}_{-1.9-1.0}$ | [53] | $10.6^{+6.4+1.8}_{-4.9-1.6}$ | [49] | | $10.0 \pm 1.1$ |
| 415 | $\phi(K\pi)_0^{*+}$ | $8.3 \pm 1.6$ | $8.3^{+1.4}_{-0.8}$ | [54] | | | | | | $8.3^{+1.4}_{-0.8}$ |
| 416 | $\phi K_1(1270)^+$ | $6.1 \pm 1.9$ | $6.1 \pm 1.6 \pm 1.1$ | [54] | | | | | | $6.1 \pm 1.9$ |
| 417 | $\phi K_1(1400)^+$ | $< 3.2$ | $< 3.2$ | [54] | | | | | | $< 3.2$ |
| 418 | $\phi K^*(1410)^+$ | $< 4.3$ | $< 4.3$ | [54] | | | | | | $< 4.3$ |
| 419 | $\phi K_0^*(1430)^+$ | $7.0 \pm 1.6$ | $7.0 \pm 1.3 \pm 0.9$ | [54] | | | | | | $7.0 \pm 1.6$ |
| 420 | $\phi K_2^*(1430)^+$ | $8.4 \pm 2.1$ | $8.4 \pm 1.8 \pm 1.0$ | [54] | | | | | | $8.4 \pm 2.1$ |
| 421 | $\phi K_2(1770)^+$ | $< 15$ | $< 15$ | [54] | | | | | | $< 15$ |
| 422 | $\phi K_2(1820)^+$ | $< 16.3$ | $< 16.3$ | [54] | | | | | | $< 16.3$ |
| 423 | $a_1^+K^{*0}$ | $< 3.6$ | $< 3.6$ | [55] | | | | | | $< 3.6$ |
| 424 | $\phi\phi K^+$ § | $5.0 \pm 1.2$ | $5.6 \pm 0.5 \pm 0.3$ | [56] | $2.6^{+1.1}_{-0.9} \pm 0.3$ | [46] | | | | $5.0 \pm 0.5$ |
| 425 | $\eta'\eta'K^+$ | $< 25$ | $< 25$ | [57] | | | | | | $< 25$ |
| 426 | $K^+\omega\phi$ | $< 1.9$ | | | $< 1.9$ | [58] | | | | $< 1.9$ |
| 427 | $K^+X(1812)$ † | $< 0.32$ | | | $< 0.32$ | [58] | | | | $< 0.32$ |

Results for CDF and LHCb are relative BFs converted to absolute BFs.
CLEO upper limits that have been greatly superseded are not shown.
† In this product of BFs, all daughter BFs not shown are set to 100%.
‡ Average of results in $K_S^0K^+K^-$, $K_S^0K_S^0K^+$ [15].
§ $M_{\phi\phi} < 2.85$ GeV/$c^2$.

# Heavy FLavor AVeraging group (HFLAV) - December 2017

## $B^+$ Branching Fractions (decays without strange mesons) ($\times 10^{-6}$) - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | *BABAR* | Belle | CLEO | CDF | LHCb | Our Avg. |
|---|---|---|---|---|---|---|---|---|
| 446 | $\pi^+\pi^0$ | $5.5 \pm 0.4$ | $5.02 \pm 0.46 \pm 0.29$ [4] | $5.86 \pm 0.26 \pm 0.38$ [2] | $4.6^{+1.8+0.6}_{-1.6-0.7}$ [3] | | | $5.48^{+0.35}_{-0.34}$ |
| 447 | $\pi^+\pi^+\pi^-$ | $15.2 \pm 1.4$ | $15.2 \pm 0.6 \pm 1.3$ [59] | | | | | $15.2 \pm 1.4$ |
| 448 | $\rho^0\pi^+$ | $8.3 \pm 1.2$ | $8.1 \pm 0.7^{+1.3}_{-1.6}$ [59] | $8.0^{+2.3}_{-2.0} \pm 0.7$ [60] | $10.4^{+3.3}_{-3.4} \pm 2.1$[18] | | | $8.3^{+1.2}_{-1.3}$ |
| 449 | $f_0(980)\pi^+$ † | $< 1.5$ | $< 1.5$ [59] | | | | | $< 1.5$ |
| 450 | $f_2(1270)\pi^+$ | $1.6^{+0.7}_{-0.4}$ | $1.57 \pm 0.42^{+0.55}_{-0.25}$ [59] | | | | | $1.57^{+0.69}_{-0.49}$ |
| 451 | $\rho(1450)^0\pi^+$ † | $1.4^{+0.6}_{-0.9}$ | $1.4 \pm 0.4^{+0.5}_{-0.8}$ [59] | | | | | $1.4^{+0.6}_{-0.9}$ |
| 452 | $f_0(1370)\pi^+$ † | $< 4.0$ | $< 4.0$ [59] | | | | | $< 4.0$ |
| 454 | $\pi^+\pi^-\pi^+(NR)$ | $5.3^{+1.5}_{-1.1}$ | $5.3 \pm 0.7^{+1.3}_{-0.8}$ [59] | | | | | $5.3^{+1.5}_{-1.1}$ |
| 455 | $\pi^+\pi^0\pi^0$ | $< 890$ | $< 890$ ‡ [61] | | | | | $< 890$ ‡ |
| 456 | $\rho^+\pi^0$ | $10.9 \pm 1.4$ | $10.2 \pm 1.4 \pm 0.9$ [62] | $13.2 \pm 2.3^{+1.4}_{-1.9}$ [63] | | | | $10.9^{+1.4}_{-1.5}$ |
| 458 | $\rho^+\rho^0$ | $24.0 \pm 1.9$ | $23.7 \pm 1.4 \pm 1.4$ [64] | $31.7 \pm 7.1^{+3.8}_{-6.7}$ [65] | | | | $24.0^{+1.9}_{-2.0}$ |
| 459 | $f_0(980)\rho^+$ † | $< 2.0$ | $< 2.0$ [64] | | | | | $< 2.0$ |
| 460 | $a_1^+\pi^0$ | $26 \pm 7$ | $26.4 \pm 5.4 \pm 4.1$ [66] | | | | | $26.4 \pm 6.8$ |
| 461 | $a_1^0\pi^+$ | $20 \pm 6$ | $20.4 \pm 4.7 \pm 3.4$ [66] | | | | | $20.4 \pm 5.8$ |
| 462 | $\omega\pi^+$ | $6.9 \pm 0.5$ | $6.7 \pm 0.5 \pm 0.4$ [16] | $6.9 \pm 0.6 \pm 0.5$ [67] | $11.3^{+3.3}_{-2.9} \pm 1.4$[18] | | | $6.9 \pm 0.5$ |
| 463 | $\omega\rho^+$ | $15.9 \pm 2.1$ | $15.9 \pm 1.6 \pm 1.4$ [19] | | | | | $15.9 \pm 2.1$ |
| 464 | $\eta\pi^+$ | $4.02 \pm 0.27$ | $4.00 \pm 0.40 \pm 0.24$ [5] | $4.07 \pm 0.26 \pm 0.21$ [9] | $1.2^{+2.8}_{-1.2}$ [10] | | | $4.02 \pm 0.27$ |
| 465 | $\eta\rho^+$ | $7.0 \pm 2.9$ | $9.9 \pm 1.2 \pm 0.8$ [68] | $4.1^{+1.4}_{-1.3} \pm 0.4$ [12] | $4.8^{+5.2}_{-3.8}$ [10] | | | $6.9 \pm 1.0$ |
| 466 | $\eta'\pi^+$ | $2.7 \pm 0.9$ | $3.5 \pm 0.6 \pm 0.2$ [5] | $1.8^{+0.7}_{-0.6} \pm 0.1$ [6] | $1.0^{+5.8}_{-1.0}$ [10] | | | $2.7^{+0.5}_{-0.4}$ |
| 467 | $\eta'\rho^+$ | $9.7 \pm 2.2$ | $9.7^{+1.9}_{-1.8} \pm 1.1$ [7] | $< 5.8$ [8] | | | | $9.7^{+2.2}_{-2.1}$ |
| 468 | $\phi\pi^+$ | $< 0.15$ | $< 0.24$ [69] | $< 0.33$ [70] | | | $< 0.15$[71] | $< 0.15$ |
| 469 | $\phi\rho^+$ | $< 3.0$ | $< 3.0$ [72] | | | | | $< 3.0$ |
| 470 | $a_0(980)^0\pi^+$ † | $< 5.8$ | $< 5.8$ [20] | | | | | $< 5.8$ |
| 471 | $a_0(980)^+\pi^0$ † | $< 1.4$ | $< 1.4$ [73] | | | | | $< 1.4$ |
| 472 | $\pi^+\pi^+\pi^+\pi^-\pi^-$ | $< 860$ | $< 860$ ‡ [61] | | | | | $< 860$ ‡ |
| 473 | $\rho^0 a_1(1260)^+$ | $< 620$ | | | $< 620$ [74] | | | $< 620$ |
| 474 | $\rho^0 a_2(1320)^+$ | $< 720$ | | | $< 720$ [74] | | | $< 720$ |
| 475 | $b_1^0\pi^+$ † | $6.7 \pm 2.0$ | $6.7 \pm 1.7 \pm 1.0$ [39] | | | | | $6.7 \pm 2.0$ |
| 476 | $b_1^+\pi^0$ † | $< 3.3$ | $< 3.3$ [35] | | | | | $< 3.3$ |
| 477 | $\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$ | $< 6300$ | $< 6300$ ‡ [61] | | | | | $< 6300$ ‡ |
| 478 | $b_1^+\rho^0$ † | $< 5.2$ | $< 5.2$ [40] | | | | | $< 5.2$ |
| 480 | $b_1^0\rho^+$ † | $< 3.3$ | $< 3.3$ [40] | | | | | $< 3.3$ |

Results for LHCb are relative BFs converted to absolute BFs.
CLEO upper limits that have been greatly superseded are not shown.
† In this product of BFs, all daughter BFs not shown are set to 100%.
‡ Result from ARGUS. Cited in the *BABAR* column to avoid adding a column to the table.

# Heavy FLavor AVeraging group (HFLAV) - December 2017

## $B^0$ Branching Fractions (decays with strange mesons part 1) ($\times 10^{-6}$) - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | *BABAR* | Belle | CLEO | CDF | LHCb | Our Avg. |
|---|---|---|---|---|---|---|---|---|
| 257 | $K^+\pi^-$ | $19.6 \pm 0.5$ | $19.1 \pm 0.6 \pm 0.6$ [75] | $20.0 \pm 0.34 \pm 0.60$ [2] | $18.0^{+2.3+1.2}_{-2.1-0.9}$ [3] | | | $19.57^{+0.53}_{-0.52}$ |
| 258 | $K^0\pi^0$ | $9.9 \pm 0.5$ | $10.1 \pm 0.6 \pm 0.4$ [76] | $9.68 \pm 0.46 \pm 0.50$ [2] | $12.8^{+4.0+1.7}_{-3.3-1.4}$ [3] | | | $9.93 \pm 0.49$ |
| 259 | $\eta' K^0$ | $66 \pm 4$ | $68.5 \pm 2.2 \pm 3.1$ [5] | $58.9^{+3.6}_{-3.5} \pm 4.3$ [6] | $89^{+18}_{-16} \pm 9$ [10] | | | $66.1 \pm 3.1$ |
| 260 | $\eta' K^{*0}$ | $2.8 \pm 0.6$ | $3.1^{+0.9}_{-0.8} \pm 0.3$ [7] | $2.6 \pm 0.7 \pm 0.2$ [77] | $7.8^{+7.7}_{-5.7}$ [10] | | | $2.8^{+0.6}_{-0.5}$ |
| 261 | $\eta' K_0^*(1430)^0$ | $6.3 \pm 1.6$ | $6.3 \pm 1.3 \pm 0.9$ [7] | | | | | $6.3 \pm 1.6$ |
| 262 | $\eta' K_2^*(1430)^0$ | $13.7 \pm 3.2$ | $13.7^{+3.0}_{-1.9} \pm 1.2$ [7] | | | | | $13.7^{+3.2}_{-2.2}$ |
| 263 | $\eta K^0$ | $1.23^{+0.27}_{-0.24}$ | $1.15^{+0.43}_{-0.38} \pm 0.09$ [5] | $1.27^{+0.33}_{-0.29} \pm 0.08$ [9] | $0.0^{+3.0}_{-0.0}$ [10] | | | $1.23^{+0.27}_{-0.24}$ |
| 264 | $\eta K^{*0}$ | $15.9 \pm 1.0$ | $16.5 \pm 1.1 \pm 0.8$ [11] | $15.2 \pm 1.2 \pm 1.0$ [12] | $13.8^{+5.5}_{-4.6} \pm 1.6$ [10] | | | $15.9 \pm 1.0$ |
| 265 | $\eta K_0^*(1430)^0$ | $11.0 \pm 2.2$ | $11.0 \pm 1.6 \pm 1.5$ [11] | | | | | $11.0 \pm 2.2$ |
| 266 | $\eta K_2^*(1430)^0$ | $9.6 \pm 2.1$ | $9.6 \pm 1.8 \pm 1.1$ [11] | | | | | $9.6 \pm 2.1$ |
| 267 | $\omega K^0$ | $4.8 \pm 0.4$ | $5.4 \pm 0.8 \pm 0.3$ [16] | $4.5 \pm 0.4 \pm 0.3$ [17] | $10.0^{+5.4}_{-4.2} \pm 1.4$ [18] | | | $4.8 \pm 0.4$ |
| 268 | $a_0(980)^0 K^0$ † | $< 7.8$ | $< 7.8$ [20] | | | | | $< 7.8$ |
| 269 | $b_1^0 K^0$ † | $< 7.8$ | $< 7.8$ [35] | | | | | $< 7.8$ |
| 270 | $a_0(980)^- K^+$ † | $< 1.9$ | $< 1.9$ [78] | | | | | $< 1.9$ |
| 271 | $b_1^- K^+$ † | $7.4 \pm 1.4$ | $7.4 \pm 1.0 \pm 1.0$ [39] | | | | | $7.4 \pm 1.4$ |
| 272 | $b_1^0 K^{*0}$ † | $< 8.0$ | $< 8.0$ [40] | | | | | $< 8.0$ |
| 273 | $b_1^- K^{*+}$ † | $< 5.0$ | $< 5.0$ [40] | | | | | $< 5.0$ |
| 274 | $a_0(1450)^- K^+$ † | $< 3.1$ | $< 3.1$ [78] | | | | | $< 3.1$ |
| 275 | $K_S X^0(\text{Familon})$ † | $< 53$ | | | $< 53$ [79] | | | $< 53$ |
| 276 | $\omega K^{*0}$ | $2.0 \pm 0.5$ | $2.2 \pm 0.6 \pm 0.2$ [19] | $1.8 \pm 0.7^{+0.3}_{-0.2}$ [80] | | | | $2.0 \pm 0.5$ |
| 277 | $\omega (K\pi)_0^{*0}$ | $18.4 \pm 2.5$ | $18.4^{+1.8}_{-1.7}$ [19] | | | | | $18.4^{+1.8}_{-1.7}$ |
| 278 | $\omega K_0^*(1430)^0$ | $16.0 \pm 3.4$ | $16.0 \pm 1.6 \pm 3.0$ [19] | | | | | $16.0 \pm 3.4$ |
| 279 | $\omega K_2^*(1430)^0$ | $10.1 \pm 2.3$ | $10.1 \pm 2.0 \pm 1.1$ [19] | | | | | $10.1 \pm 2.3$ |
| 280 | $\omega K^+\pi^-$ $(NR)$ [1] | $5.1 \pm 1.0$ | | $5.1 \pm 0.7 \pm 0.7$ [80] | | | | $5.1 \pm 1.0$ |
| 281 | $K^+\pi^-\pi^0$ | $37.8 \pm 3.2$ | $38.5 \pm 1.0 \pm 3.9$ [81] | $36.6^{+4.2}_{-4.3} \pm 3.0$ [82] | | | | $37.8 \pm 3.2$ |
| 282 | $\rho^- K^+$ | $7.0 \pm 0.9$ | $6.6 \pm 0.5 \pm 0.8$ [81] | $15.1^{+3.4+2.4}_{-3.3-2.6}$ [82] | | | | $7.0 \pm 0.9$ |
| 283 | $\rho(1450)^- K^+$ | $2.4 \pm 1.2$ | $2.4 \pm 1.0 \pm 0.6$ [81] | | | | | $2.4 \pm 1.2$ |
| 284 | $\rho(1700)^- K^+$ | $0.6 \pm 0.7$ | $0.6 \pm 0.6 \pm 0.4$ [81] | | | | | $0.6 \pm 0.7$ |
| 285 | $K^+\pi^-\pi^0$ $(NR)$ | $2.8 \pm 0.6$ | $2.8 \pm 0.5 \pm 0.4$ [81] | $< 9.4$ [82] | | | | $2.8 \pm 0.6$ |
| 286 | $(K\pi)_0^{*+}\pi^-$ | $34 \pm 5$ | $34.2 \pm 2.4 \pm 4.1$ [81] | | | | | $34.2 \pm 4.8$ |
| 287 | $(K\pi)_0^{*+}\pi^0$ | $8.6 \pm 1.7$ | $8.6^{+1.1}_{-1.3}$ [81] | | | | | $8.6^{+1.1}_{-1.3}$ |

Results for LHCb are relative BFs converted to absolute BFs.
CLEO upper limits that have been greatly superseded are not shown.
† In this product of BFs, all daughter BFs not shown are set to 100%.
[1] $0.755 < M(K\pi) < 1.250$ GeV/$c^2$.

# Heavy FLavor AVeraging group (HFLAV) - December 2017

## $B^0$ Branching Fractions (decays with strange mesons part 2) ($\times 10^{-6}$) - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | *BABAR* | | Belle | | CLEO | | CDF | | LHCb | | Our Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 288 | $K_2^*(1430)^0\pi^0$ | $< 4.0$ | $< 4.0$ | [83] | | | | | | | | | $< 4.0$ |
| 289 | $K^*(1680)^0\pi^0$ | $< 7.5$ | $< 7.5$ | [83] | | | | | | | | | $< 7.5$ |
| 290 | $K_x^{*0}\pi^0$ [2] | $6.1 \pm 1.6$ | | | $6.1^{+1.6+0.5}_{-1.5-0.6}$ | [82] | | | | | | | $6.1^{+1.7}_{-1.6}$ |
| 291 | $K^0\pi^+\pi^-$ | $52.0 \pm 2.4$ | $50.2 \pm 1.5 \pm 1.8$ | [84] | $47.5 \pm 2.4 \pm 3.7$ | [85] | $50^{+10}_{-9} \pm 7$ | [30] | | | $48.8^{+3.2}_{-2.8}$ § | [86] | $49.4 \pm 1.7$ |
| 292 | $K^0\pi^+\pi^-$ $(NR)$ | $14.7^{+4.0}_{-2.6}$ | $11.1^{+2.5}_{-1.0} \pm 0.9$ | [84] | $19.9 \pm 2.5^{+1.7}_{-2.0}$ | [85] | | | | | | | $14.7 \pm 2.0$ |
| 293 | $\rho^0 K^0$ | $4.7 \pm 0.6$ | $4.4 \pm 0.7 \pm 0.3$ | [84] | $6.1 \pm 1.0^{+1.1}_{-1.2}$ | [85] | | | | | | | $4.7 \pm 0.7$ |
| 294 | $K^{*+}\pi^-$ | $8.4 \pm 0.8$ | $8.2 \pm 0.9$ [3] | [81, 84] | $8.4 \pm 1.1^{+1.0}_{-0.9}$ | [85] | $16^{+6}_{-5} \pm 2$ | [30] | | | | | $8.4 \pm 0.8$ |
| 295 | $K_0^*(1430)^+\pi^-$ | $33 \pm 7$ | $29.9^{+2.3}_{-1.7} \pm 3.6$ | [84] | $49.7 \pm 3.8^{+6.8}_{-8.2}$ | [85] | | | | | | | $33.5^{+3.9}_{-3.8}$ |
| 296 | $K_x^{*+}\pi^-$ [2] | $5.1 \pm 1.6$ | | | $5.1^{+1.5+0.6}_{-1.5-0.7}$ | [82] | | | | | | | $5.1^{+1.6}_{-1.7}$ |
| 297 | $K^*(1410)^+\pi^-$ † | $< 3.8$ | | | $< 3.8$ | [85] | | | | | | | $< 3.8$ |
| 298 | $f_0(980)K^0$ † | $7.0 \pm 0.9$ | $6.9 \pm 0.8 \pm 0.6$ | [84] | $7.6 \pm 1.7^{+0.9}_{-1.3}$ | [85] | | | | | | | $7.0 \pm 0.9$ |
| 299 | $f_2(1270)^0 K^0$ | $2.7^{+1.3}_{-1.2}$ | $2.7^{+1.0}_{-0.8} \pm 0.9$ | [84] | $< 2.5$ † | [85] | | | | | | | $2.7^{+1.3}_{-1.2}$ |
| 300 | $f_x(1300)^0 K^0$ | $1.8 \pm 0.7$ | $1.81^{+0.55}_{-0.45} \pm 0.48$ | [84] | | | | | | | | | $1.81^{+0.73}_{-0.66}$ |
| 301 | $K^{*0}\pi^0$ | $3.3 \pm 0.6$ | $3.3 \pm 0.5 \pm 0.4$ | [81] | $< 3.5$ | [82] | | | | | | | $3.3 \pm 0.6$ |
| 302 | $K_2^*(1430)^+\pi^-$ | $< 6$ | $< 16.2$ | [83] | $< 6.3$ | [85] | | | | | | | $< 6.3$ |
| 303 | $K^*(1680)^+\pi^-$ | $< 10$ | $< 25$ | [83] | $< 10.1$ | [85] | | | | | | | $< 10.1$ |
| 304 | $K^+\pi^-\pi^+\pi^-$ | $< 230$ | $< 230$ [4] | [87] | | | | | | | | | $< 230$ [4] |
| 305 | $\rho^0 K^+\pi^-$ | $2.8 \pm 0.7$ | | | $2.8 \pm 0.5 \pm 0.5$ [2] | [88] | | | | | | | $2.8 \pm 0.7$ |
| 306 | $f_0(980)K^+\pi^-$ | $1.4^{+0.5}_{-0.6}$ | | | $1.4 \pm 0.4^{+0.3}_{-0.4}$ [2] | [88] | | | | | | | $1.4^{+0.5}_{-0.6}$ |
| 307 | $K^+\pi^-\pi^+\pi^-$ $(NR)$ | $< 2.1$ | | | | | $< 2.1$ | [88] | | | | | $< 2.1$ |
| 308 | $K^{*0}\pi^+\pi^-$ | $55 \pm 5$ | $54.5 \pm 2.9 \pm 4.3$ | [89] | | | | | | | | | $54.5 \pm 5.2$ |
| 309 | $K^{*0}\rho^0$ | $3.9 \pm 1.3$ | $5.1 \pm 0.6^{+0.6}_{-0.8}$ | [90] | $2.1^{+0.8+0.9}_{-0.7-0.5}$ | [88] | | | | | | | $3.9 \pm 0.8$ |
| 310 | $f_0(980)K^{*0}$ † | $3.9^{+2.1}_{-1.8}$ | $5.7 \pm 0.6 \pm 0.4$ | [90] | $1.4^{+0.6+0.6}_{-0.5-0.4}$ | [88] | | | | | | | $3.9 \pm 0.5$ |
| 311 | $K_1(1270)^+\pi^-$ | $< 30$ | $17^{+6}_{-25}$ | [29] | | | | | | | | | $17^{+6}_{-25}$ |
| 312 | $K_1(1400)^+\pi^-$ | $< 27$ | $16^{+8}_{-24}$ | [29] | | | | | | | | | $16^{+8}_{-24}$ |
| 313 | $a_1^- K^+$ | $16 \pm 4$ | $16.3 \pm 2.9 \pm 2.3$ | [34] | | | | | | | | | $16.3 \pm 3.7$ |
| 314 | $K^{*+}\rho^-$ | $10.3 \pm 2.6$ | $10.3 \pm 2.3 \pm 1.3$ | [90] | | | | | | | | | $10.3 \pm 2.6$ |
| 315 | $K_0(1430)^+\rho^-$ | $28 \pm 12$ | $28 \pm 10 \pm 6$ | [90] | | | | | | | | | $28 \pm 11$ |
| 316 | $K_1(1400)^0\rho^0$ | $< 3000$ | $28 \pm 10 \pm 6$ [5] | [38] | | | | | | | | | $28 \pm 11$ |
| 317 | $K_0^*(1430)^0\rho^0$ | $27 \pm 6$ | $27 \pm 4 \pm 4$ | [90] | | | | | | | | | $27 \pm 5$ |
| 318 | $K_0^*(1430)^0 f_0(980)$ | $2.7 \pm 0.9$ | $2.7 \pm 0.7 \pm 0.6$ | [90] | | | | | | | | | $2.7 \pm 0.9$ |
| 319 | $K_2^*(1430)^0 f_0(980)$ | $8.6 \pm 2.0$ | $8.6 \pm 1.7 \pm 1.0$ | [90] | | | | | | | | | $8.6 \pm 2.0$ |
| 320 | $K^+K^-$ | $0.078 \pm 0.015$ | $< 0.5$ | [75] | $0.10 \pm 0.08 \pm 0.04$ | [2] | | | $0.23 \pm 0.10 \pm 0.10$ | [91] | $0.0780 \pm 0.0127 \pm 0.0084$ | [92] | $0.0803 \pm 0.0147$ |
| 321 | $K^0\overline{K}^0$ | $1.21 \pm 0.16$ | $1.08 \pm 0.28 \pm 0.11$ | [1] | $1.26 \pm 0.19 \pm 0.05$ | [2] | | | | | | | $1.21 \pm 0.16$ |
| 322 | $K^0K^-\pi^+$ | $6.5 \pm 0.8$ | $6.4 \pm 1.0 \pm 0.6$ | [93] | $< 18$ | [26] | | | | | $6.07 \pm 0.84$ [1] | [86] | $6.18 \pm 0.68$ |
| 323 | $K^{*\mp}K^{\pm}$ | | | | | | | | | | $< 0.4$ | [94] | $< 0.4$ |
| 324 | $K^{*0}\overline{K}^0$ ‡ | $< 0.96$ | $< 1.9$ | [95] | | | | | | | $< 0.96$ | [96] | $< 0.96$ |
| 325 | $K^+K^-\pi^0$ | $2.2 \pm 0.6$ | | | $2.17 \pm 0.60 \pm 0.24$ | [97] | | | | | | | $2.17 \pm 0.65$ |
| 326 | $K_S K_S \pi^0$ | $< 0.9$ | $< 0.9$ | [98] | | | | | | | | | $< 0.9$ |
| 327 | $K_S K_S \eta$ | $< 1.0$ | $< 1.0$ | [98] | | | | | | | | | $< 1.0$ |
| 328 | $K_S K_S \eta'$ | $< 2.0$ | $< 2.0$ | [98] | | | | | | | | | $< 2.0$ |
| 329 | $K^+K^-K^0$ | $24.9 \pm 3.1$ | $26.5 \pm 0.9 \pm 0.8$ | [15] | $28.3 \pm 3.3 \pm 4.0$ | [26] | | | | | $27.3 \pm 1.9$ [1] | [86] | $26.8 \pm 1.0$ |
| 330 | $\phi K^0$ | $7.3 \pm 0.7$ | $7.1 \pm 0.6^{+0.4}_{-0.3}$ | [15] | $9.0^{+2.2}_{-1.8} \pm 0.7$ | [53] | $5.4^{+3.7}_{-2.7} \pm 0.7$ | [49] | | | | | $7.3^{+0.7}_{-0.6}$ |
| 331 | $f_0(980)K^0$ † | $7.0^{+3.5}_{-3.0}$ | $7.0^{+2.6}_{-1.8} \pm 2.4$ | [15] | | | | | | | | | $7.0^{+3.5}_{-3.0}$ |

Results for CDF and LHCb are relative BFs converted to absolute BFs.
CLEO upper limits that have been greatly superseded are not shown.
† In this product of BFs, all daughter BFs not shown are set to 100%. ‡ Includes two distinct decay processes: $\mathcal{B}(B^0 \to f) + \mathcal{B}(B^0 \to \bar{f})$.
§ Obtained from a fit to the ratios of BFs measured by LHCb (Ref. [86]) and to the averages of the BFs in their numerators, as measured by other experiments (RPP 322 and 329).
[1] Obtained from a fit to the ratios of BFs measured by LHCb (Ref. [86]) and to the averages of the BFs therein, as measured by other experiments (excluding the present line).
[2] $0.75 < M(K\pi) < 1.20$ GeV/$c^2$. [3] Average of *BABAR* results from $B^0 \to K^+\pi^-\pi^0$ [81] and $B^0 \to K^0\pi^+\pi^-$ [84].
[4] Result from DELPHI. Cited in the *BABAR*column to avoid adding a column to the table.
[5] Result from ARGUS. Cited in the *BABAR*column to avoid adding a column to the table.

# Heavy FLavor AVeraging group (HFLAV) - December 2017

## $B^0$ Branching Fractions (decays with strange mesons part 3) ($\times 10^{-6}$) - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | *BABAR* | | Belle | | CLEO | | CDF | LHCb | Our Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 332 | $f_0(1500)K^0$ † | $13^{+7}_{-5}$ | $13.3^{+5.8}_{-4.4} \pm 3.2$ | [15] | | | | | | | $13.3^{+6.6}_{-5.4}$ |
| 333 | $f_2'(1525)K^0$ | $0.3^{+0.5}_{-0.4}$ | $0.29^{+0.27}_{-0.18} \pm 0.36$ | [15] | | | | | | | $0.29^{+0.45}_{-0.40}$ |
| 334 | $f_0(1710)K^0$ † | $4.4 \pm 0.9$ | $4.4 \pm 0.7 \pm 0.5$ | [15] | | | | | | | $4.4 \pm 0.9$ |
| 335 | $K^0K^+K^-$ $(NR)$ | $33 \pm 10$ | $33 \pm 5 \pm 9$ | [15] | | | | | | | $33 \pm 10$ |
| 336 | $K_SK_SK_S$ | $6.0 \pm 0.5$ | $6.19 \pm 0.48 \pm 0.19$ | [99] | $4.2^{+1.6}_{-1.3} \pm 0.8$ | [26] | | | | | $6.04 \pm 0.50$ |
| 337 | $f_0(980)K_S$ † | $2.7 \pm 1.8$ | $2.7^{+1.3}_{-1.2} \pm 1.3$ † | [99] | | | | | | | $2.7 \pm 1.8$ |
| 338 | $f_0(1710)K_S$ † | $0.50^{+0.50}_{-0.26}$ | $0.50^{+0.46}_{-0.24} \pm 0.11$ † | [99] | | | | | | | $0.50^{+0.47}_{-0.26}$ |
| 339 | $f_0(2010)K_S$ † | $0.5 \pm 0.6$ | $0.54^{+0.21}_{-0.20} \pm 0.52$ † | [99] | | | | | | | $0.54 \pm 0.56$ |
| 340 | $K_SK_SK_S$ $(NR)$ | $13.3 \pm 3.1$ | $13.3^{+2.2}_{-2.3} \pm 2.2$ | [99] | | | | | | | $13.3^{+3.1}_{-3.2}$ |
| 341 | $K_SK_SK_L$ | $< 16$ | $< 16$ [2] | [100] | | | | | | | $< 16$ [2] |
| 342 | $K^{*0}K^+K^-$ | $27.5 \pm 2.6$ | $27.5 \pm 1.3 \pm 2.2$ | [89] | | | | | | | $27.5 \pm 2.6$ |
| 343 | $\phi K^{*0}$ | $10.0 \pm 0.5$ | $9.7 \pm 0.5 \pm 0.6$ | [101] | $10.4 \pm 0.5 \pm 0.6$ | [102] | $11.5^{+4.5+1.8}_{-3.7-1.7}$ | [49] | | | $10.1^{+0.6}_{-0.5}$ |
| 344 | $K^+\pi^-\pi^+K^-$ $(NR)$ | $< 71.7$ | | | $< 71.7$ [3] | [103] | | | | | $< 71.7$ [3] |
| 345 | $K^{*0}\pi^+K^-$ | $4.5 \pm 1.3$ | $4.6 \pm 1.1 \pm 0.8$ | [89] | $< 13.9$ [3] | [103] | | | | | $4.6 \pm 1.4$ |
| 346 | $K^{*0}\overline{K}^{*0}$ | $0.8 \pm 0.5$ | $1.28^{+0.35}_{-0.30} \pm 0.11$ | [104] | $0.26^{+0.33+0.10}_{-0.29-0.08}$ | [103] | | | | | $0.81 \pm 0.23$ |
| 347 | $K^+\pi^-K^+\pi^-$ $(NR)$ | $< 6.0$ | | | $< 6.0$ [3] | [103] | | | | | $< 6.0$ [3] |
| 348 | $K^{*0}K^+\pi^-$ | $< 2.2$ | $< 2.2$ | [89] | $< 7.6$ [3] | [103] | | | | | $< 2.2$ |
| 349 | $K^{*0}K^{*0}$ | $< 0.2$ | $< 0.41$ | [104] | $< 0.2$ | [103] | | | | | $< 0.2$ |
| 350 | $K^{*+}K^{*-}$ | $< 2.0$ | $< 2.0$ | [105] | | | | | | | $< 2.0$ |
| 351 | $K_1^*(1400)^0\phi$ | $< 5000$ | $< 5000$ ‡ | [38] | | | | | | | $< 5000$ ‡ |
| 352 | $(K\pi)_0^{*0}\phi$ | $4.3 \pm 0.4$ | $4.3 \pm 0.4 \pm 0.4$ | [101] | $4.3 \pm 0.4 \pm 0.4$ | [102] | | | | | $4.3 \pm 0.4$ |
| 353 | $(K\pi)_0^{*0}\phi$ | $< 1.7$ | $< 1.7$ [4] | [106] | | | | | | | $< 1.7$ [4] |
| 354 | $K_0^*(1430)^0\pi^+K^-$ | $< 31.8$ | | | $< 31.8$ [3] | [103] | | | | | $< 31.8$ [3] |
| 355 | $K_0^*(1430)^0\overline{K}^{*0}$ | $< 3.3$ | | | $< 3.3$ | [103] | | | | | $< 3.3$ |
| 356 | $K_0^*(1430)^0\overline{K}_0^*(1430)^0$ | $< 8.4$ | | | $< 8.4$ | [103] | | | | | $< 8.4$ |
| 357 | $\phi K_0^*(1430)^0$ | $3.9 \pm 0.8$ | $3.9 \pm 0.5 \pm 0.6$ | [101] | $4.3 \pm 0.4 \pm 0.4$ | [102] | | | | | $4.2 \pm 0.5$ |
| 358 | $K_0^*(1430)^0K^{*0}$ | $< 1.7$ | | | $< 1.7$ | [103] | | | | | $< 1.7$ |
| 359 | $K_0^*(1430)^0K_0^*(1430)^0$ | $< 4.7$ | | | $< 4.7$ | [103] | | | | | $< 4.7$ |
| 360 | $\phi K^*(1680)^0$ | $< 3.5$ | $< 3.5$ | [106] | | | | | | | $< 3.5$ |
| 361 | $\phi K_3^*(1780)^0$ | $< 2.7$ | $< 2.7$ | [106] | | | | | | | $< 2.7$ |
| 362 | $\phi K_4^*(2045)^0$ | $< 15.3$ | $< 15.3$ | [106] | | | | | | | $< 15.3$ |
| 363 | $\rho^0K_2^*(1430)^0$ | $< 1100$ | $< 1100$ ‡ | [38] | | | | | | | $< 1100$ ‡ |
| 364 | $\phi K_2^*(1430)^0$ | $6.8 \pm 0.9$ | $7.5 \pm 0.9 \pm 0.5$ | [101] | $5.5^{+0.9}_{-0.7} \pm 1.0$ | [102] | | | | | $6.8 \pm 0.8$ |
| 365 | $\phi\phi K^0$ § | $4.5 \pm 0.9$ | $4.5 \pm 0.8 \pm 0.3$ | [56] | | | | | | | $4.5 \pm 0.9$ |
| 366 | $\eta'\eta'K^0$ | $< 31$ | $< 31$ | [57] | | | | | | | $< 31$ |

† In this product of BFs, all daughter BFs not shown are set to 100%. ‡ Result from ARGUS. Cited in the *BABAR* column to avoid adding a column to the table.
§ $M_{\phi\phi} < 2.85$ GeV/$c^2$.
[2] $0.75 < M(K\pi) < 1.20$ GeV/$c^2$. [3] $0.70 < M(K\pi) < 1.70$ GeV/$c^2$.
[4] $1.60 < M(K\pi) < 2.15$ GeV/$c^2$.

# Heavy FLavor AVeraging group (HFLAV) - December 2017

## $B^0$ Branching Fractions (decays without strange mesons part 1) ($\times 10^{-6}$) - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | *BABAR* | | Belle | | CLEO | | CDF | LHCb | | Our Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 387 | $\pi^+\pi^-$ | $5.12 \pm 0.19$ | $5.5 \pm 0.4 \pm 0.3$ | [75] | $5.04 \pm 0.21 \pm 0.18$ | [2] | $4.5^{+1.4}_{-1.2}{}^{+0.5}_{-0.4}$ | [3] | $5.02 \pm 0.33 \pm 0.35$ ‡ | [107] | $5.08 \pm 0.17 \pm 0.37$ [108] | $5.10 \pm 0.19$ |
| 388 | $\pi^0\pi^0$ | $1.91 \pm 0.22$ | $1.83 \pm 0.21 \pm 0.13$ | [76] | $1.31 \pm 0.19 \pm 0.18$ | [109] | | | | | | $1.59 \pm 0.18$ |
| 389 | $\eta\pi^0$ | $0.41 \pm 0.17$ | $< 1.5$ | [68] | $0.41^{+0.17}_{-0.15}{}^{+0.05}_{-0.07}$ | [110] | $< 2.9$ | [10] | | | | $0.41^{+0.18}_{-0.17}$ |
| 390 | $\eta\eta$ | $< 1.0$ | $< 1.0$ | [5] | $0.76^{+0.27}_{-0.23}{}^{+0.14}_{-0.16}$ | [111] | | | | | | $0.76^{+0.30}_{-0.28}$ |
| 391 | $\eta'\pi^0$ | $1.2 \pm 0.6$ | $0.9 \pm 0.4 \pm 0.1$ | [68] | $2.8 \pm 1.0 \pm 0.3$ | [6] | $0.0^{+1.8}_{-0.0}$ | [10] | | | | $1.2 \pm 0.4$ |
| 392 | $\eta'\eta'$ | $< 1.7$ | $< 1.7$ | [5] | $< 6.5$ | [8] | | | | | | $< 1.7$ |
| 393 | $\eta'\eta$ | $< 1.2$ | $< 1.2$ | [68] | $< 4.5$ | [8] | | | | | | $< 1.2$ |
| 394 | $\eta'\rho^0$ | $< 1.3$ | $< 2.8$ | [7] | $< 1.3$ | [8] | | | | | | $< 1.3$ |
| 395 | $f_0(980)\eta'$ † | $< 0.9$ | $< 0.9$ | [7] | | | | | | | | $< 0.9$ |
| 396 | $\eta\rho^0$ | $< 1.5$ | $< 1.5$ | [78] | $< 1.9$ | [12] | | | | | | $< 1.5$ |
| 397 | $f_0(980)\eta$ † | $< 0.4$ | $< 0.4$ | [78] | | | | | | | | $< 0.4$ |
| 398 | $\omega\eta$ | $0.94^{+0.40}_{-0.31}$ | $0.94^{+0.35}_{-0.30} \pm 0.09$ | [5] | | | | | | | | $0.94^{+0.36}_{-0.31}$ |
| 399 | $\omega\eta'$ | $1.0^{+0.5}_{-0.4}$ | $1.01^{+0.46}_{-0.38} \pm 0.09$ | [5] | $< 2.2$ | [8] | | | | | | $1.01^{+0.47}_{-0.39}$ |
| 400 | $\omega\rho^0$ | $< 1.6$ | $< 1.6$ | [19] | | | | | | | | $< 1.6$ |
| 401 | $f_0(980)\omega$ † | $< 1.5$ | $< 1.5$ | [19] | | | | | | | | $< 1.5$ |
| 402 | $\omega\omega$ | $1.2 \pm 0.4$ | $1.2 \pm 0.3^{+0.3}_{-0.2}$ | [112] | | | | | | | | $1.2 \pm 0.4$ |
| 403 | $\phi\pi^0$ | $< 0.15$ | $< 0.28$ | [69] | $< 0.15$ | [70] | | | | | | $< 0.15$ |
| 404 | $\phi\eta$ | $< 0.5$ | $< 0.5$ | [5] | | | | | | | | $< 0.5$ |
| 405 | $\phi\eta'$ | $< 0.5$ | $< 1.1$ | [5] | $< 0.5$ | [8] | | | | | | $< 0.5$ |
| 406 | $\phi\pi^+\pi^-$ | $0.18 \pm 0.05$ | | | | | | | | $0.182 \pm 0.048 \pm 0.014$ § | [113] | $0.182 \pm 0.050$ |
| 407 | $\phi\rho^0$ | $< 0.33$ | $< 0.33$ | [72] | | | | | | | | $< 0.33$ |
| 408 | $f_0(980)\phi$ † | $< 0.38$ | $< 0.38$ | [72] | | | | | | | | $< 0.38$ |
| 409 | $\omega\phi$ | $< 0.7$ | $< 0.7$ | [112] | | | | | | | | $< 0.7$ |
| 410 | $\phi\phi$ | $< 0.028$ | $< 0.2$ | [72] | | | | | | $< 0.028$ | [114] | $< 0.028$ |
| 411 | $a_0^{\mp}(980)\pi^{\pm}$ † | $< 3.1$ | $< 3.1$ | [78] | | | | | | | | $< 3.1$ |
| 412 | $a_0^{\mp}(1450)\pi^{\pm}$ † | $< 2.3$ | $< 2.3$ | [78] | | | | | | | | $< 2.3$ |
| 413 | $\pi^+\pi^-\pi^0$ | $< 720$ | $< 720$ ¶ | [61] | | | | | | | | $< 720$ ¶ |
| 414 | $\rho^0\pi^0$ | $2.0 \pm 0.5$ | $1.4 \pm 0.6 \pm 0.3$ | [115] | $3.0 \pm 0.5 \pm 0.7$ | [116] | $1.6^{+2.0}_{-1.4} \pm 0.8$ | [18] | | | | $2.0 \pm 0.5$ |
| 415 | $\rho^{\mp}\pi^{\pm}$ | $23.0 \pm 2.3$ | $22.6 \pm 1.8 \pm 2.2$ | [117] | $22.6 \pm 1.1 \pm 4.4$ | [116] | $27.6^{+8.4}_{-7.4} \pm 4.2$ | [18] | | | | $23.0 \pm 2.3$ |
| 416 | $\pi^+\pi^-\pi^+\pi^-$ | $< 11.2$ | $< 23.1$ | [118] | $< 11.2$ | [119] | | | | | | $< 11.2$ |
| 417 | $\rho^0\pi^+\pi^-(NR)$ | $< 8.8$ | $< 8.8$ | [118] | $< 12$ | [119] | | | | | | $< 8.8$ |
| 418 | $\rho^0\rho^0$ | $0.96 \pm 0.15$ | $0.92 \pm 0.32 \pm 0.14$ | [118] | $1.02 \pm 0.30 \pm 0.15$ | [119] | | | | $0.94 \pm 0.17 \pm 0.11$ ‡ | [120] | $0.95 \pm 0.16$ |
| 419 | $f_0(980)\pi^+\pi^-(NR)$ † | $< 3.0$ | | | $< 3.0$ | [119] | | | | | | $< 3.0$ |
| 420 | $f_0(980)\rho^0$ † | $0.78 \pm 0.25$ | $< 0.40$ | [118] | $0.78 \pm 0.22 \pm 0.11$ | [119] | | | | | | $0.78 \pm 0.25$ |
| 421 | $f_0(980)f_0(980), 4\pi$ †◇ | $< 0.19$ | $< 0.19$ | [118] | $< 0.2$ | [119] | | | | | | $< 0.19$ |
| 422 | $f_0(980)f_0(980), 2\pi 2K$ †[1] | $< 0.23$ | $< 0.23$ | [72] | | | | | | | | $< 0.23$ |
| 423 | $a_1^{\mp}\pi^{\pm}$ | $26 \pm 5$ | $33.2 \pm 3.8 \pm 3.0$ | [121] | $22.2 \pm 2.0 \pm 2.8$ | [122] | | | | | | $25.9 \pm 2.8$ |
| 424 | $a_2^{\mp}\pi^{\pm}$ | $< 6.3$ | | | $< 6.3$ | [122] | | | | | | $< 6.3$ |
| 425 | $\pi^+\pi^-\pi^0\pi^0$ | $< 3100$ | $< 3100$ ¶ | [61] | | | | | | | | $< 3100$ ¶ |
| 426 | $\rho^+\rho^-$ | $27.7 \pm 1.9$ | $25.5 \pm 2.1^{+3.6}_{-3.9}$ | [123] | $28.3 \pm 1.5 \pm 1.5$ | [124] | | | | | | $27.7 \pm 1.9$ |
| 427 | $a_1(1260)^0\pi^0$ | $< 1100$ | $< 1100$ ¶ | [61] | | | | | | | | $< 1100$ ¶ |
| 428 | $\omega\pi^0$ | $< 0.5$ | $< 0.5$ | [68] | $< 2.0$ | [67] | | | | | | $< 0.5$ |
| 429 | $\pi^+\pi^+\pi^-\pi^-\pi^0$ | $< 9000$ | $< 9000$ ¶ | [61] | | | | | | | | $< 9000$ ¶ |
| 430 | $a_1^{\pm}\rho^{\mp}$ | $< 61$ | $< 61$ | [125] | | | | | | | | $< 61$ |
| 431 | $a_1^0\rho^0$ | $< 2400$ | $< 2400$ ¶ | [61] | | | | | | | | $< 2400$ ¶ |

Results for CDF and LHCb are relative BFs converted to absolute BFs.
CLEO upper limits that have been greatly superseded are not shown.
† In this product of BFs, all daughter BFs not shown are set to 100%.
‡ Result given as $0.94 \pm 0.17 \pm 0.09 \pm 0.06$ where last error is from $\mathcal{B}(B^0 \to \phi K^{*0})$.
§ In the mass range $400 < m(\pi^+\pi^-) < 1600$ GeV/$c^2$.
¶ Result from ARGUS. Cited in the *BABAR* column to avoid adding a column to the table.
◇ Both $f_0(980)$ decay into $\pi^+\pi^-$.
[1] Using the final state $\pi^+\pi^- K^+ K^-$.

# Heavy FLavor AVeraging group (HFLAV) - December 2017

$B^0$ Branching Fractions (decays without strange mesons part 2) ($\times 10^{-6}$) - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | *BABAR* | | Belle | CLEO | CDF | LHCb | Our Avg. |
|---|---|---|---|---|---|---|---|---|---|
| 432 | $b_1^{\mp}\pi^{\pm}$ † | $10.9 \pm 1.5$ | $10.9 \pm 1.2 \pm 0.9$ | [39] | | | | | $10.9 \pm 1.5$ |
| 433 | $b_1^0\pi^0$ † | $< 1.9$ | $< 1.9$ | [35] | | | | | $< 1.9$ |
| 434 | $b_1^{\pm}\rho^{\mp}$ † | $< 1.4$ | $< 1.4$ | [40] | | | | | $< 1.4$ |
| 435 | $b_1^0\rho^0$ † | $< 3.4$ | $< 3.4$ | [40] | | | | | $< 3.4$ |
| 436 | $\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-$ | $< 3000$ | $< 3000$ ‡ | [61] | | | | | $< 3000$ ‡ |
| 437 | $a_1^{\pm}a_1^{\mp}$ | $11.8 \pm 2.6$ | $11.8 \pm 2.6$ | [126] | | | | | $11.8 \pm 2.6$ |
| 438 | $\pi+\pi^+\pi^+\pi^-\pi^-\pi^-\pi^0$ | $< 11000$ | $< 11000$ ‡ | [61] | | | | | $< 11000$ ‡ |

Results for CDF and LHCb are relative BFs converted to absolute BFs.
CLEO upper limits that have been greatly superseded are not shown.
† In this product of BFs, all daughter BFs not shown are set to 100%.
‡ Result from ARGUS. Cited in the *BABAR* column to avoid adding a column to the table.

# Heavy FLavor AVeraging group (HFLAV) - December 2017

## Compilation of $B^0$ relative Branching Fractions - UL at 90% CL

Preliminary  Updated results not included in PDG Live as of Dec. 31, 2017

| RPP# | Mode | PDG2017 Avg. | CDF | LHCb | | Our Avg. |
|---|---|---|---|---|---|---|
| 320 | $\mathcal{B}(B^0 \to K^+K^-)/\mathcal{B}(B^0 \to K^+\pi^-)$ | | $0.012 \pm 0.005 \pm 0.005$ [91] | $0.00398 \pm 0.00065 \pm 0.00042$ | [92] | $0.00416 \pm 0.00099$ |
| 323 | $\mathcal{B}(B^0 \to K^{*\mp}K^{\pm})/\mathcal{B}(B^0 \to K^{*+}\pi^-)$ | | | $< 0.05$ | [94] | $< 0.05$ |
| 324 | $\mathcal{B}(B^0 \to K^0_S K^{*0})/\mathcal{B}(B^0 \to K^0_S \pi^+\pi^-)$ † | | | $< 0.020$ | [96] | $< 0.020$ |
| 387 | $\mathcal{B}(B^0 \to \pi^+\pi^-)/\mathcal{B}(B^0 \to K^+\pi^-)$ | $0.261 \pm 0.015$ | $0.259 \pm 0.017 \pm 0.016$[107] | $0.262 \pm 0.009 \pm 0.017$ | [108] | $0.261 \pm 0.015$ |

† Numerator includes two distinct decay processes: $\mathcal{B}(B^0 \to f) + \mathcal{B}(B^0 \to \bar{f})$.

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