# $c\overline{c}$ MESONS
# (including possibly non-$q\overline{q}$ states)

$\boxed{\eta_c(1S)}$ $\qquad\qquad I^G(J^{PC}) = 0^+(0^{-+})$

Mass $m = 2983.9 \pm 0.4$ MeV $\quad$ (S = 1.2)
Full width $\Gamma = 32.0 \pm 0.7$ MeV

| $\eta_c(1S)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|
| **Decays involving hadronic resonances** | | | |
| $\eta'(958)\pi\pi$ | ( 1.87±0.26) % | | 1323 |
| $\eta'(958)K\overline{K}$ | ( 1.61±0.25) % | | 1131 |
| $\rho\rho$ | ( 1.5 ±0.4 ) % | | 1275 |
| $K^*(892)^0 K^-\pi^+ +$ c.c. | ( 1.5 ±0.5 ) % | | 1278 |
| $K^*(892)\overline{K}^*(892)$ | ( 6.3 ±1.2 ) $\times 10^{-3}$ | | 1196 |
| $K^*(892)^0\overline{K}^*(892)^0\pi^+\pi^-$ | ( 1.1 ±0.5 ) % | | 1073 |
| $\phi K^+ K^-$ | ( 2.9 ±1.4 ) $\times 10^{-3}$ | | 1104 |
| $\phi\phi$ | ( 1.58±0.19) $\times 10^{-3}$ | | 1089 |
| $\phi 2(\pi^+\pi^-)$ | < 4 $\times 10^{-3}$ | 90% | 1251 |
| $a_0(980)\pi$ | seen | | 1327 |
| $K^*(892)\overline{K} +$ c.c. | < 1.28 % | 90% | 1310 |
| $f_2(1270)\eta$ | seen | | 1145 |
| $f_2(1270)\eta'$ | seen | | 984 |
| $\omega\omega$ | ( 2.1 ±0.5 ) $\times 10^{-3}$ | | 1270 |
| $\omega\phi$ | < 2.5 $\times 10^{-4}$ | 90% | 1185 |
| $f_2(1270)f_2(1270)$ | ( 9.7 ±2.5 ) $\times 10^{-3}$ | | 774 |
| $f_2(1270)f'_2(1525)$ | ( 9.1 ±3.0 ) $\times 10^{-3}$ | | 524 |
| $f_0(500)\eta$ | seen | | − |
| $f_0(500)\eta'$ | seen | | − |
| $f_0(980)\eta$ | seen | | 1264 |
| $f_0(980)\eta'$ | seen | | 1130 |
| $f_0(1500)\eta$ | seen | | 1016 |
| $f_0(1710)\eta'$ | seen | | 623 |
| $f_0(2100)\eta'$ | seen | | † |
| $f_0(2200)\eta$ | seen | | 498 |
| $a_0(1320)\pi$ | seen | | − |
| $a_0(1450)\pi$ | seen | | 1140 |
| $a_0(1700)\pi$ | seen | | − |
| $a_0(1950)\pi$ | seen | | 860 |
| $K^*_0(1430)\overline{K}$ | seen | | − |
| $K^*_2(1430)\overline{K}$ | seen | | − |

| $K_0^*(1950)\overline{K}$ | | seen | | $-$ |

## Decays into stable hadrons

| Mode | | Fraction | CL | $p$ |
|---|---|---|---|---|
| $K\overline{K}\pi$ | | $(7.0 \pm 0.4)\%$ | | 1381 |
| $K\overline{K}\eta$ | | $(1.32\pm0.15)\%$ | | 1265 |
| $\eta\pi^+\pi^-$ | | $(1.7 \pm 0.5)\%$ | | 1428 |
| $\eta 2(\pi^+\pi^-)$ | | $(4.6 \pm1.4)\%$ | | 1386 |
| $K^+K^-\pi^+\pi^-$ | | $(6.5 \pm1.0)\times10^{-3}$ | | 1345 |
| $K^+K^-\pi^+\pi^-\pi^0$ | | $(3.4 \pm0.5)\%$ | | 1304 |
| $K^0K^-\pi^+\pi^-\pi^+$ +c.c. | | $(5.7 \pm1.6)\%$ | | $-$ |
| $K^+K^-2(\pi^+\pi^-)$ | | $(7.6 \pm2.4)\times10^{-3}$ | | 1254 |
| $2(K^+K^-)$ | | $(1.38\pm0.29)\times10^{-3}$ | | 1056 |
| $\pi^+\pi^-\pi^0$ | | $< 5 \times10^{-4}$ | 90% | 1476 |
| $\pi^+\pi^-\pi^0\pi^0$ | | $(4.8 \pm1.1)\%$ | | 1460 |
| $2(\pi^+\pi^-)$ | | $(8.7 \pm1.1)\times10^{-3}$ | | 1459 |
| $2(\pi^+\pi^-\pi^0)$ | | $(16.2 \pm2.1)\%$ | | 1409 |
| $3(\pi^+\pi^-)$ | | $(1.8 \pm0.4)\%$ | | 1407 |
| $p\overline{p}$ | | $(1.35\pm0.13)\times10^{-3}$ | | 1160 |
| $p\overline{p}\pi^0$ | | $(3.6 \pm1.4)\times10^{-3}$ | | 1101 |
| $\Lambda\overline{\Lambda}$ | | $(1.02\pm0.23)\times10^{-3}$ | | 991 |
| $K^+\overline{p}\Lambda$+ c.c. | | $(2.5 \pm0.4)\times10^{-3}$ | | 772 |
| $\overline{\Lambda}(1520)\Lambda$+ c.c. | | $(3.1 \pm1.3)\times10^{-3}$ | | 694 |
| $\Sigma^+\overline{\Sigma}^-$ | | $(2.1 \pm0.6)\times10^{-3}$ | | 901 |
| $\Xi^-\overline{\Xi}^+$ | | $(9.0 \pm2.6)\times10^{-4}$ | | 692 |
| $\pi^+\pi^-p\overline{p}$ | | $(5.5 \pm1.9)\times10^{-3}$ | | 1027 |

## Radiative decays

| Mode | | Fraction | | $p$ |
|---|---|---|---|---|
| $\gamma\gamma$ | | $(1.68\pm0.12)\times10^{-4}$ | | 1492 |

## Charge conjugation ($C$), Parity ($P$), Lepton Family number ($LF$) violating modes

| Mode | | | Fraction | CL | $p$ |
|---|---|---|---|---|---|
| $\pi^+\pi^-$ | $P,CP$ | $<$ | $1.1 \times10^{-4}$ | 90% | 1485 |
| $\pi^0\pi^0$ | $P,CP$ | $<$ | $4 \times10^{-5}$ | 90% | 1486 |
| $K^+K^-$ | $P,CP$ | $<$ | $6 \times10^{-4}$ | 90% | 1408 |
| $K_S^0 K_S^0$ | $P,CP$ | $<$ | $3.1 \times10^{-4}$ | 90% | 1407 |

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## $J/\psi(1S)$

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass $m = 3096.900 \pm 0.006$ MeV

Full width $\Gamma = 92.6 \pm 1.7$ keV   (S = 1.1)

| $J/\psi(1S)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | Scale factor/ Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|
| hadrons | $(87.7 \pm 0.5)\%$ | | $-$ |
| virtual$\gamma \to$ hadrons | $(13.50 \pm 0.30)\%$ | | $-$ |

| | | | | |
|---|---|---|---|---|
| $ggg$ | | $(64.1 \pm 1.0\ )\ \%$ | | $-$ |
| $\gamma gg$ | | $(\ 8.8 \pm 1.1\ )\ \%$ | | $-$ |
| $e^+e^-$ | | $(\ 5.971 \pm 0.032)\ \%$ | | 1548 |
| $e^+e^-\gamma$ | [a] | $(\ 8.8 \pm 1.4\ ) \times 10^{-3}$ | | 1548 |
| $\mu^+\mu^-$ | | $(\ 5.961 \pm 0.033)\ \%$ | | 1545 |

### Decays involving hadronic resonances

| | | | | |
|---|---|---|---|---|
| $\rho\pi$ | | $(\ 1.69 \pm 0.15\ )\ \%$ | S=2.4 | 1448 |
| $\rho^0\pi^0$ | | $(\ 5.6 \pm 0.7\ ) \times 10^{-3}$ | | 1448 |
| $a_2(1320)^0\pi^+\pi^- \to$ $2(\pi^+\pi^-)\pi^0$ | | $(\ 2.8 \pm 0.6\ ) \times 10^{-3}$ | | $-$ |
| $a_2(1320)^+\pi^-\pi^0 +$ c.c $\to$ $2(\pi^+\pi^-)\pi^0$ | | $(\ 3.7 \pm 0.7\ ) \times 10^{-3}$ | | $-$ |
| $a_2(1320)\rho$ | | $(\ 1.09 \pm 0.22\ )\ \%$ | | 1123 |
| $\eta\pi^+\pi^-$ | | $(\ 3.8 \pm 0.7\ ) \times 10^{-4}$ | | 1487 |
| $\eta\pi^+\pi^-\pi^0$ | | $(\ 1.17 \pm 0.20\ )\ \%$ | | 1470 |
| $\eta\pi^+\pi^-3\pi^0$ | | $(\ 4.9 \pm 1.0\ ) \times 10^{-3}$ | | 1419 |
| $\eta\rho$ | | $(\ 1.93 \pm 0.23\ ) \times 10^{-4}$ | | 1396 |
| $\eta\phi(2170) \to\ \eta\phi f_0(980) \to$ $\eta\phi\pi^+\pi^-$ | | $(\ 1.2 \pm 0.4\ ) \times 10^{-4}$ | | 628 |
| $\eta\phi(2170) \to$ $\eta K^*(892)^0\overline{K}^*(892)^0$ | | $<\ 2.52\ \ \ \ \ \ \times 10^{-4}$ | CL=90% | $-$ |
| $\eta K^\pm K^0_S\pi^\mp$ | [b] | $(\ 2.2 \pm 0.4\ ) \times 10^{-3}$ | | 1278 |
| $\eta K^*(892)^0\overline{K}^*(892)^0$ | | $(\ 1.15 \pm 0.26\ ) \times 10^{-3}$ | | 1003 |
| $\rho\eta'(958)$ | | $(\ 8.1 \pm 0.8\ ) \times 10^{-5}$ | S=1.6 | 1281 |
| $\rho^\pm\pi^\mp\pi^+\pi^-2\pi^0$ | | $(\ 2.8 \pm 0.8\ )\ \%$ | | 1364 |
| $\rho^+\rho^-\pi^+\pi^-\pi^0$ | | $(\ 6 \pm 4\ ) \times 10^{-3}$ | | 1186 |
| $\rho^+K^+K^-\pi^- +$ c.c $\to$ $K^+K^-\pi^+\pi^-\pi^0$ | | $(\ 3.5 \pm 0.8\ ) \times 10^{-3}$ | | $-$ |
| $\rho^\mp K^\pm K^0_S$ | | $(\ 1.9 \pm 0.4\ ) \times 10^{-3}$ | | 1269 |
| $\rho(1450)\pi \to\ \pi^+\pi^-\pi^0$ | | $(\ 2.3 \pm 0.7\ ) \times 10^{-3}$ | | $-$ |
| $\rho(1450)^\pm\pi^\mp \to\ K^0_S K^\pm\pi^\mp$ | | $(\ 3.5 \pm 0.6\ ) \times 10^{-4}$ | | $-$ |
| $\rho(1450)^0\pi^0 \to\ K^+K^-\pi^0$ | | $(\ 2.7 \pm 0.6\ ) \times 10^{-4}$ | | $-$ |
| $\rho(1450)\eta'(958) \to$ $\pi^+\pi^-\eta'(958)$ | | $(\ 3.3 \pm 0.7\ ) \times 10^{-6}$ | | $-$ |
| $\rho(1700)\pi \to\ \pi^+\pi^-\pi^0$ | | $(\ 1.7 \pm 1.1\ ) \times 10^{-4}$ | | $-$ |
| $\rho(2150)\pi \to\ \pi^+\pi^-\pi^0$ | | $(\ 8 \pm 40\ ) \times 10^{-6}$ | | $-$ |
| $\omega\pi^0$ | | $(\ 4.5 \pm 0.5\ ) \times 10^{-4}$ | S=1.4 | 1446 |
| $\omega\pi^0 \to\ \pi^+\pi^-\pi^0$ | | $(\ 1.7 \pm 0.8\ ) \times 10^{-5}$ | | $-$ |
| $\omega\pi^+\pi^-$ | | $(\ 8.5 \pm 1.0\ ) \times 10^{-3}$ | S=1.3 | 1435 |
| $\omega\pi^0\pi^0$ | | $(\ 3.4 \pm 0.8\ ) \times 10^{-3}$ | | 1436 |
| $\omega 3\pi^0$ | | $(\ 1.9 \pm 0.6\ ) \times 10^{-3}$ | | 1419 |
| $\omega f_2(1270)$ | | $(\ 4.3 \pm 0.6\ ) \times 10^{-3}$ | | 1142 |
| $\omega\eta$ | | $(\ 1.74 \pm 0.20\ ) \times 10^{-3}$ | S=1.6 | 1394 |
| $\omega\pi^+\pi^-\pi^0$ | | $(\ 4.0 \pm 0.7\ ) \times 10^{-3}$ | | 1418 |

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|---|---|---|---|---|
| $\omega\pi^0\eta$ | | $(\ 3.4\ \pm\ 1.7\ )\times 10^{-4}$ | | 1363 |
| $\omega\pi^+\pi^+\pi^-\pi^-$ | | $(\ 8.5\ \pm\ 3.4\ )\times 10^{-3}$ | | 1392 |
| $\omega\pi^+\pi^-2\pi^0$ | | $(\ 3.3\ \pm\ 0.5\ )\ \%$ | | 1394 |
| $\omega\eta'\pi^+\pi^-$ | | $(\ 1.12\ \pm\ 0.13\ )\times 10^{-3}$ | | 1173 |
| $\omega\eta'(958)$ | | $(\ 1.89\ \pm\ 0.18\ )\times 10^{-4}$ | | 1279 |
| $\omega f_0(980)$ | | $(\ 1.4\ \pm\ 0.5\ )\times 10^{-4}$ | | 1267 |
| $\omega f_0(1710)\to\ \omega K\overline{K}$ | | $(\ 4.8\ \pm\ 1.1\ )\times 10^{-4}$ | | 878 |
| $\omega f_1(1420)$ | | $(\ 6.8\ \pm\ 2.4\ )\times 10^{-4}$ | | 1062 |
| $\omega f_2'(1525)$ | | $<\ 2.2\ \ \ \ \ \ \ \ \ \ \times 10^{-4}$ | CL=90% | 1007 |
| $\omega X(1835)\to\ \omega p\overline{p}$ | | $<\ 3.9\ \ \ \ \ \ \ \ \ \ \times 10^{-6}$ | CL=95% | – |
| $\omega X(1835),\ X\to\ \eta'\pi^+\pi^-$ | | $<\ 6.2\ \ \ \ \ \ \ \ \ \ \times 10^{-5}$ | | – |
| $\omega K^+ K^-$ | | $(\ 1.52\ \pm\ 0.31\ )\times 10^{-3}$ | | 1268 |
| $\omega K^\pm K^0_S\pi^\mp$ | [b] | $(\ 3.4\ \pm\ 0.5\ )\times 10^{-3}$ | | 1210 |
| $\omega K\overline{K}$ | | $(\ 1.9\ \pm\ 0.4\ )\times 10^{-3}$ | | 1268 |
| $\omega K^*(892)\overline{K}+$ c.c. | | $(\ 6.1\ \pm\ 0.9\ )\times 10^{-3}$ | | 1097 |
| $\eta' K^{*\pm} K^\mp$ | | $(\ 1.48\ \pm\ 0.13\ )\times 10^{-3}$ | | – |
| $\eta' K^{*0}\overline{K}^0+$ c.c. | | $(\ 1.66\ \pm\ 0.21\ )\times 10^{-3}$ | | 1000 |
| $\eta' h_1(1415)\to\ \eta' K^*\overline{K}+$ c.c. | | $(\ 2.16\ \pm\ 0.31\ )\times 10^{-4}$ | | – |
| $\eta' h_1(1415)\to\ \eta' K^{*\pm} K^\mp$ | | $(\ 1.51\ \pm\ 0.23\ )\times 10^{-4}$ | | – |
| $\eta' h_1(1415)\to\ \gamma\eta'\eta'$ | | $(\ 4.7\ {}^{+\ 1.1}_{-\ 2.0}\ )\times 10^{-7}$ | | – |
| $\overline{K} K^*(892)+$c.c. $\to$ $K^0_S K^\pm\pi^\mp$ | | $(\ 5.0\ \pm\ 0.5\ )\times 10^{-3}$ | | – |
| $K^+ K^*(892)^-+$ c.c. | | $(\ 6.0\ {}^{+\ 0.8}_{-\ 1.0}\ )\times 10^{-3}$ | S=2.9 | 1373 |
| $K^+ K^*(892)^-+$ c.c. $\to$ $K^+ K^-\pi^0$ | | $(\ 2.69\ {}^{+\ 0.13}_{-\ 0.20}\ )\times 10^{-3}$ | | – |
| $K^+ K^*(892)^-+$ c.c. $\to$ $K^0 K^\pm\pi^\mp+$ c.c. | | $(\ 3.0\ \pm\ 0.4\ )\times 10^{-3}$ | | – |
| $K^0\overline{K}^*(892)^0+$ c.c. | | $(\ 4.2\ \pm\ 0.4\ )\times 10^{-3}$ | | 1373 |
| $K^0\overline{K}^*(892)^0+$ c.c. $\to$ $K^0 K^\pm\pi^\mp+$ c.c. | | $(\ 3.2\ \pm\ 0.4\ )\times 10^{-3}$ | | – |
| $\overline{K}^*(892)^0 K^+\pi^-+$ c.c. | | $(\ 5.7\ \pm\ 0.8\ )\times 10^{-3}$ | | 1343 |
| $K^*(892)^\pm K^\mp\pi^0$ | | $(\ 4.1\ \pm\ 1.3\ )\times 10^{-3}$ | | 1344 |
| $K^*(892)^+ K^0_S\pi^-+$ c.c. | | $(\ 2.0\ \pm\ 0.5\ )\times 10^{-3}$ | | 1342 |
| $K^*(892)^+ K^0_S\pi^-+$ c.c. $\to$ $K^0_S K^0_S\pi^+\pi^-$ | | $(\ 6.7\ \pm\ 2.2\ )\times 10^{-4}$ | | – |
| $K^*(892)^0 K^-\pi^++$ c.c. $\to$ $K^+ K^-\pi^+\pi^-$ | | $(\ 3.8\ \pm\ 0.5\ )\times 10^{-3}$ | | – |
| $K^*(892)^0 K^0_S\to\ \gamma K^0_S K^0_S$ | | $(\ 6.3\ {}^{+\ 0.6}_{-\ 0.5}\ )\times 10^{-6}$ | | – |
| $K^*(892)^0 K^0_S\pi^0$ | | $(\ 7\ \pm\ 4\ )\times 10^{-4}$ | | 1343 |
| $K^*(892)^\pm K^*(700)^\mp$ | | $(\ 1.1\ {}^{+\ 1.0}_{-\ 0.6}\ )\times 10^{-3}$ | | – |
| $K^*(892)^0\overline{K}^*(892)^0$ | | $(\ 2.3\ \pm\ 0.6\ )\times 10^{-4}$ | | 1266 |

| | | |
|---|---|---|
| $K^*(892)^\pm K^*(892)^\mp$ | $(\ 1.00\ {}^{+\ 0.22}_{-\ 0.40}\ ) \times 10^{-3}$ | 1266 |
| $K_1(1400)^\pm K^\mp$ | $(\ 3.8\ \pm\ 1.4\ ) \times 10^{-3}$ | 1170 |
| $K^*(1410)\overline{K} + $ c.c. $\rightarrow$ $K^\pm K^\mp \pi^0$ | $(\ 7\ \pm\ 4\ ) \times 10^{-5}$ | – |
| $K^*(1410)\overline{K} + $ c.c. $\rightarrow$ $K^0_S K^\pm \pi^\mp$ | $(\ 8\ \pm\ 6\ ) \times 10^{-5}$ | – |
| $K^*_2(1430)\overline{K} + $ c.c. $\rightarrow$ $K^\pm K^\mp \pi^0$ | $(\ 1.0\ \pm\ 0.5\ ) \times 10^{-4}$ | – |
| $K^*_2(1430)\overline{K} + $ c.c. $\rightarrow$ $K^0_S K^\pm \pi^\mp$ | $(\ 4.0\ \pm\ 1.0\ ) \times 10^{-4}$ | – |
| $\overline{K}^*_2(1430) K + $ c.c. | $<\ 4.0\ \times 10^{-3}$ CL=90% | 1158 |
| $K^*_2(1430)^+ K^- + $ c.c. $\rightarrow$ $K^+ K^- \pi^0$ | $(\ 2.69\ {}^{+\ 0.25}_{-\ 0.19}\ ) \times 10^{-4}$ | – |
| $K^*_2(1430)^0 K^- \pi^+ + $ c.c. $\rightarrow$ $K^+ K^- \pi^+ \pi^-$ | $(\ 2.6\ \pm\ 0.9\ ) \times 10^{-3}$ | – |
| $K^*_2(1430)^+ K^0_S \pi^- + $ c.c. | $(\ 3.6\ \pm\ 1.8\ ) \times 10^{-3}$ | 1116 |
| $\overline{K}^*_2(1430)^0 K^*(892)^0 + $ c.c. | $(\ 4.67\ \pm\ 0.29\ ) \times 10^{-3}$ | 1011 |
| $K^*_2(1430)^- K^*(892)^+ + $ c.c. | $(\ 3.4\ \pm\ 2.9\ ) \times 10^{-3}$ | 1011 |
| $K^*_2(1430)^- K^*(892)^+ + $ c.c. $\rightarrow$ $K^*(892)^+ K^0_S \pi^- + $ c.c. | $(\ 4\ \pm\ 4\ ) \times 10^{-4}$ | – |
| $K^*_2(1430)^0 \overline{K}^*_2(1430)^0$ | $<\ 2.9\ \times 10^{-3}$ CL=90% | 601 |
| $\overline{K}_2(1770)^0 K^*(892)^0 + $ c.c. $\rightarrow$ $K^*(892)^0 K^- \pi^+ + $ c.c. | $(\ 6.9\ \pm\ 0.9\ ) \times 10^{-4}$ | – |
| $K^*_2(1980)^+ K^- + $ c.c. $\rightarrow$ $K^+ K^- \pi^0$ | $(\ 1.10\ {}^{+\ 0.60}_{-\ 0.14}\ ) \times 10^{-5}$ | – |
| $K^*_4(2045)^+ K^- + $ c.c. $\rightarrow$ $K^+ K^- \pi^0$ | $(\ 6.2\ {}^{+\ 2.9}_{-\ 1.6}\ ) \times 10^{-6}$ | – |
| $K_1(1270)^\pm K^\mp$ | $<\ 3.0\ \times 10^{-3}$ CL=90% | 1240 |
| $K_1(1270) K^0_S \rightarrow \gamma K^0_S K^0_S$ | $(\ 8.5\ \pm\ 2.5\ ) \times 10^{-7}$ | – |
| $a_2(1320)^\pm \pi^\mp$ | [b] $<\ 4.3\ \times 10^{-3}$ CL=90% | 1263 |
| $\phi \pi^0$ | $3 \times 10^{-6}$ or $1 \times 10^{-7}$ | 1377 |
| $\phi \pi^+ \pi^-$ | $(\ 9.4\ \pm\ 1.5\ ) \times 10^{-4}$ S=1.7 | 1365 |
| $\phi \pi^0 \pi^0$ | $(\ 5.0\ \pm\ 1.0\ ) \times 10^{-4}$ | 1366 |
| $\phi 2(\pi^+ \pi^-)$ | $(\ 1.60\ \pm\ 0.32\ ) \times 10^{-3}$ | 1318 |
| $\phi \eta$ | $(\ 7.4\ \pm\ 0.6\ ) \times 10^{-4}$ S=1.2 | 1320 |
| $\phi \eta'(958)$ | $(\ 4.6\ \pm\ 0.5\ ) \times 10^{-4}$ S=2.2 | 1192 |
| $\phi \eta \eta'$ | $(\ 2.32\ \pm\ 0.17\ ) \times 10^{-4}$ | 885 |
| $\phi f_0(980)$ | $(\ 3.2\ \pm\ 0.9\ ) \times 10^{-4}$ S=1.9 | 1178 |
| $\phi f_0(980) \rightarrow \phi \pi^+ \pi^-$ | $(\ 2.60\ \pm\ 0.34\ ) \times 10^{-4}$ | – |
| $\phi f_0(980) \rightarrow \phi \pi^0 \pi^0$ | $(\ 1.8\ \pm\ 0.5\ ) \times 10^{-4}$ | – |
| $\phi \pi^0 f_0(980) \rightarrow \phi \pi^0 \pi^+ \pi^-$ | $(\ 4.5\ \pm\ 1.0\ ) \times 10^{-6}$ | – |

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|---|---|---|---|---|
| $\phi\pi^0 f_0(980) \to \phi\pi^0 p^0 \pi^0$ | ( 1.7 $\pm$ 0.6 ) $\times 10^{-6}$ | | | 1045 |
| $\phi f_0(980)\eta \to \eta\phi\pi^+\pi^-$ | ( 3.2 $\pm$ 1.0 ) $\times 10^{-4}$ | | | – |
| $\phi a_0(980)^0 \to \phi\eta\pi^0$ | ( 4.4 $\pm$ 1.4 ) $\times 10^{-6}$ | | | – |
| $\phi f_2(1270)$ | ( 3.2 $\pm$ 0.6 ) $\times 10^{-4}$ | | | 1036 |
| $\phi f_1(1285)$ | ( 2.6 $\pm$ 0.5 ) $\times 10^{-4}$ | | | 1032 |
| $\phi f_1(1285) \to$ $\phi\pi^0 f_0(980) \to$ $\phi\pi^0\pi^+\pi^-$ | ( 9.4 $\pm$ 2.8 ) $\times 10^{-7}$ | | | 952 |
| $\phi f_1(1285) \to$ $\phi\pi^0 f_0(980) \to \phi 3\pi^0$ | ( 2.1 $\pm$ 2.2 ) $\times 10^{-7}$ | | | 955 |
| $\phi\eta(1405) \to \phi\eta\pi^+\pi^-$ | ( 2.0 $\pm$ 1.0 ) $\times 10^{-5}$ | | | 946 |
| $\phi f_2'(1525)$ | ( 8 $\pm$ 4 ) $\times 10^{-4}$ | S=2.7 | | 877 |
| $\phi X(1835) \to \phi p\overline{p}$ | < 2.1 $\times 10^{-7}$ | CL=90% | | – |
| $\phi X(1835) \to \phi\eta\pi^+\pi^-$ | < 2.8 $\times 10^{-4}$ | CL=90% | | 578 |
| $\phi X(1870) \to \phi\eta\pi^+\pi^-$ | < 6.13 $\times 10^{-5}$ | CL=90% | | – |
| $\phi K\overline{K}$ | ( 1.77 $\pm$ 0.16 ) $\times 10^{-3}$ | S=1.3 | | 1179 |
| $\phi f_0(1710) \to \phi K\overline{K}$ | ( 3.6 $\pm$ 0.6 ) $\times 10^{-4}$ | | | 875 |
| $\phi K^+ K^-$ | ( 8.3 $\pm$ 1.1 ) $\times 10^{-4}$ | | | 1179 |
| $\phi K_S^0 K_S^0$ | ( 5.9 $\pm$ 1.5 ) $\times 10^{-4}$ | | | 1176 |
| $\phi K^\pm K_S^0 \pi^\mp$ | [b] ( 7.2 $\pm$ 0.8 ) $\times 10^{-4}$ | | | 1114 |
| $\phi K^*(892)\overline{K} +$ c.c. | ( 2.18 $\pm$ 0.23 ) $\times 10^{-3}$ | | | 969 |
| $b_1(1235)^\pm \pi^\mp$ | [b] ( 3.0 $\pm$ 0.5 ) $\times 10^{-3}$ | | | 1300 |
| $b_1(1235)^0 \pi^0$ | ( 2.3 $\pm$ 0.6 ) $\times 10^{-3}$ | | | 1300 |
| $f_2'(1525) K^+ K^-$ | ( 1.06 $\pm$ 0.35 ) $\times 10^{-3}$ | | | 897 |
| $\Delta(1232)^+ \overline{p}$ | < 1 $\times 10^{-4}$ | CL=90% | | 1100 |
| $\Delta(1232)^{++} \overline{p}\pi^-$ | ( 1.6 $\pm$ 0.5 ) $\times 10^{-3}$ | | | 1030 |
| $\Delta(1232)^{++} \overline{\Delta}(1232)^{--}$ | ( 1.10 $\pm$ 0.29 ) $\times 10^{-3}$ | | | 938 |
| $\overline{\Sigma}(1385)^0 p K^-$ | ( 5.1 $\pm$ 3.2 ) $\times 10^{-4}$ | | | 646 |
| $\Sigma(1385)^0 \overline{\Lambda} +$ c.c. | < 8.2 $\times 10^{-6}$ | CL=90% | | 911 |
| $\Sigma(1385)^- \overline{\Sigma}^+$ (or c.c.) | [b] ( 3.1 $\pm$ 0.5 ) $\times 10^{-4}$ | | | 855 |
| $\Sigma(1385)^- \overline{\Sigma}(1385)^+$ (or c.c.) | [b] ( 1.16 $\pm$ 0.05 ) $\times 10^{-3}$ | | | 697 |
| $\Sigma(1385)^0 \overline{\Sigma}(1385)^0$ | ( 1.07 $\pm$ 0.08 ) $\times 10^{-3}$ | | | 697 |
| $\Lambda(1520)\overline{\Lambda} +$ c.c. $\to \gamma\Lambda\overline{\Lambda}$ | < 4.1 $\times 10^{-6}$ | CL=90% | | – |
| $\overline{\Lambda}(1520)\Lambda +$ c.c. | < 1.80 $\times 10^{-3}$ | CL=90% | | 807 |
| $\Xi^0 \overline{\Xi}^0$ | ( 1.17 $\pm$ 0.04 ) $\times 10^{-3}$ | | | 818 |
| $\Xi(1530)^- \overline{\Xi}^+ +$ c.c. | ( 3.18 $\pm$ 0.08 ) $\times 10^{-4}$ | | | 600 |
| $\Xi(1530)^0 \overline{\Xi}^0$ | ( 3.2 $\pm$ 1.4 ) $\times 10^{-4}$ | | | 608 |
| $\Theta(1540)\overline{\Theta}(1540) \to$ $K_S^0 p K^- \overline{n} +$ c.c. | [c] < 1.1 $\times 10^{-5}$ | CL=90% | | – |
| $\Theta(1540) K^- \overline{n} \to K_S^0 p K^- \overline{n}$ | [c] < 2.1 $\times 10^{-5}$ | CL=90% | | – |
| $\Theta(1540) K_S^0 \overline{p} \to K_S^0 \overline{p} K^+ n$ | [c] < 1.6 $\times 10^{-5}$ | CL=90% | | – |
| $\overline{\Theta}(1540) K^+ n \to K_S^0 \overline{p} K^+ n$ | [c] < 5.6 $\times 10^{-5}$ | CL=90% | | – |
| $\overline{\Theta}(1540) K_S^0 p \to K_S^0 p K^- \overline{n}$ | [c] < 1.1 $\times 10^{-5}$ | CL=90% | | – |

## Decays into stable hadrons

| | | | |
|---|---|---|---|
| $2(\pi^+\pi^-)\pi^0$ | ( 4.2 $\pm$ 0.4 ) % | S=2.1 | 1496 |
| $3(\pi^+\pi^-)\pi^0$ | ( 2.9 $\pm$ 0.6 ) % | | 1433 |
| $\pi^+\pi^- 3\pi^0$ | ( 1.9 $\pm$ 0.9 ) % | | 1497 |
| $\pi^+\pi^- 4\pi^0$ | ( 6.5 $\pm$ 1.3 ) $\times 10^{-3}$ | | 1470 |
| $\rho^\pm\pi^\mp\pi^0\pi^0$ | ( 1.41 $\pm$ 0.22 ) % | | 1421 |
| $\rho^+\rho^-\pi^0$ | ( 6.0 $\pm$ 1.1 ) $\times 10^{-3}$ | | 1298 |
| $\pi^+\pi^-\pi^0$ | ( 2.10 $\pm$ 0.08 ) % | S=1.6 | 1533 |
| $2(\pi^+\pi^-\pi^0)$ | ( 1.61 $\pm$ 0.20 ) % | | 1468 |
| $\pi^+\pi^-\pi^0 K^+ K^-$ | ( 1.52 $\pm$ 0.27 ) % | S=1.4 | 1368 |
| $\pi^+\pi^-$ | ( 1.47 $\pm$ 0.14 ) $\times 10^{-4}$ | | 1542 |
| $2(\pi^+\pi^-)$ | ( 3.20 $\pm$ 0.25 ) $\times 10^{-3}$ | S=1.2 | 1517 |
| $3(\pi^+\pi^-)$ | ( 4.3 $\pm$ 0.4 ) $\times 10^{-3}$ | | 1466 |
| $2(\pi^+\pi^-)3\pi^0$ | ( 6.2 $\pm$ 0.9 ) % | | 1435 |
| $4(\pi^+\pi^-)\pi^0$ | ( 9.0 $\pm$ 3.0 ) $\times 10^{-3}$ | | 1345 |
| $2(\pi^+\pi^-)\eta$ | ( 2.29 $\pm$ 0.28 ) $\times 10^{-3}$ | | 1446 |
| $3(\pi^+\pi^-)\eta$ | ( 7.2 $\pm$ 1.5 ) $\times 10^{-4}$ | | 1379 |
| $2(\pi^+\pi^-\pi^0)\eta$ | ( 1.6 $\pm$ 0.5 ) $\times 10^{-3}$ | | 1381 |
| $\pi^+\pi^-\pi^0\pi^0\eta$ | ( 2.4 $\pm$ 0.5 ) $\times 10^{-3}$ | | 1448 |
| $\rho^\pm\pi^\mp\pi^0\eta$ | ( 1.9 $\pm$ 0.8 ) $\times 10^{-3}$ | | 1326 |
| $K^+ K^-$ | ( 2.86 $\pm$ 0.21 ) $\times 10^{-4}$ | | 1468 |
| $K^0_S K^0_L$ | ( 1.95 $\pm$ 0.11 ) $\times 10^{-4}$ | S=2.4 | 1466 |
| $K^0_S K^0_S$ | < 1.4 $\times 10^{-8}$ | CL=95% | 1466 |
| $K \overline{K} \pi$ | ( 6.1 $\pm$ 1.0 ) $\times 10^{-3}$ | | 1442 |
| $K^+ K^- \pi^0$ | ( 2.88 $\pm$ 0.12 ) $\times 10^{-3}$ | | 1442 |
| $K^0_S K^\pm \pi^\mp$ | ( 5.6 $\pm$ 0.5 ) $\times 10^{-3}$ | | 1440 |
| $K^0_S K^0_L \pi^0$ | ( 2.06 $\pm$ 0.26 ) $\times 10^{-3}$ | | 1440 |
| $K^*(892)^0 \overline{K}^0 + $ c.c. $\rightarrow$ $K^0_S K^0_L \pi^0$ | ( 1.21 $\pm$ 0.18 ) $\times 10^{-3}$ | | − |
| $K^*_2(1430)^0 \overline{K}^0 + $ c.c. $\rightarrow$ $K^0_S K^0_L \pi^0$ | ( 4.3 $\pm$ 1.3 ) $\times 10^{-4}$ | | − |
| $K^+ K^- \pi^+ \pi^-$ | ( 7.0 $\pm$ 1.0 ) $\times 10^{-3}$ | | 1407 |
| $K^+ K^- \pi^0 \pi^0$ | ( 2.13 $\pm$ 0.22 ) $\times 10^{-3}$ | | 1410 |
| $K^0_S K^0_L \pi^+ \pi^-$ | ( 3.8 $\pm$ 0.6 ) $\times 10^{-3}$ | | 1406 |
| $K^0_S K^0_L \pi^0 \pi^0$ | ( 1.9 $\pm$ 0.4 ) $\times 10^{-3}$ | | 1408 |
| $K^0_S K^0_L \eta$ | ( 1.45 $\pm$ 0.33 ) $\times 10^{-3}$ | | 1328 |
| $K^0_S K^0_S \pi^+ \pi^-$ | ( 1.68 $\pm$ 0.19 ) $\times 10^{-3}$ | | 1406 |
| $K^\mp K^0_S \pi^\pm \pi^0$ | ( 5.7 $\pm$ 0.5 ) $\times 10^{-3}$ | | 1408 |
| $K^+ K^- 2(\pi^+\pi^-)$ | ( 3.1 $\pm$ 1.3 ) $\times 10^{-3}$ | | 1320 |
| $K^+ K^- \pi^+ \pi^- \eta$ | ( 4.7 $\pm$ 0.7 ) $\times 10^{-3}$ | | 1221 |
| $2(K^+ K^-)$ | ( 7.2 $\pm$ 0.8 ) $\times 10^{-4}$ | | 1131 |
| $K^+ K^- K^0_S K^0_S$ | ( 4.2 $\pm$ 0.7 ) $\times 10^{-4}$ | | 1127 |
| $p\overline{p}$ | ( 2.120 $\pm$ 0.029 ) $\times 10^{-3}$ | | 1232 |

| | | | | |
|---|---|---|---|---|
| $p\overline{p}\pi^0$ | | ( 1.19 $\pm$ 0.08 ) $\times 10^{-3}$ | S=1.1 | 1176 |
| $p\overline{p}\pi^+\pi^-$ | | ( 6.0 $\pm$ 0.5 ) $\times 10^{-3}$ | S=1.3 | 1107 |
| $p\overline{p}\pi^+\pi^-\pi^0$ | [d] | ( 2.3 $\pm$ 0.9 ) $\times 10^{-3}$ | S=1.9 | 1033 |
| $p\overline{p}\eta$ | | ( 2.00 $\pm$ 0.12 ) $\times 10^{-3}$ | | 948 |
| $p\overline{p}\rho$ | | < 3.1 $\times 10^{-4}$ | CL=90% | 774 |
| $p\overline{p}\omega$ | | ( 9.8 $\pm$ 1.0 ) $\times 10^{-4}$ | S=1.3 | 768 |
| $p\overline{p}\eta'(958)$ | | ( 1.29 $\pm$ 0.14 ) $\times 10^{-4}$ | S=2.0 | 596 |
| $p\overline{p}a_0(980) \to p\overline{p}\pi^0\eta$ | | ( 6.8 $\pm$ 1.8 ) $\times 10^{-5}$ | | – |
| $p\overline{p}\phi$ | | ( 5.19 $\pm$ 0.33 ) $\times 10^{-5}$ | | 527 |
| $p\overline{n}\pi^-$ | | ( 2.12 $\pm$ 0.09 ) $\times 10^{-3}$ | | 1174 |
| $n\overline{n}$ | | ( 2.09 $\pm$ 0.16 ) $\times 10^{-3}$ | | 1231 |
| $n\overline{n}\pi^+\pi^-$ | | ( 4 $\pm$ 4 ) $\times 10^{-3}$ | | 1106 |
| $nN(1440)$ | | seen | | 978 |
| $nN(1520)$ | | seen | | 928 |
| $nN(1535)$ | | seen | | 917 |
| $\Lambda\overline{\Lambda}$ | | ( 1.89 $\pm$ 0.09 ) $\times 10^{-3}$ | S=2.8 | 1074 |
| $\Lambda\overline{\Lambda}\pi^0$ | | ( 3.8 $\pm$ 0.4 ) $\times 10^{-5}$ | | 998 |
| $\Lambda\overline{\Lambda}\pi^+\pi^-$ | | ( 4.3 $\pm$ 1.0 ) $\times 10^{-3}$ | | 903 |
| $\Lambda\overline{\Lambda}\eta$ | | ( 1.62 $\pm$ 0.17 ) $\times 10^{-4}$ | | 672 |
| $\Lambda\overline{\Sigma}^-\pi^+$ (or c.c.) | [b] | ( 8.3 $\pm$ 0.7 ) $\times 10^{-4}$ | S=1.2 | 950 |
| $pK^-\overline{\Lambda}$+c.c. | | ( 8.6 $\pm$ 1.1 ) $\times 10^{-4}$ | | 876 |
| $pK^-\overline{\Sigma}^0$ | | ( 2.9 $\pm$ 0.8 ) $\times 10^{-4}$ | | 819 |
| $\overline{\Lambda}nK_S^0$ + c.c. | | ( 6.5 $\pm$ 1.1 ) $\times 10^{-4}$ | | 872 |
| $\Lambda\overline{\Sigma}$ + c.c. | | ( 2.83 $\pm$ 0.23 ) $\times 10^{-5}$ | | 1034 |
| $\Sigma^+\overline{\Sigma}^-$ | | ( 1.07 $\pm$ 0.04 ) $\times 10^{-3}$ | | 992 |
| $\Sigma^0\overline{\Sigma}^0$ | | ( 1.172$\pm$ 0.032) $\times 10^{-3}$ | S=1.4 | 988 |
| $\Sigma^+\overline{\Sigma}^-\eta$ | | ( 6.3 $\pm$ 0.4 ) $\times 10^{-5}$ | | 498 |
| $\Xi^-\overline{\Xi}^+$ | | ( 9.7 $\pm$ 0.8 ) $\times 10^{-4}$ | S=1.4 | 807 |

## Radiative decays

| | | | | |
|---|---|---|---|---|
| $\gamma\eta_c(1S)$ | | ( 1.7 $\pm$ 0.4 ) % | S=1.5 | 111 |
| $\quad\gamma\eta_c(1S) \to 3\gamma$ | | ( 3.8 $^{+1.3}_{-1.0}$ ) $\times 10^{-6}$ | S=1.1 | – |
| $\quad\gamma\eta_c(1S) \to \gamma\eta\eta\eta'$ | | ( 4.9 $\pm$ 0.8 ) $\times 10^{-5}$ | | – |
| $3\gamma$ | | ( 1.16 $\pm$ 0.22 ) $\times 10^{-5}$ | | 1548 |
| $4\gamma$ | | < 9 $\times 10^{-6}$ | CL=90% | 1548 |
| $5\gamma$ | | < 1.5 $\times 10^{-5}$ | CL=90% | 1548 |
| $\gamma\pi^0$ | | ( 3.56 $\pm$ 0.17 ) $\times 10^{-5}$ | | 1546 |
| $\gamma\pi^0\pi^0$ | | ( 1.15 $\pm$ 0.05 ) $\times 10^{-3}$ | | 1543 |
| $\gamma 2\pi^+2\pi^-$ | | ( 2.8 $\pm$ 0.5 ) $\times 10^{-3}$ | S=1.9 | 1517 |
| $\quad\gamma f_2(1270)f_2(1270)$ | | ( 9.5 $\pm$ 1.7 ) $\times 10^{-4}$ | | 878 |
| $\quad\gamma f_2(1270)f_2(1270)$(non reso-<br>nant) | | ( 8.2 $\pm$ 1.9 ) $\times 10^{-4}$ | | – |
| $\gamma\pi^+\pi^-2\pi^0$ | | ( 8.3 $\pm$ 3.1 ) $\times 10^{-3}$ | | 1518 |
| $\gamma K_S^0 K_S^0$ | | ( 8.1 $\pm$ 0.4 ) $\times 10^{-4}$ | | 1466 |

| | | | | |
|---|---|---|---|---|
| $\gamma(K\overline{K}\pi)\ [J^{PC} = 0^{-+}]$ | $(\ 7\quad \pm\ 4\quad) \times 10^{-4}$ | S=2.1 | 1442 |
| $\gamma K^+ K^- \pi^+ \pi^-$ | $(\ 2.1\ \pm\ 0.6\ ) \times 10^{-3}$ | | 1407 |
| $\gamma K^*(892)\overline{K}^*(892)$ | $(\ 4.0\ \pm\ 1.3\ ) \times 10^{-3}$ | | 1266 |
| $\gamma\eta$ | $(\ 1.085\pm\ 0.018) \times 10^{-3}$ | | 1500 |
| $\gamma\eta\pi^0$ | $(\ 2.14\ \pm\ 0.31\ ) \times 10^{-5}$ | | 1497 |
| $\quad\gamma a_0(980)^0 \to\ \gamma\eta\pi^0$ | $<\ 2.5\qquad\qquad \times 10^{-6}$ | CL=95% | – |
| $\quad\gamma a_2(1320)^0 \to\ \gamma\eta\pi^0$ | $<\ 6.6\qquad\qquad \times 10^{-6}$ | CL=95% | – |
| $\gamma\eta\pi\pi$ | $(\ 6.1\ \pm\ 1.0\ ) \times 10^{-3}$ | | 1487 |
| $\quad\gamma\eta_2(1870) \to\ \gamma\eta\pi^+\pi^-$ | $(\ 6.2\ \pm\ 2.4\ ) \times 10^{-4}$ | | – |
| $\gamma\eta'(958)$ | $(\ 5.25\ \pm\ 0.07\ ) \times 10^{-3}$ | S=1.3 | 1400 |
| $\gamma\rho\rho$ | $(\ 4.5\ \pm\ 0.8\ ) \times 10^{-3}$ | | 1340 |
| $\gamma\rho\omega$ | $<\ 5.4\qquad\qquad \times 10^{-4}$ | CL=90% | 1338 |
| $\gamma\rho\phi$ | $<\ 8.8\qquad\qquad \times 10^{-5}$ | CL=90% | 1258 |
| $\gamma\omega\omega$ | $(\ 1.61\ \pm\ 0.33\ ) \times 10^{-3}$ | | 1336 |
| $\gamma\phi\phi$ | $(\ 4.0\ \pm\ 1.2\ ) \times 10^{-4}$ | S=2.1 | 1166 |
| $\gamma\eta(1405/1475) \to\ \gamma K\overline{K}\pi$ | $(\ 2.8\ \pm\ 0.6\ ) \times 10^{-3}$ | S=1.6 | 1223 |
| $\gamma\eta(1405/1475) \to\ \gamma\gamma\rho^0$ | $(\ 7.8\ \pm\ 2.0\ ) \times 10^{-5}$ | S=1.8 | 1223 |
| $\gamma\eta(1405/1475) \to\ \gamma\eta\pi^+\pi^-$ | $(\ 3.0\ \pm\ 0.5\ ) \times 10^{-4}$ | | – |
| $\gamma\eta(1405/1475) \to\ \gamma\rho^0\rho^0$ | $(\ 1.7\ \pm\ 0.4\ ) \times 10^{-3}$ | S=1.3 | 1223 |
| $\gamma\eta(1405/1475) \to\ \gamma\gamma\phi$ | $<\ 8.2\qquad\qquad \times 10^{-5}$ | CL=95% | – |
| $\gamma\eta(1405) \to\ \gamma\gamma\gamma$ | $<\ 2.63\qquad\qquad \times 10^{-6}$ | CL=90% | – |
| $\gamma\eta(1475) \to\ \gamma\gamma\gamma$ | $<\ 1.86\qquad\qquad \times 10^{-6}$ | CL=90% | – |
| $\gamma\eta(1760) \to\ \gamma\rho^0\rho^0$ | $(\ 1.3\ \pm\ 0.9\ ) \times 10^{-4}$ | | 1048 |
| $\gamma\eta(1760) \to\ \gamma\omega\omega$ | $(\ 1.98\ \pm\ 0.33\ ) \times 10^{-3}$ | | – |
| $\gamma\eta(1760) \to\ \gamma\gamma\gamma$ | $<\ 4.80\qquad\qquad \times 10^{-6}$ | CL=90% | – |
| $\gamma\eta(2225)$ | $(\ 3.14\ ^{+\ 0.50}_{-\ 0.19}\ ) \times 10^{-4}$ | | 752 |
| $\gamma f_2(1270)$ | $(\ 1.63\ \pm\ 0.12\ ) \times 10^{-3}$ | S=1.3 | 1286 |
| $\quad\gamma f_2(1270) \to\ \gamma K^0_S K^0_S$ | $(\ 2.58\ ^{+\ 0.60}_{-\ 0.22}\ ) \times 10^{-5}$ | | – |
| $\gamma f_1(1285)$ | $(\ 6.1\ \pm\ 0.8\ ) \times 10^{-4}$ | | 1283 |
| $\gamma f_0(1370) \to\ \gamma K\overline{K}$ | $(\ 4.2\ \pm\ 1.5\ ) \times 10^{-4}$ | | – |
| $\quad\gamma f_0(1370) \to\ \gamma K^0_S K^0_S$ | $(\ 1.1\ \pm\ 0.4\ ) \times 10^{-5}$ | | – |
| $\gamma f_1(1420) \to\ \gamma K\overline{K}\pi$ | $(\ 7.9\ \pm\ 1.3\ ) \times 10^{-4}$ | | 1220 |
| $\gamma f_0(1500) \to\ \gamma\pi\pi$ | $(\ 1.09\ \pm\ 0.24\ ) \times 10^{-4}$ | | 1183 |
| $\gamma f_0(1500) \to\ \gamma\eta\eta$ | $(\ 1.7\ ^{+\ 0.6}_{-\ 1.4}\ ) \times 10^{-5}$ | | – |
| $\gamma f_0(1500) \to\ \gamma K^0_S K^0_S$ | $(\ 1.59\ ^{+\ 0.24}_{-\ 0.60}\ ) \times 10^{-5}$ | | – |
| $\gamma f_1(1510) \to\ \gamma\eta\pi^+\pi^-$ | $(\ 4.5\ \pm\ 1.2\ ) \times 10^{-4}$ | | – |
| $\gamma f'_2(1525)$ | $(\ 5.7\ ^{+\ 0.8}_{-\ 0.5}\ ) \times 10^{-4}$ | S=1.5 | 1177 |
| $\quad\gamma f'_2(1525) \to\ \gamma K^0_S K^0_S$ | $(\ 8.0\ ^{+\ 0.7}_{-\ 0.5}\ ) \times 10^{-5}$ | | – |
| $\gamma f'_2(1525) \to\ \gamma\eta\eta$ | $(\ 3.4\ \pm\ 1.4\ ) \times 10^{-5}$ | | – |
| $\gamma f_2(1640) \to\ \gamma\omega\omega$ | $(\ 2.8\ \pm\ 1.8\ ) \times 10^{-4}$ | | – |

| | | | |
|---|---|---|---|
| $\gamma f_0(1710) \to \gamma\pi\pi$ | $( 3.8 \pm 0.5 ) \times 10^{-4}$ | | – |
| $\gamma f_0(1710) \to \gamma K\overline{K}$ | $( 9.5 {\,}^{+\,1.0}_{-\,0.5} ) \times 10^{-4}$ | S=1.5 | 1075 |
| $\gamma f_0(1710) \to \gamma\omega\omega$ | $( 3.1 \pm 1.0 ) \times 10^{-4}$ | | – |
| $\gamma f_0(1710) \to \gamma\eta\eta$ | $( 2.4 {\,}^{+\,1.2}_{-\,0.7} ) \times 10^{-4}$ | | – |
| $\gamma f_0(1710) \to \gamma\omega\phi$ | $( 2.5 \pm 0.6 ) \times 10^{-4}$ | | – |
| $\gamma f_0(1770) \to \gamma K^0_S K^0_S$ | $( 1.11 {\,}^{+\,0.20}_{-\,0.33} ) \times 10^{-5}$ | | – |
| $\gamma f_2(1810) \to \gamma\eta\eta$ | $( 5.4 {\,}^{+\,3.5}_{-\,2.4} ) \times 10^{-5}$ | | – |
| $\gamma\eta_1(1855) \to \gamma\eta\eta'$ | $( 2.7 {\,}^{+\,0.4}_{-\,0.5} ) \times 10^{-6}$ | | – |
| $\gamma f_2(1910) \to \gamma\omega\omega$ | $( 2.0 \pm 1.4 ) \times 10^{-4}$ | | – |
| $\gamma f_2(1950) \to \gamma K^*(892)\overline{K}^*(892)$ | $( 7.0 \pm 2.2 ) \times 10^{-4}$ | | – |
| $\gamma f_0(2020) \to \gamma\eta'\eta'$ | $( 2.63 {\,}^{+\,0.32}_{-\,0.50} ) \times 10^{-4}$ | | – |
| $\gamma f_4(2050)$ | $( 2.7 \pm 0.7 ) \times 10^{-3}$ | | 891 |
| $\gamma f_0(2100) \to \gamma\eta\eta$ | $( 1.13 {\,}^{+\,0.60}_{-\,0.30} ) \times 10^{-4}$ | | – |
| $\gamma f_0(2100) \to \gamma\pi\pi$ | $( 6.2 \pm 1.0 ) \times 10^{-4}$ | | – |
| $\gamma f_0(2200) \to \gamma K\overline{K}$ | $( 5.9 \pm 1.3 ) \times 10^{-4}$ | | – |
| $\gamma f_0(2200) \to \gamma K^0_S K^0_S$ | $( 2.72 {\,}^{+\,0.19}_{-\,0.50} ) \times 10^{-4}$ | | – |
| $\gamma f_J(2220) \to \gamma\pi\pi$ | $< 3.9 \times 10^{-5}$ | CL=90% | – |
| $\gamma f_J(2220) \to \gamma K\overline{K}$ | $< 4.1 \times 10^{-5}$ | CL=90% | – |
| $\gamma f_J(2220) \to \gamma p\overline{p}$ | $( 1.5 \pm 0.8 ) \times 10^{-5}$ | | – |
| $\gamma f_0(2330) \to \gamma K^0_S K^0_S$ | $( 4.9 \pm 0.7 ) \times 10^{-5}$ | | – |
| $\gamma f_0(2330) \to \gamma\eta'\eta'$ | $( 6.1 {\,}^{+\,4.0}_{-\,1.8} ) \times 10^{-6}$ | | – |
| $\gamma f_2(2340) \to \gamma\eta\eta$ | $( 5.6 {\,}^{+\,2.4}_{-\,2.2} ) \times 10^{-5}$ | | – |
| $\gamma f_2(2340) \to \gamma K^0_S K^0_S$ | $( 5.5 {\,}^{+\,4.0}_{-\,1.5} ) \times 10^{-5}$ | | – |
| $\gamma f_2(2340) \to \gamma\eta'\eta'$ | $( 8.7 {\,}^{+\,0.9}_{-\,1.8} ) \times 10^{-6}$ | | – |
| $\gamma f_0(2470) \to \gamma\eta'\eta'$ | $( 8.2 {\,}^{+\,4.0}_{-\,2.8} ) \times 10^{-7}$ | | – |
| $\gamma X(1835) \to \gamma\pi^+\pi^-\eta'$ | $( 2.7 {\,}^{+\,0.6}_{-\,0.8} ) \times 10^{-4}$ | S=1.6 | 1006 |
| $\gamma X(1835) \to \gamma p\overline{p}$ | $( 7.7 {\,}^{+\,1.5}_{-\,0.9} ) \times 10^{-5}$ | | – |
| $\gamma X(1835) \to \gamma K^0_S K^0_S \eta$ | $( 3.3 {\,}^{+\,2.0}_{-\,1.3} ) \times 10^{-5}$ | | – |
| $\gamma X(1835) \to \gamma\gamma\gamma$ | $< 3.56 \times 10^{-6}$ | CL=90% | – |
| $\gamma X(1835) \to \gamma 3(\pi^+\pi^-)$ | $( 2.4 {\,}^{+\,0.7}_{-\,0.8} ) \times 10^{-5}$ | | – |
| $\gamma X(2370) \to \gamma K^+ K^- \eta'$ | $( 1.8 \pm 0.7 ) \times 10^{-5}$ | | – |
| $\gamma X(2370) \to \gamma K^0_S K^0_S \eta'$ | $( 1.2 \pm 0.5 ) \times 10^{-5}$ | | – |
| $\gamma X(2370) \to \gamma\eta\eta\eta'$ | $< 9.2 \times 10^{-6}$ | CL=90% | – |

| | | | | | |
|---|---|---|---|---|---|
| $\gamma p \overline{p}$ | | ( 3.8 $\pm$ 1.0 ) $\times 10^{-4}$ | | | 1232 |
| $\gamma p \overline{p} \pi^+ \pi^-$ | | < 7.9 | $\times 10^{-4}$ | CL=90% | 1107 |
| $\gamma \Lambda \overline{\Lambda}$ | | < 1.3 | $\times 10^{-4}$ | CL=90% | 1074 |
| $\gamma A^0 \to \gamma$ invisible | [e] < 1.7 | | $\times 10^{-6}$ | CL=90% | – |
| $\gamma A^0 \to \gamma \mu^+ \mu^-$ | [f] < 7.8 | | $\times 10^{-7}$ | CL=90% | – |

### Dalitz decays

| | | | | | |
|---|---|---|---|---|---|
| $\pi^0 e^+ e^-$ | | ( 7.6 $\pm$ 1.4 ) $\times 10^{-7}$ | | | 1546 |
| $\eta e^+ e^-$ | | ( 1.42 $\pm$ 0.08 ) $\times 10^{-5}$ | | | 1500 |
| $\eta'(958) e^+ e^-$ | | ( 6.59 $\pm$ 0.18 ) $\times 10^{-5}$ | | | 1400 |
| $X(1835) e^+ e^-$, $X \to$ $\pi^+ \pi^- \eta'$ | | ( 3.58 $\pm$ 0.25 ) $\times 10^{-6}$ | | | – |
| $X(2120) e^+ e^-$, $X \to$ $\pi^+ \pi^- \eta'$ | | ( 8.2 $\pm$ 1.3 ) $\times 10^{-7}$ | | | – |
| $X(2370) e^+ e^-$, $X \to$ $\pi^+ \pi^- \eta'$ | | ( 1.08 $\pm$ 0.17 ) $\times 10^{-6}$ | | | – |
| $\eta U \to \eta e^+ e^-$ | [g] < 9.11 | | $\times 10^{-7}$ | CL=90% | – |
| $\eta'(958) U \to \eta'(958) e^+ e^-$ | [g] < 2.0 | | $\times 10^{-7}$ | CL=90% | – |
| $\phi e^+ e^-$ | | < 1.2 | $\times 10^{-7}$ | CL=90% | 1381 |

### Weak decays

| | | | | | |
|---|---|---|---|---|---|
| $D^- e^+ \nu_e$ + c.c. | | < 7.1 | $\times 10^{-8}$ | CL=90% | 984 |
| $\overline{D}^0 e^+ e^-$ + c.c. | | < 8.5 | $\times 10^{-8}$ | CL=90% | 987 |
| $D_s^- e^+ \nu_e$ + c.c. | | < 1.3 | $\times 10^{-6}$ | CL=90% | 923 |
| $D_s^{*-} e^+ \nu_e$ + c.c. | | < 1.8 | $\times 10^{-6}$ | CL=90% | 828 |
| $D^- \pi^+$ + c.c. | | < 7.5 | $\times 10^{-5}$ | CL=90% | 977 |
| $\overline{D}^0 \overline{K}^0$ + c.c. | | < 1.7 | $\times 10^{-4}$ | CL=90% | 898 |
| $\overline{D}^0 \overline{K}^{*0}$ + c.c. | | < 2.5 | $\times 10^{-6}$ | CL=90% | 670 |
| $D_s^- \pi^+$ + c.c. | | < 1.3 | $\times 10^{-4}$ | CL=90% | 915 |
| $D_s^- \rho^+$ + c.c. | | < 1.3 | $\times 10^{-5}$ | CL=90% | 663 |

### Charge conjugation ($C$), Parity ($P$), Lepton Family number ($LF$) violating modes

| | | | | | |
|---|---|---|---|---|---|
| $\gamma \gamma$ | C | < 2.7 | $\times 10^{-7}$ | CL=90% | 1548 |
| $\gamma \phi$ | C | < 1.4 | $\times 10^{-6}$ | CL=90% | 1381 |
| $e^\pm \mu^\mp$ | LF | < 1.6 | $\times 10^{-7}$ | CL=90% | 1547 |
| $e^\pm \tau^\mp$ | LF | < 7.5 | $\times 10^{-8}$ | CL=90% | 1039 |
| $\mu^\pm \tau^\mp$ | LF | < 2.0 | $\times 10^{-6}$ | CL=90% | 1035 |
| $\Lambda_c^+ e^-$ + c.c. | | < 6.9 | $\times 10^{-8}$ | CL=90% | – |

### Other decays

| | | | | | |
|---|---|---|---|---|---|
| invisible | | < 7 | $\times 10^{-4}$ | CL=90% | – |

## $\chi_{c0}(1P)$ $\qquad\qquad\qquad I^G(J^{PC}) = 0^+(0^{++})$

Mass $m = 3414.71 \pm 0.30$ MeV
Full width $\Gamma = 10.8 \pm 0.6$ MeV

| $\chi_{c0}(1P)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | Scale factor/ Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|
| **Hadronic decays** | | | |
| $2(\pi^+\pi^-)$ | $(2.34\pm0.18)$ % | | 1679 |
| $\rho^0\pi^+\pi^-$ | $(9.1\ \pm2.9\ ) \times 10^{-3}$ | | 1607 |
| $f_0(980)f_0(980)$ | $(6.6\ \pm2.1\ ) \times 10^{-4}$ | | 1391 |
| $\pi^+\pi^-\pi^0\pi^0$ | $(3.3\ \pm0.4\ )$ % | | 1680 |
| $\rho^+\pi^-\pi^0 +$ c.c. | $(2.9\ \pm0.4\ )$ % | | 1607 |
| $4\pi^0$ | $(3.3\ \pm0.4\ ) \times 10^{-3}$ | | 1681 |
| $\pi^+\pi^- K^+ K^-$ | $(1.81\pm0.14)$ % | | 1580 |
| $K_0^*(1430)^0\overline{K}_0^*(1430)^0 \to$ $\pi^+\pi^- K^+ K^-$ | $(9.8\ ^{+4.0}_{-2.8}\ ) \times 10^{-4}$ | | – |
| $K_0^*(1430)^0\overline{K}_2^*(1430)^0 +$ c.c. $\to$ $\pi^+\pi^- K^+ K^-$ | $(8.0\ ^{+2.0}_{-2.4}\ ) \times 10^{-4}$ | | – |
| $K_1(1270)^+ K^- +$ c.c. $\to$ $\pi^+\pi^- K^+ K^-$ | $(6.3\ \pm1.9\ ) \times 10^{-3}$ | | – |
| $K_1(1400)^+ K^- +$ c.c. $\to$ $\pi^+\pi^- K^+ K^-$ | $< 2.7\qquad \times 10^{-3}$ | CL=90% | – |
| $f_0(980)f_0(980)$ | $(1.6\ ^{+1.0}_{-0.9}\ ) \times 10^{-4}$ | | 1391 |
| $f_0(980)f_0(2200)$ | $(7.9\ ^{+2.0}_{-2.5}\ ) \times 10^{-4}$ | | 586 |
| $f_0(1370)f_0(1370)$ | $< 2.7\qquad \times 10^{-4}$ | CL=90% | 1019 |
| $f_0(1370)f_0(1500)$ | $< 1.7\qquad \times 10^{-4}$ | CL=90% | 907 |
| $f_0(1370)f_0(1710)$ | $(6.7\ ^{+3.5}_{-2.3}\ ) \times 10^{-4}$ | | 709 |
| $f_0(1500)f_0(1370)$ | $< 1.3\qquad \times 10^{-4}$ | CL=90% | 907 |
| $f_0(1500)f_0(1500)$ | $< 5\qquad \times 10^{-5}$ | CL=90% | 774 |
| $f_0(1500)f_0(1710)$ | $< 7\qquad \times 10^{-5}$ | CL=90% | 515 |
| $K^+ K^-\pi^+\pi^-\pi^0$ | $(8.6\ \pm0.9\ ) \times 10^{-3}$ | | 1545 |
| $K_S^0 K^\pm\pi^\mp\pi^+\pi^-$ | $(4.2\ \pm0.4\ ) \times 10^{-3}$ | | 1543 |
| $K^+ K^-\pi^0\pi^0$ | $(5.6\ \pm0.9\ ) \times 10^{-3}$ | | 1582 |
| $K^+\pi^-\overline{K}^0\pi^0 +$ c.c. | $(2.49\pm0.33)$ % | | 1581 |
| $\rho^+ K^- K^0 +$ c.c. | $(1.21\pm0.21)$ % | | 1458 |
| $K^*(892)^- K^+\pi^0 \to$ $K^+\pi^-\overline{K}^0\pi^0 +$ c.c. | $(4.6\ \pm1.2\ ) \times 10^{-3}$ | | – |
| $K_S^0 K_S^0\pi^+\pi^-$ | $(5.7\ \pm1.1\ ) \times 10^{-3}$ | | 1579 |
| $K^+ K^-\eta\pi^0$ | $(3.0\ \pm0.7\ ) \times 10^{-3}$ | | 1468 |
| $3(\pi^+\pi^-)$ | $(1.20\pm0.18)$ % | | 1633 |
| $K^+\overline{K}^*(892)^0\pi^- +$ c.c. | $(7.5\ \pm1.6\ ) \times 10^{-3}$ | | 1523 |

| | | | |
|---|---|---|---|
| $K^*(892)^0 \overline{K}^*(892)^0$ | $(1.7 \pm 0.6) \times 10^{-3}$ | | 1456 |
| $\pi\pi$ | $(8.51 \pm 0.33) \times 10^{-3}$ | | 1702 |
| $\pi^0 \eta$ | $< 1.8 \times 10^{-4}$ | | 1661 |
| $\pi^0 \eta'$ | $< 1.1 \times 10^{-3}$ | | 1570 |
| $\pi^0 \eta_c$ | $< 1.6 \times 10^{-3}$ | CL=90% | 383 |
| $\eta\eta$ | $(3.01 \pm 0.19) \times 10^{-3}$ | | 1617 |
| $\eta\eta'$ | $(9.1 \pm 1.1) \times 10^{-5}$ | | 1521 |
| $\eta'\eta'$ | $(2.17 \pm 0.12) \times 10^{-3}$ | | 1413 |
| $\omega\omega$ | $(9.7 \pm 1.1) \times 10^{-4}$ | | 1517 |
| $\omega\phi$ | $(1.41 \pm 0.13) \times 10^{-4}$ | | 1447 |
| $\omega K^+ K^-$ | $(1.94 \pm 0.21) \times 10^{-3}$ | | 1457 |
| $K^+ K^-$ | $(6.05 \pm 0.31) \times 10^{-3}$ | | 1634 |
| $K^0_S K^0_S$ | $(3.16 \pm 0.17) \times 10^{-3}$ | | 1633 |
| $\pi^+ \pi^- \eta$ | $< 2.0 \times 10^{-4}$ | CL=90% | 1651 |
| $\pi^+ \pi^- \eta'$ | $< 4 \times 10^{-4}$ | CL=90% | 1560 |
| $\overline{K}^0 K^+ \pi^- + $ c.c. | $< 9 \times 10^{-5}$ | CL=90% | 1610 |
| $K^+ K^- \pi^0$ | $< 6 \times 10^{-5}$ | CL=90% | 1611 |
| $K^+ K^- \eta$ | $< 2.3 \times 10^{-4}$ | CL=90% | 1512 |
| $K^+ K^- K^0_S K^0_S$ | $(1.4 \pm 0.5) \times 10^{-3}$ | | 1331 |
| $K^0_S K^0_S K^0_S K^0_S$ | $(5.8 \pm 0.5) \times 10^{-4}$ | | 1327 |
| $K^+ K^- K^+ K^-$ | $(2.82 \pm 0.29) \times 10^{-3}$ | | 1333 |
| $K^+ K^- \phi$ | $(9.7 \pm 2.5) \times 10^{-4}$ | | 1381 |
| $\overline{K}^0 K^+ \pi^- \phi + $ c.c. | $(3.7 \pm 0.6) \times 10^{-3}$ | | 1326 |
| $K^+ K^- \pi^0 \phi$ | $(1.90 \pm 0.35) \times 10^{-3}$ | | 1329 |
| $\phi \pi^+ \pi^- \pi^0$ | $(1.18 \pm 0.15) \times 10^{-3}$ | | 1525 |
| $\phi\phi$ | $(8.0 \pm 0.7) \times 10^{-4}$ | | 1370 |
| $\phi\phi\eta$ | $(8.4 \pm 1.0) \times 10^{-4}$ | | 1100 |
| $p\overline{p}$ | $(2.21 \pm 0.08) \times 10^{-4}$ | | 1426 |
| $p\overline{p}\pi^0$ | $(7.0 \pm 0.7) \times 10^{-4}$ | S=1.3 | 1379 |
| $p\overline{p}\eta$ | $(3.5 \pm 0.4) \times 10^{-4}$ | | 1187 |
| $p\overline{p}\omega$ | $(5.2 \pm 0.6) \times 10^{-4}$ | | 1043 |
| $p\overline{p}\phi$ | $(6.0 \pm 1.4) \times 10^{-5}$ | | 876 |
| $p\overline{p}\pi^+ \pi^-$ | $(2.1 \pm 0.7) \times 10^{-3}$ | S=1.4 | 1320 |
| $p\overline{p}\pi^0 \pi^0$ | $(1.04 \pm 0.28) \times 10^{-3}$ | | 1324 |
| $p\overline{p} K^+ K^-$ (non-resonant) | $(1.22 \pm 0.26) \times 10^{-4}$ | | 890 |
| $p\overline{p} K^0_S K^0_S$ | $< 8.8 \times 10^{-4}$ | CL=90% | 884 |
| $p\overline{n}\pi^-$ | $(1.27 \pm 0.11) \times 10^{-3}$ | | 1376 |
| $\overline{p}n\pi^+$ | $(1.37 \pm 0.12) \times 10^{-3}$ | | 1376 |
| $p\overline{n}\pi^- \pi^0$ | $(2.34 \pm 0.21) \times 10^{-3}$ | | 1321 |
| $\overline{p}n\pi^+ \pi^0$ | $(2.21 \pm 0.18) \times 10^{-3}$ | | 1321 |
| $\Lambda\overline{\Lambda}$ | $(3.59 \pm 0.15) \times 10^{-4}$ | | 1292 |
| $\Lambda\overline{\Lambda}\pi^+ \pi^-$ | $(1.18 \pm 0.13) \times 10^{-3}$ | | 1153 |
| $\Lambda\overline{\Lambda}\pi^+ \pi^-$ (non-resonant) | $< 5 \times 10^{-4}$ | CL=90% | 1153 |
| $\Lambda\overline{\Lambda}\eta$ | $(2.3 \pm 0.4) \times 10^{-4}$ | | 979 |

| | | | |
|---|---|---|---|
| $\Sigma(1385)^+ \overline{\Lambda} \pi^- +$ c.c. | $< 5 \qquad \times 10^{-4}$ | CL=90% | 1083 |
| $\Sigma(1385)^- \overline{\Lambda} \pi^+ +$ c.c. | $< 5 \qquad \times 10^{-4}$ | CL=90% | 1083 |
| $K^+ \overline{p} \Lambda +$ c.c. | $(1.25 \pm 0.12) \times 10^{-3}$ | S=1.3 | 1132 |
| $n K_S^0 \overline{\Lambda} +$ c.c. | $(6.6 \pm 0.5) \times 10^{-4}$ | | 1129 |
| $K^*(892)^+ \overline{p} \Lambda +$ c.c. | $(4.8 \pm 0.9) \times 10^{-4}$ | | 845 |
| $K^+ \overline{p} \Lambda(1520) +$ c.c. | $(2.9 \pm 0.7) \times 10^{-4}$ | | 859 |
| $\Lambda(1520) \overline{\Lambda}(1520)$ | $(3.1 \pm 1.2) \times 10^{-4}$ | | 780 |
| $\Sigma^0 \overline{\Sigma}^0$ | $(4.68 \pm 0.32) \times 10^{-4}$ | | 1222 |
| $\Sigma^+ \overline{p} K_S^0 +$ c.c. | $(3.52 \pm 0.27) \times 10^{-4}$ | | 1089 |
| $\Sigma^0 \overline{p} K^+ +$ c.c. | $(3.03 \pm 0.20) \times 10^{-4}$ | | 1090 |
| $\Sigma^+ \overline{\Sigma}^-$ | $(4.6 \pm 0.8) \times 10^{-4}$ | S=2.6 | 1225 |
| $\Sigma^- \overline{\Sigma}^+$ | $(5.1 \pm 0.5) \times 10^{-4}$ | | 1217 |
| $\Sigma(1385)^+ \overline{\Sigma}(1385)^-$ | $(1.6 \pm 0.6) \times 10^{-4}$ | | 1001 |
| $\Sigma(1385)^- \overline{\Sigma}(1385)^+$ | $(2.3 \pm 0.7) \times 10^{-4}$ | | 1001 |
| $K^- \Lambda \overline{\Xi}^+ +$ c.c. | $(1.94 \pm 0.35) \times 10^{-4}$ | | 873 |
| $\Xi^0 \overline{\Xi}^0$ | $(4.5 \pm 0.5) \times 10^{-4}$ | S=1.7 | 1089 |
| $\Xi^- \overline{\Xi}^+$ | $(4.45 \pm 0.19) \times 10^{-4}$ | | 1081 |
| $\eta_c \pi^+ \pi^-$ | $< 7 \qquad \times 10^{-4}$ | CL=90% | 307 |

### Radiative decays

| | | | |
|---|---|---|---|
| $\gamma J/\psi(1S)$ | $(1.40 \pm 0.05)$ % | | 303 |
| $\gamma \rho^0$ | $< 9 \qquad \times 10^{-6}$ | CL=90% | 1619 |
| $\gamma \omega$ | $< 8 \qquad \times 10^{-6}$ | CL=90% | 1618 |
| $\gamma \phi$ | $< 6 \qquad \times 10^{-6}$ | CL=90% | 1555 |
| $\gamma \gamma$ | $(2.04 \pm 0.09) \times 10^{-4}$ | | 1707 |
| $e^+ e^- J/\psi(1S)$ | $(1.33 \pm 0.29) \times 10^{-4}$ | | 303 |
| $\mu^+ \mu^- J/\psi(1S)$ | $< 1.9 \qquad \times 10^{-5}$ | CL=90% | 226 |

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## $\chi_{c1}(1P)$ $\qquad\qquad I^G(J^{PC}) = 0^+(1^{++})$

Mass $m = 3510.67 \pm 0.05$ MeV $\quad$ (S = 1.2)
Full width $\Gamma = 0.84 \pm 0.04$ MeV

| $\chi_{c1}(1P)$ DECAY MODES | Fraction $(\Gamma_i/\Gamma)$ | Scale factor/ Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|
| $e^+ e^-$ | $\left( 1.4 \begin{smallmatrix} +1.5 \\ -1.0 \end{smallmatrix} \right) \times 10^{-7}$ | | 1755 |

### Hadronic decays

| | | | |
|---|---|---|---|
| $3(\pi^+ \pi^-)$ | $(5.8 \pm 1.4) \times 10^{-3}$ | S=1.2 | 1683 |
| $2(\pi^+ \pi^-)$ | $(7.6 \pm 2.6) \times 10^{-3}$ | | 1728 |
| $\pi^+ \pi^- \pi^0 \pi^0$ | $(1.19 \pm 0.15)$ % | | 1729 |
| $\rho^+ \pi^- \pi^0 +$ c.c. | $(1.45 \pm 0.24)$ % | | 1658 |
| $\rho^0 \pi^+ \pi^-$ | $(3.9 \pm 3.5) \times 10^{-3}$ | | 1657 |
| $4\pi^0$ | $(5.4 \pm 0.8) \times 10^{-4}$ | | 1729 |

| | | | |
|---|---|---|---|
| $\pi^+\pi^- K^+ K^-$ | $(\ 4.5\ \pm 1.0\ )\times 10^{-3}$ | | 1632 |
| $K^+ K^-\pi^0\pi^0$ | $(\ 1.12\pm 0.27)\times 10^{-3}$ | | 1634 |
| $K^+ K^-\pi^+\pi^-\pi^0$ | $(\ 1.15\pm 0.13)\ \%$ | | 1598 |
| $K^0_S K^\pm\pi^\mp\pi^+\pi^-$ | $(\ 7.5\ \pm 0.8\ )\times 10^{-3}$ | | 1596 |
| $K^+\pi^- \overline{K}^0\pi^0 +$ c.c. | $(\ 8.6\ \pm 1.4\ )\times 10^{-3}$ | | 1632 |
| $\quad\rho^- K^+ \overline{K}^0 +$ c.c. | $(\ 5.0\ \pm 1.2\ )\times 10^{-3}$ | | 1514 |
| $\quad K^*(892)^0 \overline{K}^0\pi^0 \to$ | $(\ 2.3\ \pm 0.6\ )\times 10^{-3}$ | | – |
| $\qquad K^+\pi^- \overline{K}^0\pi^0 +$ c.c. | | | |
| $K^+ K^-\eta\pi^0$ | $(\ 1.12\pm 0.34)\times 10^{-3}$ | | 1523 |
| $\pi^+\pi^- K^0_S K^0_S$ | $(\ 6.9\ \pm 2.9\ )\times 10^{-4}$ | | 1630 |
| $K^+ K^-\eta$ | $(\ 3.2\ \pm 1.0\ )\times 10^{-4}$ | | 1566 |
| $\overline{K}^0 K^+\pi^- +$ c.c. | $(\ 7.0\ \pm 0.6\ )\times 10^{-3}$ | | 1661 |
| $\quad K^*(892)^0 \overline{K}^0 +$ c.c. | $(10\ \ \ \pm 4\ \ \ )\times 10^{-4}$ | | 1602 |
| $\quad K^*(892)^+ K^- +$ c.c. | $(\ 1.4\ \pm 0.6\ )\times 10^{-3}$ | | 1602 |
| $\quad K^*_J(1430)^0 \overline{K}^0 +$ c.c. $\to$ | $<\ 8\qquad\qquad \times 10^{-4}$ | CL=90% | – |
| $\qquad K^0_S K^+\pi^- +$ c.c. | | | |
| $\quad K^*_J(1430)^+ K^- +$ c.c. $\to$ | $<\ 2.1\qquad\qquad \times 10^{-3}$ | CL=90% | – |
| $\qquad K^0_S K^+\pi^- +$ c.c. | | | |
| $K^+ K^-\pi^0$ | $(\ 1.81\pm 0.24)\times 10^{-3}$ | | 1662 |
| $\eta\pi^+\pi^-$ | $(\ 4.62\pm 0.23)\times 10^{-3}$ | | 1701 |
| $\quad a_0(980)^+\pi^- +$ c.c. $\to\ \eta\pi^+\pi^-$ | $(\ 3.2\ \pm 0.4\ )\times 10^{-3}$ | S=2.2 | – |
| $\quad a_2(1320)^+\pi^- +$ c.c. $\to\ \eta\pi^+\pi^-$ | $(\ 1.76\pm 0.24)\times 10^{-4}$ | | – |
| $\quad a_2(1700)^+\pi^- +$ c.c. $\to\ \eta\pi^+\pi^-$ | $(\ 4.6\ \pm 0.7\ )\times 10^{-5}$ | | – |
| $\quad f_2(1270)\eta \to\ \eta\pi^+\pi^-$ | $(\ 3.5\ \pm 0.6\ )\times 10^{-4}$ | | – |
| $\quad f_4(2050)\eta \to\ \eta\pi^+\pi^-$ | $(\ 2.5\ \pm 0.9\ )\times 10^{-5}$ | | – |
| $\quad \pi_1(1400)^+\pi^- +$ c.c. $\to$ | $<\ 5\qquad\qquad \times 10^{-5}$ | CL=90% | – |
| $\qquad \eta\pi^+\pi^-$ | | | |
| $\quad \pi_1(1600)^+\pi^- +$ c.c. $\to$ | $<\ 1.5\qquad\qquad \times 10^{-5}$ | CL=90% | – |
| $\qquad \eta\pi^+\pi^-$ | | | |
| $\quad \pi_1(2015)^+\pi^- +$ c.c. $\to$ | $<\ 8\qquad\qquad \times 10^{-6}$ | CL=90% | – |
| $\qquad \eta\pi^+\pi^-$ | | | |
| $f_2(1270)\eta$ | $(\ 6.7\ \pm 1.1\ )\times 10^{-4}$ | | 1467 |
| $\pi^+\pi^-\eta'$ | $(\ 2.2\ \pm 0.4\ )\times 10^{-3}$ | | 1612 |
| $K^+ K^-\eta'(958)$ | $(\ 8.8\ \pm 0.9\ )\times 10^{-4}$ | | 1461 |
| $\quad K^*_0(1430)^+ K^- +$ c.c. | $(\ 6.4\ ^{+2.2}_{-2.8}\ )\times 10^{-4}$ | | – |
| $\quad f_0(980)\eta'(958)$ | $(\ 1.6\ ^{+1.4}_{-0.7}\ )\times 10^{-4}$ | | 1460 |
| $\quad f_0(1710)\eta'(958)$ | $(\ 7\ \ \ ^{+7}_{-5}\ \ )\times 10^{-5}$ | | 1100 |
| $\quad f'_2(1525)\eta'(958)$ | $(\ 9\ \ \ \pm 6\ \ \ )\times 10^{-5}$ | | 1229 |
| $\pi^0 f_0(980) \to\ \pi^0\pi^+\pi^-$ | $(\ 3.5\ \pm 0.9\ )\times 10^{-7}$ | | – |
| $K^+ \overline{K}^*(892)^0\pi^- +$ c.c. | $(\ 3.2\ \pm 2.1\ )\times 10^{-3}$ | | 1577 |
| $K^*(892)^0 \overline{K}^*(892)^0$ | $(\ 1.4\ \pm 0.4\ )\times 10^{-3}$ | | 1512 |
| $K^+ K^- K^0_S K^0_S$ | $<\ 4\qquad\qquad \times 10^{-4}$ | CL=90% | 1390 |

| | | | |
|---|---|---|---|
| $K_S^0 K_S^0 K_S^0 K_S^0$ | $(\ 3.5\ \pm 1.0\ )\times 10^{-5}$ | | 1387 |
| $K^+ K^- K^+ K^-$ | $(\ 5.4\ \pm 1.1\ )\times 10^{-4}$ | | 1393 |
| $K^+ K^- \phi$ | $(\ 4.1\ \pm 1.5\ )\times 10^{-4}$ | | 1440 |
| $\overline{K}^0 K^+ \pi^- \phi +$ c.c. | $(\ 3.3\ \pm 0.5\ )\times 10^{-3}$ | | 1387 |
| $K^+ K^- \pi^0 \phi$ | $(\ 1.62 \pm 0.30)\times 10^{-3}$ | | 1390 |
| $\phi \pi^+ \pi^- \pi^0$ | $(\ 7.5\ \pm 1.0\ )\times 10^{-4}$ | | 1578 |
| $\omega \omega$ | $(\ 5.7\ \pm 0.7\ )\times 10^{-4}$ | | 1571 |
| $\omega K^+ K^-$ | $(\ 7.8\ \pm 0.9\ )\times 10^{-4}$ | | 1513 |
| $\omega \phi$ | $(\ 2.7\ \pm 0.4\ )\times 10^{-5}$ | | 1503 |
| $\phi \phi$ | $(\ 4.2\ \pm 0.5\ )\times 10^{-4}$ | | 1429 |
| $\phi \phi \eta$ | $(\ 3.0\ \pm 0.5\ )\times 10^{-4}$ | | 1172 |
| $p \overline{p}$ | $(\ 7.60 \pm 0.34)\times 10^{-5}$ | | 1484 |
| $p \overline{p} \pi^0$ | $(\ 1.55 \pm 0.18)\times 10^{-4}$ | | 1438 |
| $p \overline{p} \eta$ | $(\ 1.45 \pm 0.25)\times 10^{-4}$ | | 1254 |
| $p \overline{p} \omega$ | $(\ 2.12 \pm 0.31)\times 10^{-4}$ | | 1117 |
| $p \overline{p} \phi$ | $<\ \ 1.7\ \ \ \ \ \ \ \ \ \times 10^{-5}$ | CL=90% | 962 |
| $p \overline{p} \pi^+ \pi^-$ | $(\ 5.0\ \pm 1.9\ )\times 10^{-4}$ | | 1381 |
| $p \overline{p} \pi^0 \pi^0$ | $<\ \ 5\ \ \ \ \ \ \ \ \ \ \times 10^{-4}$ | CL=90% | 1385 |
| $p \overline{p} K^+ K^-$ (non-resonant) | $(\ 1.27 \pm 0.22)\times 10^{-4}$ | | 974 |
| $p \overline{p} K_S^0 K_S^0$ | $<\ \ 4.5\ \ \ \ \ \ \ \ \ \times 10^{-4}$ | CL=90% | 968 |
| $p \overline{n} \pi^-$ | $(\ 3.8\ \pm 0.5\ )\times 10^{-4}$ | | 1435 |
| $\overline{p} n \pi^+$ | $(\ 3.9\ \pm 0.5\ )\times 10^{-4}$ | | 1435 |
| $p \overline{n} \pi^- \pi^0$ | $(\ 1.03 \pm 0.12)\times 10^{-3}$ | | 1383 |
| $\overline{p} n \pi^+ \pi^0$ | $(\ 1.01 \pm 0.12)\times 10^{-3}$ | | 1383 |
| $\Lambda \overline{\Lambda}$ | $(\ 1.27 \pm 0.08)\times 10^{-4}$ | | 1355 |
| $\Lambda \overline{\Lambda} \pi^+ \pi^-$ | $(\ 2.9\ \pm 0.5\ )\times 10^{-4}$ | | 1223 |
| $\quad \Lambda \overline{\Lambda} \pi^+ \pi^-$ (non-resonant) | $(\ 2.5\ \pm 0.6\ )\times 10^{-4}$ | | 1223 |
| $\Lambda \overline{\Lambda} \eta$ | $(\ 5.9\ \pm 1.5\ )\times 10^{-5}$ | | 1059 |
| $\quad \Sigma(1385)^+ \overline{\Lambda} \pi^- +$ c.c. | $<\ \ 1.3\ \ \ \ \ \ \ \ \ \times 10^{-4}$ | CL=90% | 1157 |
| $\quad \Sigma(1385)^- \overline{\Lambda} \pi^+ +$ c.c. | $<\ \ 1.3\ \ \ \ \ \ \ \ \ \times 10^{-4}$ | CL=90% | 1157 |
| $K^+ \overline{p} \Lambda +$ c.c. | $(\ 4.2\ \pm 0.4\ )\times 10^{-4}$ | S=1.2 | 1203 |
| $n K_S^0 \overline{\Lambda} +$ c.c. | $(\ 1.66 \pm 0.17)\times 10^{-4}$ | | 1200 |
| $K^*(892)^+ \overline{p} \Lambda +$ c.c. | $(\ 4.9\ \pm 0.7\ )\times 10^{-4}$ | | 935 |
| $K^+ \overline{p} \Lambda(1520) +$ c.c. | $(\ 1.7\ \pm 0.4\ )\times 10^{-4}$ | | 951 |
| $\Lambda(1520) \overline{\Lambda}(1520)$ | $<\ \ 9\ \ \ \ \ \ \ \ \ \ \times 10^{-5}$ | CL=90% | 880 |
| $\Sigma^0 \overline{\Sigma}^0$ | $(\ 4.2\ \pm 0.6\ )\times 10^{-5}$ | | 1288 |
| $\Sigma^+ \overline{p} K_S^0 +$ c.c. | $(\ 1.53 \pm 0.12)\times 10^{-4}$ | | 1163 |
| $\Sigma^0 \overline{p} K^+ +$ c.c. | $(\ 1.46 \pm 0.10)\times 10^{-4}$ | | 1163 |
| $\Sigma^+ \overline{\Sigma}^-$ | $(\ 3.6\ \pm 0.7\ )\times 10^{-5}$ | | 1291 |
| $\Sigma^- \overline{\Sigma}^+$ | $(\ 5.7\ \pm 1.5\ )\times 10^{-5}$ | | 1283 |
| $\Sigma(1385)^+ \overline{\Sigma}(1385)^-$ | $<\ \ 9\ \ \ \ \ \ \ \ \ \ \times 10^{-5}$ | CL=90% | 1081 |
| $\Sigma(1385)^- \overline{\Sigma}(1385)^+$ | $<\ \ 5\ \ \ \ \ \ \ \ \ \ \times 10^{-5}$ | CL=90% | 1081 |
| $K^- \Lambda \overline{\Xi}^+ +$ c.c. | $(\ 1.35 \pm 0.24)\times 10^{-4}$ | | 963 |
| $\Xi^0 \overline{\Xi}^0$ | $(\ 7.5\ \pm 1.3\ )\times 10^{-5}$ | | 1163 |

| | | | |
|---|---|---|---|
| $\Xi^- \overline{\Xi}^+$ | ( 6.0 $\pm$0.6 ) $\times 10^{-5}$ | | 1155 |
| $\pi^+ \pi^- + K^+ K^-$ | < 2.1 $\times 10^{-3}$ | | – |
| $K_S^0 K_S^0$ | < 6 $\times 10^{-5}$ | CL=90% | 1683 |
| $\eta_c \pi^+ \pi^-$ | < 3.2 $\times 10^{-3}$ | CL=90% | 413 |

### Radiative decays

| | | | |
|---|---|---|---|
| $\gamma J/\psi(1S)$ | (34.3 $\pm$1.0 ) % | | 389 |
| $\gamma \rho^0$ | ( 2.16$\pm$0.17) $\times 10^{-4}$ | | 1670 |
| $\gamma \omega$ | ( 6.8 $\pm$0.8 ) $\times 10^{-5}$ | | 1668 |
| $\gamma \phi$ | ( 2.4 $\pm$0.5 ) $\times 10^{-5}$ | | 1607 |
| $\gamma \gamma$ | < 6.3 $\times 10^{-6}$ | CL=90% | 1755 |
| $e^+ e^- J/\psi(1S)$ | ( 3.46$\pm$0.22) $\times 10^{-3}$ | | 389 |
| $\mu^+ \mu^- J/\psi(1S)$ | ( 2.33$\pm$0.29) $\times 10^{-4}$ | | 335 |

## $h_c(1P)$

$$I^G(J^{PC}) = 0^-(1^{+-})$$

Mass $m = 3525.37 \pm 0.14$ MeV   (S = 1.2)
Full width $\Gamma = 0.78 \pm 0.28$ MeV

| $h_c(1P)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|
| $J/\psi(1S)\pi^0$ | < 5 $\times 10^{-4}$ | 90% | 382 |
| $J/\psi(1S)\pi\pi$ | not seen | | 312 |
| $J/\psi(1S)\pi^+ \pi^-$ | < 2.7 $\times 10^{-3}$ | 90% | 305 |
| $p\overline{p}$ | < 1.7 $\times 10^{-4}$ | 90% | 1492 |
| $p\overline{p}\pi^0$ | < 8 $\times 10^{-4}$ | 90% | 1447 |
| $p\overline{p}\pi^+ \pi^-$ | ( 3.3$\pm$0.6) $\times 10^{-3}$ | | 1390 |
| $p\overline{p}\pi^0 \pi^0$ | < 6 $\times 10^{-4}$ | 90% | 1394 |
| $p\overline{p}\pi^+ \pi^- \pi^0$ | ( 4.4$\pm$1.3) $\times 10^{-3}$ | | 1331 |
| $p\overline{p}\eta$ | ( 7.4$\pm$2.2) $\times 10^{-4}$ | | 1264 |
| $\pi^+ \pi^- \pi^0$ | ( 1.9$\pm$0.5) $\times 10^{-3}$ | | 1749 |
| $\pi^+ \pi^- \pi^0 \eta$ | ( 8.3$\pm$2.4) $\times 10^{-3}$ | | 1695 |
| $2\pi^+ 2\pi^- \pi^0$ | ( 9.4$\pm$1.7) $\times 10^{-3}$ | | 1716 |
| $3\pi^+ 3\pi^- \pi^0$ | < 1.0 % | 90% | 1661 |
| $K^+ K^- \pi^+ \pi^-$ | < 7 $\times 10^{-4}$ | 90% | 1640 |
| $K^+ K^- \pi^+ \pi^- \pi^0$ | ( 3.8$\pm$0.8) $\times 10^{-3}$ | | 1606 |
| $K^+ K^- \pi^+ \pi^- \eta$ | < 2.7 $\times 10^{-3}$ | 90% | 1480 |
| $K^+ K^- \pi^0$ | < 6 $\times 10^{-4}$ | 90% | 1670 |
| $K^+ K^- \pi^0 \eta$ | < 2.4 $\times 10^{-3}$ | 90% | 1532 |
| $K^+ K^- \eta$ | < 1.0 $\times 10^{-3}$ | 90% | 1574 |
| $2K^+ 2K^- \pi^0$ | < 2.8 $\times 10^{-4}$ | 90% | 1339 |
| $K_S^0 K^\pm \pi^\mp$ | < 6 $\times 10^{-4}$ | 90% | 1668 |
| $K_S^0 K^\pm \pi^\mp \pi^+ \pi^-$ | ( 3.2$\pm$1.0) $\times 10^{-3}$ | | 1604 |

### Radiative decays

| | | |
|---|---|---|
| $\gamma\eta$ | $(4.7\pm2.1)\times10^{-4}$ | 1720 |
| $\gamma\eta'(958)$ | $(1.5\pm0.4)\times10^{-3}$ | 1633 |
| $\gamma\eta_c(1S)$ | $(57\ \pm5\ )\,\%$ | 500 |

## $\chi_{c2}(1P)$ 　　　　　 $I^G(J^{PC}) = 0^+(2^{++})$

Mass $m = 3556.17 \pm 0.07$ MeV
Full width $\Gamma = 1.97 \pm 0.09$ MeV

| $\chi_{c2}(1P)$ DECAY MODES | Fraction $(\Gamma_i/\Gamma)$ | Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|

### Hadronic decays

| | | | |
|---|---|---|---|
| $2(\pi^+\pi^-)$ | $(1.02\pm0.09)\,\%$ | | 1751 |
| $\pi^+\pi^-\pi^0\pi^0$ | $(1.83\pm0.23)\,\%$ | | 1752 |
| $\rho^+\pi^-\pi^0 +$ c.c. | $(2.19\pm0.34)\,\%$ | | 1682 |
| $4\pi^0$ | $(1.11\pm0.15)\times10^{-3}$ | | 1752 |
| $K^+K^-\pi^0\pi^0$ | $(2.1\ \pm0.4\ )\times10^{-3}$ | | 1658 |
| $K^+\pi^-\overline{K}^0\pi^0 +$ c.c. | $(1.38\pm0.20)\,\%$ | | 1657 |
| $\rho^-K^+\overline{K}^0 +$ c.c. | $(4.1\ \pm1.2\ )\times10^{-3}$ | | 1540 |
| $K^*(892)^0K^-\pi^+ \to$ $K^-\pi^+K^0\pi^0 +$ c.c. | $(2.9\ \pm0.8\ )\times10^{-3}$ | | – |
| $K^*(892)^0\overline{K}^0\pi^0 \to$ $K^+\pi^-\overline{K}^0\pi^0 +$ c.c. | $(3.8\ \pm0.9\ )\times10^{-3}$ | | – |
| $K^*(892)^-K^+\pi^0 \to$ $K^+\pi^-\overline{K}^0\pi^0 +$ c.c. | $(3.7\ \pm0.8\ )\times10^{-3}$ | | – |
| $K^*(892)^+\overline{K}^0\pi^- \to$ $K^+\pi^-\overline{K}^0\pi^0 +$ c.c. | $(2.9\ \pm0.8\ )\times10^{-3}$ | | – |
| $K^+K^-\eta\pi^0$ | $(1.3\ \pm0.4\ )\times10^{-3}$ | | 1549 |
| $K^+K^-\pi^+\pi^-$ | $(8.4\ \pm0.9\ )\times10^{-3}$ | | 1656 |
| $K^+K^-\pi^+\pi^-\pi^0$ | $(1.17\pm0.13)\,\%$ | | 1623 |
| $K^0_S K^\pm\pi^\mp\pi^+\pi^-$ | $(7.3\ \pm0.8\ )\times10^{-3}$ | | 1621 |
| $K^+\overline{K}^*(892)^0\pi^- +$ c.c. | $(2.1\ \pm1.1\ )\times10^{-3}$ | | 1602 |
| $K^*(892)^0\overline{K}^*(892)^0$ | $(2.3\ \pm0.4\ )\times10^{-3}$ | | 1538 |
| $3(\pi^+\pi^-)$ | $(8.6\ \pm1.8\ )\times10^{-3}$ | | 1707 |
| $\phi\phi$ | $(1.06\pm0.09)\times10^{-3}$ | | 1457 |
| $\phi\phi\eta$ | $(5.3\ \pm0.6\ )\times10^{-4}$ | | 1206 |
| $\omega\omega$ | $(8.4\ \pm1.0\ )\times10^{-4}$ | | 1597 |
| $\omega K^+K^-$ | $(7.3\ \pm0.9\ )\times10^{-4}$ | | 1540 |
| $\omega\phi$ | $(9.6\ \pm2.7\ )\times10^{-6}$ | | 1529 |
| $\pi\pi$ | $(2.23\pm0.09)\times10^{-3}$ | | 1773 |
| $\rho^0\pi^+\pi^-$ | $(3.7\ \pm1.6\ )\times10^{-3}$ | | 1682 |
| $\pi^+\pi^-\pi^0$ (non-resonant) | $(2.0\ \pm0.4\ )\times10^{-5}$ | | 1765 |
| $\rho(770)^\pm\pi^\mp$ | $(6\ \ \pm4\ \ )\times10^{-6}$ | | – |

| | | | |
|---|---|---|---|
| $\pi^+\pi^-\eta$ | $(\ 4.8\ \pm 1.3\ )\times 10^{-4}$ | | 1724 |
| $\pi^+\pi^-\eta'$ | $(\ 5.0\ \pm 1.8\ )\times 10^{-4}$ | | 1636 |
| $\eta\eta$ | $(\ 5.4\ \pm 0.4\ )\times 10^{-4}$ | | 1692 |
| $K^+K^-$ | $(\ 1.01\pm 0.06)\times 10^{-3}$ | | 1708 |
| $K^0_S K^0_S$ | $(\ 5.2\ \pm 0.4\ )\times 10^{-4}$ | | 1707 |
| $K^*(892)^\pm K^\mp$ | $(\ 1.44\pm 0.21)\times 10^{-4}$ | | 1627 |
| $K^*(892)^0\overline{K}^0 +$ c.c. | $(\ 1.24\pm 0.27)\times 10^{-4}$ | | 1627 |
| $K^*_2(1430)^\pm K^\mp$ | $(\ 1.48\pm 0.12)\times 10^{-3}$ | | – |
| $K^*_2(1430)^0\overline{K}^0 +$ c.c. | $(\ 1.24\pm 0.17)\times 10^{-3}$ | | 1443 |
| $K^*_3(1780)^\pm K^\mp$ | $(\ 5.2\ \pm 0.8\ )\times 10^{-4}$ | | – |
| $K^*_3(1780)^0\overline{K}^0 +$ c.c. | $(\ 5.6\ \pm 2.1\ )\times 10^{-4}$ | | 1274 |
| $a_2(1320)^0\pi^0$ | $(\ 1.29\pm 0.34)\times 10^{-3}$ | | – |
| $a_2(1320)^\pm\pi^\mp$ | $(\ 1.8\ \pm 0.6\ )\times 10^{-3}$ | | 1530 |
| $\overline{K}^0 K^+\pi^- +$ c.c. | $(\ 1.28\pm 0.18)\times 10^{-3}$ | | 1685 |
| $K^+K^-\pi^0$ | $(\ 3.0\ \pm 0.8\ )\times 10^{-4}$ | | 1686 |
| $K^+K^-\eta$ | $<\ 3.2\ \ \ \ \ \ \times 10^{-4}$ | 90% | 1592 |
| $K^+K^-\eta'(958)$ | $(\ 1.94\pm 0.34)\times 10^{-4}$ | | 1488 |
| $\eta\eta'$ | $(\ 2.2\ \pm 0.5\ )\times 10^{-5}$ | | 1600 |
| $\eta'\eta'$ | $(\ 4.6\ \pm 0.6\ )\times 10^{-5}$ | | 1498 |
| $\pi^+\pi^- K^0_S K^0_S$ | $(\ 2.2\ \pm 0.5\ )\times 10^{-3}$ | | 1655 |
| $K^+K^- K^0_S K^0_S$ | $<\ 4\ \ \ \ \ \ \ \times 10^{-4}$ | 90% | 1418 |
| $K^0_S K^0_S K^0_S K^0_S$ | $(\ 1.13\pm 0.18)\times 10^{-4}$ | | 1415 |
| $K^+K^- K^+K^-$ | $(\ 1.65\pm 0.20)\times 10^{-3}$ | | 1421 |
| $K^+K^-\phi$ | $(\ 1.42\pm 0.29)\times 10^{-3}$ | | 1468 |
| $\overline{K}^0 K^+\pi^-\phi +$ c.c. | $(\ 4.8\ \pm 0.7\ )\times 10^{-3}$ | | 1416 |
| $K^+K^-\pi^0\phi$ | $(\ 2.7\ \pm 0.5\ )\times 10^{-3}$ | | 1419 |
| $\phi\pi^+\pi^-\pi^0$ | $(\ 9.3\ \pm 1.2\ )\times 10^{-4}$ | | 1603 |
| $p\overline{p}$ | $(\ 7.33\pm 0.33)\times 10^{-5}$ | | 1510 |
| $p\overline{p}\pi^0$ | $(\ 4.7\ \pm 0.4\ )\times 10^{-4}$ | | 1465 |
| $p\overline{p}\eta$ | $(\ 1.74\pm 0.25)\times 10^{-4}$ | | 1285 |
| $p\overline{p}\omega$ | $(\ 3.6\ \pm 0.4\ )\times 10^{-4}$ | | 1152 |
| $p\overline{p}\phi$ | $(\ 2.8\ \pm 0.9\ )\times 10^{-5}$ | | 1002 |
| $p\overline{p}\pi^+\pi^-$ | $(\ 1.32\pm 0.34)\times 10^{-3}$ | | 1410 |
| $p\overline{p}\pi^0\pi^0$ | $(\ 7.8\ \pm 2.3\ )\times 10^{-4}$ | | 1414 |
| $p\overline{p}K^+K^-$ (non-resonant) | $(\ 1.91\pm 0.32)\times 10^{-4}$ | | 1013 |
| $p\overline{p}K^0_S K^0_S$ | $<\ 7.9\ \ \ \ \ \ \times 10^{-4}$ | 90% | 1007 |
| $p\overline{n}\pi^-$ | $(\ 8.5\ \pm 0.9\ )\times 10^{-4}$ | | 1463 |
| $\overline{p}n\pi^+$ | $(\ 8.9\ \pm 0.8\ )\times 10^{-4}$ | | 1463 |
| $p\overline{n}\pi^-\pi^0$ | $(\ 2.17\pm 0.18)\times 10^{-3}$ | | 1411 |
| $\overline{p}n\pi^+\pi^0$ | $(\ 2.11\pm 0.18)\times 10^{-3}$ | | 1411 |
| $\Lambda\overline{\Lambda}$ | $(\ 1.83\pm 0.16)\times 10^{-4}$ | | 1384 |
| $\Lambda\overline{\Lambda}\pi^+\pi^-$ | $(\ 1.25\pm 0.15)\times 10^{-3}$ | | 1255 |
| $\quad\Lambda\overline{\Lambda}\pi^+\pi^-$ (non-resonant) | $(\ 6.6\ \pm 1.5\ )\times 10^{-4}$ | | 1255 |

| | | | |
|---|---|---|---|
| $\Lambda\overline{\Lambda}\eta$ | $(1.05\pm0.26)\times10^{-4}$ | | 1096 |
| $\Sigma(1385)^+\overline{\Lambda}\pi^-$ + c.c. | $<\ 4\qquad\times10^{-4}$ | 90% | 1192 |
| $\Sigma(1385)^-\overline{\Lambda}\pi^+$ + c.c. | $<\ 6\qquad\times10^{-4}$ | 90% | 1192 |
| $K^+\overline{p}\Lambda$ + c.c. | $(7.8\ \pm0.5\ )\times10^{-4}$ | | 1236 |
| $nK_S^0\overline{\Lambda}$ + c.c. | $(3.58\pm0.28)\times10^{-4}$ | | 1233 |
| $K^*(892)^+\overline{p}\Lambda$ + c.c. | $(8.2\ \pm1.1\ )\times10^{-4}$ | | 976 |
| $K^+\overline{p}\Lambda(1520)$ + c.c. | $(2.8\ \pm0.7\ )\times10^{-4}$ | | 992 |
| $\Lambda(1520)\overline{\Lambda}(1520)$ | $(4.6\ \pm1.5\ )\times10^{-4}$ | | 924 |
| $\Sigma^0\overline{\Sigma}^0$ | $(3.7\ \pm0.6\ )\times10^{-5}$ | | 1319 |
| $\Sigma^+\overline{p}K_S^0$ + c.c. | $(8.2\ \pm0.9\ )\times10^{-5}$ | | 1197 |
| $\Sigma^0\overline{p}K^+$ + c.c. | $(9.1\ \pm0.8\ )\times10^{-5}$ | | 1197 |
| $\Sigma^+\overline{\Sigma}^-$ | $(3.4\ \pm0.7\ )\times10^{-5}$ | | 1322 |
| $\Sigma^-\overline{\Sigma}^+$ | $(4.4\ \pm1.8\ )\times10^{-5}$ | | 1314 |
| $\Sigma(1385)^+\overline{\Sigma}(1385)^-$ | $<\ 1.6\qquad\times10^{-4}$ | 90% | 1118 |
| $\Sigma(1385)^-\overline{\Sigma}(1385)^+$ | $<\ 8\qquad\times10^{-5}$ | 90% | 1118 |
| $K^-\Lambda\overline{\Xi}^+$ + c.c. | $(1.76\pm0.32)\times10^{-4}$ | | 1004 |
| $\Xi^0\overline{\Xi}^0$ | $(1.83\pm0.22)\times10^{-4}$ | | 1197 |
| $\Xi^-\overline{\Xi}^+$ | $(1.44\pm0.12)\times10^{-4}$ | | 1189 |
| $J/\psi(1S)\pi^+\pi^-\pi^0$ | $<\ 1.5\qquad\%$ | 90% | 185 |
| $\pi^0\eta_c$ | $<\ 3.2\qquad\times10^{-3}$ | 90% | 511 |
| $\eta_c(1S)\pi^+\pi^-$ | $<\ 5.4\qquad\times10^{-3}$ | 90% | 459 |

### Radiative decays

| | | | |
|---|---|---|---|
| $\gamma J/\psi(1S)$ | $(19.0\ \pm0.5\ )\%$ | | 430 |
| $\gamma\rho^0$ | $<\ 1.9\qquad\times10^{-5}$ | 90% | 1694 |
| $\gamma\omega$ | $<\ 6\qquad\times10^{-6}$ | 90% | 1692 |
| $\gamma\phi$ | $<\ 7\qquad\times10^{-6}$ | 90% | 1632 |
| $\gamma\gamma$ | $(2.85\pm0.10)\times10^{-4}$ | | 1778 |
| $e^+e^-J/\psi(1S)$ | $(2.15\pm0.14)\times10^{-3}$ | | 430 |
| $\mu^+\mu^-J/\psi(1S)$ | $(2.02\pm0.33)\times10^{-4}$ | | 381 |

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## $\eta_c(2S)$ $\qquad\qquad I^G(J^{PC}) = 0^+(0^{-+})$

Quantum numbers are quark model predictions.

Mass $m = 3637.7 \pm 1.1$ MeV  (S = 1.2)
Full width $\Gamma = 13.9 \pm 2.6$ MeV

| $\eta_c(2S)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | Confidence level | $p$ (MeV/c) |
|---|---|---|---|
| hadrons | not seen | | − |
| $K\overline{K}\pi$ | $(1.9\pm1.2)\%$ | | 1729 |
| $K\overline{K}\eta$ | $(5\ \pm4\ )\times10^{-3}$ | | 1637 |
| $2\pi^+2\pi^-$ | $<\ 2.1\qquad\%$ | 90% | 1792 |
| $\rho^0\rho^0$ | $<\ 1.9\qquad\times10^{-3}$ | 90% | 1645 |

| | | | |
|---|---|---|---|
| $3\pi^+ 3\pi^-$ | ( $1.3\pm0.9$) % | | 1749 |
| $K^+ K^- \pi^+ \pi^-$ | < 1.4 % | 90% | 1700 |
| $\quad K^{*0} \overline{K}^{*0}$ | < 2.9 $\times 10^{-3}$ | 90% | 1585 |
| $K^+ K^- \pi^+ \pi^- \pi^0$ | ( $1.4\pm1.0$) % | | 1668 |
| $K^+ K^- 2\pi^+ 2\pi^-$ | < 1.4 % | 90% | 1627 |
| $K^0_S K^- 2\pi^+ \pi^- + $ c.c. | ( $1.0\pm0.8$) % | | 1666 |
| $2K^+ 2K^-$ | < 1.3 $\times 10^{-3}$ | 90% | 1470 |
| $\quad \phi\phi$ | < 1.1 $\times 10^{-3}$ | 90% | 1506 |
| $p\overline{p}$ | < 2.0 $\times 10^{-3}$ | 90% | 1558 |
| $p\overline{p}\pi^+ \pi^-$ | seen | | 1461 |
| $\gamma\gamma$ | ( $1.6\pm1.0$) $\times 10^{-4}$ | | 1819 |
| $\gamma J/\psi(1S)$ | < 1.4 % | 90% | 501 |
| $\pi^+ \pi^- \eta$ | < 6 $\times 10^{-3}$ | 90% | 1766 |
| $\pi^+ \pi^- \eta'$ | ( $2.6\pm1.9$) $\times 10^{-3}$ | | 1680 |
| $\pi^+ \pi^- \eta_c(1S)$ | < 25 % | 90% | 538 |

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## $\psi(2S)$ $\qquad\qquad I^G(J^{PC}) = 0^-(1^{--})$

Mass $m = 3686.10 \pm 0.06$ MeV $\quad$ (S = 5.9)
Full width $\Gamma = 294 \pm 8$ keV

| $\psi(2S)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | Scale factor/ Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|
| hadrons | (97.85 $\pm0.13$ ) % | | — |
| $\quad$virtual $\gamma \to$ hadrons | ( 1.73 $\pm0.14$ ) % | S=1.5 | — |
| $\quad g g g$ | (10.6 $\pm1.6$ ) % | | — |
| $\quad \gamma g g$ | ( 1.03 $\pm0.29$ ) % | | — |
| $\quad$light hadrons | (15.4 $\pm1.5$ ) % | | — |
| $\quad\quad K^0_S$ anything | (16.0 $\pm1.1$ ) % | | — |
| $e^+ e^-$ | ( 7.93 $\pm0.17$ ) $\times 10^{-3}$ | | 1843 |
| $\mu^+ \mu^-$ | ( 8.0 $\pm0.6$ ) $\times 10^{-3}$ | | 1840 |
| $\tau^+ \tau^-$ | ( 3.1 $\pm0.4$ ) $\times 10^{-3}$ | | 489 |

### Decays into $J/\psi(1S)$ and anything

| | | | |
|---|---|---|---|
| $J/\psi(1S)$ anything | (61.4 $\pm0.6$ ) % | | — |
| $J/\psi(1S)$ neutrals | (25.38 $\pm0.32$ ) % | | — |
| $J/\psi(1S)\pi^+ \pi^-$ | (34.68 $\pm0.30$ ) % | | 477 |
| $J/\psi(1S)\pi^0 \pi^0$ | (18.24 $\pm0.31$ ) % | | 481 |
| $J/\psi(1S)\eta$ | ( 3.37 $\pm0.05$ ) % | | 199 |
| $J/\psi(1S)\pi^0$ | ( 1.268$\pm0.032$) $\times 10^{-3}$ | | 528 |

### Hadronic decays

| | | | |
|---|---|---|---|
| $\pi^+ \pi^-$ | ( 7.8 $\pm2.6$ ) $\times 10^{-6}$ | | 1838 |
| $\pi^+ \pi^- \pi^0$ | ( 2.01 $\pm0.17$ ) $\times 10^{-4}$ | S=1.7 | 1830 |

| | | | | |
|---|---|---|---|---|
| $\rho(770)\pi \to \pi^+\pi^-\pi^0$ | ( 3.2 $\pm 1.2$ ) $\times 10^{-5}$ | S=1.8 | – |
| $\rho(2150)\pi \to \pi^+\pi^-\pi^0$ | ( 1.9 $^{+1.2}_{-0.4}$ ) $\times 10^{-4}$ | | – |
| $2(\pi^+\pi^-)$ | ( 2.4 $\pm 0.6$ ) $\times 10^{-4}$ | S=2.2 | 1817 |
| $\rho^0\pi^+\pi^-$ | ( 2.2 $\pm 0.6$ ) $\times 10^{-4}$ | S=1.4 | 1750 |
| $2(\pi^+\pi^-)\pi^0$ | ( 2.9 $\pm 1.0$ ) $\times 10^{-3}$ | S=4.7 | 1799 |
| $\rho\, a_2(1320)$ | ( 2.6 $\pm 0.9$ ) $\times 10^{-4}$ | | 1500 |
| $\pi^+\pi^-\pi^0\pi^0\pi^0$ | ( 5.3 $\pm 0.9$ ) $\times 10^{-3}$ | | 1800 |
| $\pi^+\pi^-4\pi^0$ | ( 1.4 $\pm 1.0$ ) $\times 10^{-3}$ | | 1778 |
| $\rho^\pm\pi^\mp\pi^0\pi^0$ | < 2.7 $\times 10^{-3}$ | CL=90% | 1737 |
| $3(\pi^+\pi^-)$ | ( 3.5 $\pm 2.0$ ) $\times 10^{-4}$ | S=2.8 | 1774 |
| $2(\pi^+\pi^-\pi^0)$ | ( 4.8 $\pm 1.5$ ) $\times 10^{-3}$ | | 1776 |
| $3(\pi^+\pi^-)\pi^0$ | ( 3.5 $\pm 1.6$ ) $\times 10^{-3}$ | | 1746 |
| $2(\pi^+\pi^-)3\pi^0$ | ( 1.42 $\pm 0.31$ ) % | | 1748 |
| $\eta\pi^+\pi^-$ | < 1.6 $\times 10^{-4}$ | CL=90% | 1791 |
| $\eta\pi^+\pi^-\pi^0$ | ( 9.5 $\pm 1.7$ ) $\times 10^{-4}$ | | 1778 |
| $\eta 2(\pi^+\pi^-)$ | ( 1.2 $\pm 0.6$ ) $\times 10^{-3}$ | | 1758 |
| $\eta\pi^+\pi^-\pi^0\pi^0$ | < 4 $\times 10^{-4}$ | CL=90% | 1760 |
| $\eta\pi^+\pi^-3\pi^0$ | < 2.1 $\times 10^{-3}$ | CL=90% | 1736 |
| $\eta 2(\pi^+\pi^-\pi^0)$ | < 2.1 $\times 10^{-3}$ | CL=90% | 1705 |
| $\rho\eta$ | ( 2.2 $\pm 0.6$ ) $\times 10^{-5}$ | S=1.1 | 1717 |
| $\eta'\pi^+\pi^-\pi^0$ | ( 4.5 $\pm 2.1$ ) $\times 10^{-4}$ | | 1692 |
| $\eta'\rho$ | ( 1.9 $^{+1.7}_{-1.2}$ ) $\times 10^{-5}$ | | 1625 |
| $\omega\pi^0$ | ( 2.1 $\pm 0.6$ ) $\times 10^{-5}$ | | 1757 |
| $\omega\pi^+\pi^-$ | ( 7.3 $\pm 1.2$ ) $\times 10^{-4}$ | S=2.1 | 1748 |
| $\omega\pi^+\pi^-2\pi^0$ | ( 8.7 $\pm 2.4$ ) $\times 10^{-3}$ | | 1715 |
| $b_1^\pm\pi^\mp$ | ( 4.0 $\pm 0.6$ ) $\times 10^{-4}$ | S=1.1 | 1635 |
| $\omega f_2(1270)$ | ( 2.2 $\pm 0.4$ ) $\times 10^{-4}$ | | 1515 |
| $\omega\pi^0\pi^0$ | ( 1.11 $\pm 0.35$ ) $\times 10^{-3}$ | | 1749 |
| $\omega 3\pi^0$ | < 8 $\times 10^{-4}$ | CL=90% | 1736 |
| $b_1^0\pi^0$ | ( 2.4 $\pm 0.6$ ) $\times 10^{-4}$ | | – |
| $\omega\eta$ | < 1.1 $\times 10^{-5}$ | CL=90% | 1715 |
| $\omega\eta'$ | ( 3.2 $^{+2.5}_{-2.1}$ ) $\times 10^{-5}$ | | 1623 |
| $\phi\pi^0$ | < 4 $\times 10^{-7}$ | CL=90% | 1699 |
| $\phi\pi^+\pi^-$ | ( 1.18 $\pm 0.26$ ) $\times 10^{-4}$ | S=1.5 | 1690 |
| $\phi f_0(980) \to \pi^+\pi^-$ | ( 7.5 $\pm 3.3$ ) $\times 10^{-5}$ | S=1.6 | – |
| $\phi\eta$ | ( 3.10 $\pm 0.31$ ) $\times 10^{-5}$ | | 1654 |
| $\eta\phi(2170),\ \phi(2170) \to$ $\phi f_0(980),\ f_0 \to \pi^+\pi^-$ | < 2.2 $\times 10^{-6}$ | CL=90% | – |
| $\phi\eta'$ | ( 1.54 $\pm 0.20$ ) $\times 10^{-5}$ | | 1555 |
| $\phi f_1(1285)$ | ( 3.0 $\pm 1.3$ ) $\times 10^{-5}$ | | 1436 |
| $\phi\eta(1405) \to \phi\pi^+\pi^-\eta$ | ( 8.5 $\pm 1.7$ ) $\times 10^{-6}$ | | – |
| $\phi f_2'(1525)$ | ( 4.4 $\pm 1.6$ ) $\times 10^{-5}$ | | 1325 |

| | | | | | |
|---|---|---|---|---|---|
| $K^+ K^-$ | | ( 7.5 $\pm 0.5$ ) $\times 10^{-5}$ | | | 1776 |
| $K^+ K^- \pi^+$ | | ( 7.3 $\pm 0.5$ ) $\times 10^{-4}$ | | | 1754 |
| $K^+ K^- \pi^0$ | | ( 4.07 $\pm 0.31$ ) $\times 10^{-5}$ | | | 1754 |
| $K_S^0 K_S^0$ | < | 4.6 $\times 10^{-6}$ | | | 1775 |
| $K_S^0 K_L^0$ | | ( 5.34 $\pm 0.33$ ) $\times 10^{-5}$ | | | 1775 |
| $K_S^0 K_L^0 \pi^0$ | < | 3.0 $\times 10^{-4}$ | CL=90% | | 1753 |
| $K^+ K^- \pi^0 \pi^0$ | | ( 2.6 $\pm 1.3$ ) $\times 10^{-4}$ | | | 1728 |
| $K^+ K^- \pi^+ \pi^- \pi^0$ | | ( 1.26 $\pm 0.09$ ) $\times 10^{-3}$ | | | 1694 |
| $\quad \omega f_0(1710) \to \omega K^+ K^-$ | | ( 5.9 $\pm 2.2$ ) $\times 10^{-5}$ | | | – |
| $\quad K^*(892)^0 K^- \pi^+ \pi^0 + $ c.c. | | ( 8.6 $\pm 2.2$ ) $\times 10^{-4}$ | | | – |
| $\quad K^*(892)^+ K^- \pi^+ \pi^- + $ c.c. | | ( 9.6 $\pm 2.8$ ) $\times 10^{-4}$ | | | – |
| $\quad K^*(892)^+ K^- \rho^0 + $ c.c. | | ( 7.3 $\pm 2.6$ ) $\times 10^{-4}$ | | | – |
| $\quad K^*(892)^0 K^- \rho^+ + $ c.c. | | ( 6.1 $\pm 1.8$ ) $\times 10^{-4}$ | | | – |
| $K_S^0 K_S^0 \pi^+ \pi^-$ | | ( 2.2 $\pm 0.4$ ) $\times 10^{-4}$ | | | 1724 |
| $K_S^0 K_L^0 \pi^0 \pi^0$ | | ( 1.3 $\pm 0.6$ ) $\times 10^{-3}$ | | | 1726 |
| $K_S^0 K_L^0 \eta$ | | ( 1.3 $\pm 0.5$ ) $\times 10^{-3}$ | | | 1661 |
| $\quad K^+ K^- \rho^0$ | | ( 2.2 $\pm 0.4$ ) $\times 10^{-4}$ | | | 1616 |
| $\quad K^*(892)^0 \overline{K}_2^*(1430)^0$ | | ( 1.9 $\pm 0.5$ ) $\times 10^{-4}$ | | | 1417 |
| $K^+ K^- \pi^+ \pi^- \eta$ | | ( 1.3 $\pm 0.7$ ) $\times 10^{-3}$ | | | 1574 |
| $K^+ K^- 2(\pi^+ \pi^-)$ | | ( 1.9 $\pm 0.9$ ) $\times 10^{-3}$ | | | 1654 |
| $K^+ K^- 2(\pi^+ \pi^-) \pi^0$ | | ( 1.00 $\pm 0.31$ ) $\times 10^{-3}$ | | | 1611 |
| $K^+ K^*(892)^- + $ c.c. | | ( 2.9 $\pm 0.4$ ) $\times 10^{-5}$ | S=1.2 | | 1698 |
| $2(K^+ K^-)$ | | ( 6.3 $\pm 1.3$ ) $\times 10^{-5}$ | | | 1499 |
| $2(K^+ K^-) \pi^0$ | | ( 1.10 $\pm 0.28$ ) $\times 10^{-4}$ | | | 1440 |
| $K^+ K^- \phi$ | | ( 7.0 $\pm 1.6$ ) $\times 10^{-5}$ | | | 1546 |
| $K_1(1270)^\pm K^\mp$ | | ( 1.00 $\pm 0.28$ ) $\times 10^{-3}$ | | | 1588 |
| $K^+ \overline{K}^*(892)^0 \pi^- + $ c.c. | | ( 6.7 $\pm 2.5$ ) $\times 10^{-4}$ | | | 1674 |
| $\eta K^+ K^-$, no $\eta \phi$ | | ( 3.49 $\pm 0.17$ ) $\times 10^{-5}$ | | | 1664 |
| $X(1750)\eta \to K^+ K^- \eta$ | | ( 4.8 $\pm 2.8$ ) $\times 10^{-6}$ | | | – |
| $K_1(1400)^\pm K^\mp$ | < | 3.1 $\times 10^{-4}$ | CL=90% | | 1532 |
| $K_2^*(1430)^\pm K^\mp$ | | ( 7.1 $^{+1.3}_{-0.9}$ ) $\times 10^{-5}$ | | | – |
| $K^*(892)^0 \overline{K}^0 + $ c.c. | | ( 1.09 $\pm 0.20$ ) $\times 10^{-4}$ | | | 1697 |
| $\omega K^+ K^-$ | | ( 1.62 $\pm 0.11$ ) $\times 10^{-4}$ | S=1.1 | | 1614 |
| $\omega K_S^0 K_S^0$ | | ( 7.0 $\pm 0.5$ ) $\times 10^{-5}$ | | | 1612 |
| $\omega K^*(892)^+ K^- + $ c.c. | | ( 2.07 $\pm 0.26$ ) $\times 10^{-4}$ | | | 1482 |
| $\omega K_2^*(1430)^+ K^- + $ c.c. | | ( 6.1 $\pm 1.2$ ) $\times 10^{-5}$ | | | 1252 |
| $\omega \overline{K}^*(892)^0 K^0$ | | ( 1.68 $\pm 0.30$ ) $\times 10^{-4}$ | | | 1481 |
| $\omega \overline{K}_2^*(1430)^0 K^0$ | | ( 5.8 $\pm 2.2$ ) $\times 10^{-5}$ | | | 1250 |
| $\omega X(1440) \to \omega K_S^0 K^- \pi^+ + $ c.c. | | ( 1.6 $\pm 0.4$ ) $\times 10^{-5}$ | | | – |
| $\omega X(1440) \to \omega K^+ K^- \pi^0$ | | ( 1.09 $\pm 0.26$ ) $\times 10^{-5}$ | | | – |
| $\omega f_1(1285) \to \omega K_S^0 K^- \pi^+ + $ c.c. | | ( 3.0 $\pm 1.0$ ) $\times 10^{-6}$ | | | – |

| | | | |
|---|---|---|---|
| $\omega f_1(1285) \to \omega K^+ K^- \pi^0$ | $(\ 1.2\ \pm 0.7\ ) \times 10^{-6}$ | | – |
| $p\overline{p}$ | $(\ 2.94\ \pm 0.08\ ) \times 10^{-4}$ | | 1586 |
| $n\overline{n}$ | $(\ 3.06\ \pm 0.15\ ) \times 10^{-4}$ | | 1586 |
| $p\overline{p}\pi^0$ | $(\ 1.53\ \pm 0.07\ ) \times 10^{-4}$ | | 1543 |
| $N(940)\overline{p}+$ c.c. $\to\ p\overline{p}\pi^0$ | $(\ 6.4\ ^{+1.8}_{-1.3}\ ) \times 10^{-5}$ | | – |
| $N(1440)\overline{p}+$ c.c. $\to\ p\overline{p}\pi^0$ | $(\ 7.3\ ^{+1.7}_{-1.5}\ ) \times 10^{-5}$ | S=2.5 | – |
| $N(1520)\overline{p}+$ c.c. $\to\ p\overline{p}\pi^0$ | $(\ 6.4\ ^{+2.3}_{-1.8}\ ) \times 10^{-6}$ | | – |
| $N(1535)\overline{p}+$ c.c. $\to\ p\overline{p}\pi^0$ | $(\ 2.5\ \pm 1.0\ ) \times 10^{-5}$ | | – |
| $N(1650)\overline{p}+$ c.c. $\to\ p\overline{p}\pi^0$ | $(\ 3.8\ ^{+1.4}_{-1.7}\ ) \times 10^{-5}$ | | – |
| $N(1720)\overline{p}+$ c.c. $\to\ p\overline{p}\pi^0$ | $(\ 1.79\ ^{+0.26}_{-0.70}\ ) \times 10^{-5}$ | | – |
| $N(2300)\overline{p}+$ c.c. $\to\ p\overline{p}\pi^0$ | $(\ 2.6\ ^{+1.2}_{-0.7}\ ) \times 10^{-5}$ | | – |
| $N(2570)\overline{p}+$ c.c. $\to\ p\overline{p}\pi^0$ | $(\ 2.13\ ^{+0.40}_{-0.31}\ ) \times 10^{-5}$ | | – |
| $p\overline{p}\pi^+\pi^-$ | $(\ 6.0\ \pm 0.4\ ) \times 10^{-4}$ | | 1491 |
| $p\overline{p}K^+K^-$ | $(\ 2.7\ \pm 0.7\ ) \times 10^{-5}$ | | 1118 |
| $p\overline{p}\eta$ | $(\ 6.0\ \pm 0.4\ ) \times 10^{-5}$ | | 1373 |
| $N(1535)\overline{p}+$ c.c. $\to\ p\overline{p}\eta$ | $(\ 4.5\ ^{+0.7}_{-0.6}\ ) \times 10^{-5}$ | | – |
| $p\overline{p}\pi^+\pi^-\pi^0$ | $(\ 7.3\ \pm 0.7\ ) \times 10^{-4}$ | | 1435 |
| $p\overline{p}\rho^0$ | $(\ 5.0\ \pm 2.2\ ) \times 10^{-5}$ | | 1252 |
| $p\overline{p}\omega$ | $(\ 6.9\ \pm 2.1\ ) \times 10^{-5}$ | | 1247 |
| $p\overline{p}\eta'$ | $(\ 1.10\ \pm 0.13\ ) \times 10^{-5}$ | | 1141 |
| $p\overline{p}\phi$ | $(\ 6.1\ \pm 0.6\ ) \times 10^{-6}$ | | 1109 |
| $\phi X(1835) \to\ p\overline{p}\phi$ | $<\ 1.82\ \times 10^{-7}$ | CL=90% | – |
| $p\overline{n}\pi^-$ or c.c. | $(\ 2.48\ \pm 0.17\ ) \times 10^{-4}$ | | – |
| $p\overline{n}\pi^-\pi^0$ | $(\ 3.2\ \pm 0.7\ ) \times 10^{-4}$ | | 1492 |
| $\Lambda\overline{\Lambda}$ | $(\ 3.81\ \pm 0.13\ ) \times 10^{-4}$ | S=1.4 | 1467 |
| $\Lambda\overline{\Lambda}\pi^0$ | $(\ 1.4\ \pm 0.7\ ) \times 10^{-6}$ | | 1412 |
| $\Lambda\overline{\Lambda}\eta$ | $(\ 2.43\ \pm 0.32\ ) \times 10^{-5}$ | | 1197 |
| $\Lambda(1670)\overline{\Lambda} \to\ \Lambda\overline{\Lambda}\eta$ | $(\ 1.3\ \pm 0.7\ ) \times 10^{-5}$ | | – |
| $\Lambda\overline{\Lambda}\omega(782)$ | $(\ 3.3\ \pm 0.4\ ) \times 10^{-5}$ | | 1037 |
| $\Lambda\overline{\Lambda}\pi^+\pi^-$ | $(\ 2.8\ \pm 0.6\ ) \times 10^{-4}$ | | 1346 |
| $\Lambda\overline{p}K^+$ | $(\ 1.00\ \pm 0.14\ ) \times 10^{-4}$ | | 1327 |
| $\Lambda\overline{p}K^*(892)^+ +$ c.c. | $(\ 6.3\ \pm 0.7\ ) \times 10^{-5}$ | | 1087 |
| $\Lambda\overline{p}K^+\pi^+\pi^-$ | $(\ 1.8\ \pm 0.4\ ) \times 10^{-4}$ | | 1167 |
| $\overline{\Lambda}nK^0_S +$ c.c. | $(\ 8.1\ \pm 1.8\ ) \times 10^{-5}$ | | 1324 |
| $\Delta^{++}\overline{\Delta}^{--}$ | $(\ 1.28\ \pm 0.35\ ) \times 10^{-4}$ | | 1371 |
| $\Lambda\overline{\Sigma}^+\pi^- +$ c.c. | $(\ 1.40\ \pm 0.13\ ) \times 10^{-4}$ | | 1376 |
| $\Lambda\overline{\Sigma}^-\pi^+ +$ c.c. | $(\ 1.54\ \pm 0.14\ ) \times 10^{-4}$ | | 1379 |
| $\Lambda\overline{\Sigma}^0 +$ c.c. | $(\ 1.6\ \pm 0.7\ ) \times 10^{-6}$ | | 1437 |
| $\Sigma^0\overline{p}K^+ +$ c.c. | $(\ 1.67\ \pm 0.18\ ) \times 10^{-5}$ | | 1291 |

| | | | |
|---|---|---|---|
| $\Sigma^+ \overline{\Sigma}^-$ | $(\ 2.43\ \pm 0.10\ ) \times 10^{-4}$ | S=1.4 | 1408 |
| $\Sigma^0 \overline{\Sigma}^0$ | $(\ 2.35\ \pm 0.09\ ) \times 10^{-4}$ | S=1.1 | 1405 |
| $\Sigma^- \overline{\Sigma}^+$ | $(\ 2.82\ \pm 0.09\ ) \times 10^{-4}$ | | 1401 |
| $\Sigma^+ \overline{\Sigma}^- \eta$ | $(\ 9.6\ \pm 2.4\ ) \times 10^{-6}$ | | 1108 |
| $\Sigma(1385)^+ \overline{\Sigma}(1385)^-$ | $(\ 8.5\ \pm 0.7\ ) \times 10^{-5}$ | | 1218 |
| $\Sigma(1385)^- \overline{\Sigma}(1385)^+$ | $(\ 8.5\ \pm 0.8\ ) \times 10^{-5}$ | | 1218 |
| $\Sigma(1385)^0 \overline{\Sigma}(1385)^0$ | $(\ 6.9\ \pm 0.7\ ) \times 10^{-5}$ | | 1218 |
| $\Xi^- \overline{\Xi}^+$ | $(\ 2.87\ \pm 0.11\ ) \times 10^{-4}$ | S=1.1 | 1284 |
| $\Xi^0 \overline{\Xi}^0$ | $(\ 2.3\ \pm 0.4\ ) \times 10^{-4}$ | S=4.2 | 1291 |
| $\Xi(1530)^0 \overline{\Xi}(1530)^0$ | $(\ 6.8\ \pm 0.4\ ) \times 10^{-5}$ | | 1025 |
| $\Lambda \overline{\Xi}^+ K^- +$ c.c. | $(\ 3.9\ \pm 0.4\ ) \times 10^{-5}$ | | 1114 |
| $\Xi(1530)^- \overline{\Xi}(1530)^+$ | $(\ 1.15\ \pm 0.07\ ) \times 10^{-4}$ | | 1025 |
| $\Xi(1530)^- \overline{\Xi}^+$ | $(\ 7.0\ \pm 1.2\ ) \times 10^{-6}$ | | 1165 |
| $\Xi(1530)^0 \overline{\Xi}^0$ | $(\ 5.3\ \pm 0.5\ ) \times 10^{-6}$ | | 1169 |
| $\Xi(1690)^- \overline{\Xi}^+ \rightarrow\ K^- \Lambda \overline{\Xi}^+ +$ c.c. | $(\ 5.2\ \pm 1.6\ ) \times 10^{-6}$ | | $-$ |
| $\Xi(1820)^- \overline{\Xi}^+ \rightarrow\ K^- \Lambda \overline{\Xi}^+ +$ c.c. | $(\ 1.20\ \pm 0.32\ ) \times 10^{-5}$ | | $-$ |
| $\Sigma^0 \overline{\Xi}^+ K^- +$ c.c. | $(\ 3.7\ \pm 0.4\ ) \times 10^{-5}$ | | 1060 |
| $\Omega^- \overline{\Omega}^+$ | $(\ 5.66\ \pm 0.30\ ) \times 10^{-5}$ | S=1.3 | 774 |
| $\eta_c \pi^+ \pi^- \pi^0$ | $<\ 1.0\ \times 10^{-3}$ | CL=90% | 512 |
| $h_c(1P) \pi^0$ | $(\ 7.4\ \pm 0.5\ ) \times 10^{-4}$ | | 85 |
| $\Lambda_c^+ \overline{p} e^+ e^- +$ c.c. | $<\ 1.7\ \times 10^{-6}$ | CL=90% | 830 |
| $\Theta(1540) \overline{\Theta}(1540) \rightarrow K_S^0 p K^- \overline{n} +$ c.c. | $[c]\ <\ 8.8\ \times 10^{-6}$ | CL=90% | $-$ |
| $\Theta(1540) K^- \overline{n} \rightarrow\ K_S^0 p K^- \overline{n}$ | $[c]\ <\ 1.0\ \times 10^{-5}$ | CL=90% | $-$ |
| $\Theta(1540) K_S^0 \overline{p} \rightarrow\ K_S^0 \overline{p} K^+ n$ | $[c]\ <\ 7.0\ \times 10^{-6}$ | CL=90% | $-$ |
| $\overline{\Theta}(1540) K^+ n \rightarrow\ K_S^0 \overline{p} K^+ n$ | $[c]\ <\ 2.6\ \times 10^{-5}$ | CL=90% | $-$ |
| $\overline{\Theta}(1540) K_S^0 p \rightarrow\ K_S^0 p K^- \overline{n}$ | $[c]\ <\ 6.0\ \times 10^{-6}$ | CL=90% | $-$ |

### Radiative decays

| | | | |
|---|---|---|---|
| $\gamma \chi_{c0}(1P)$ | $(\ 9.79\ \pm 0.20\ )\ \%$ | | 261 |
| $\gamma \chi_{c1}(1P)$ | $(\ 9.75\ \pm 0.24\ )\ \%$ | | 171 |
| $\gamma \chi_{c2}(1P)$ | $(\ 9.52\ \pm 0.20\ )\ \%$ | | 128 |
| $\gamma \eta_c(1S)$ | $(\ 3.4\ \pm 0.5\ ) \times 10^{-3}$ | S=1.3 | 635 |
| $\gamma \eta_c(2S)$ | $(\ 7\ \pm 5\ ) \times 10^{-4}$ | | 48 |
| $\gamma \pi^0$ | $(\ 1.04\ \pm 0.22\ ) \times 10^{-6}$ | S=1.4 | 1841 |
| $\gamma 2(\pi^+ \pi^-)$ | $(\ 4.0\ \pm 0.6\ ) \times 10^{-4}$ | | 1817 |
| $\gamma 3(\pi^+ \pi^-)$ | $<\ 1.7\ \times 10^{-4}$ | CL=90% | 1774 |
| $\gamma \eta'(958)$ | $(\ 1.24\ \pm 0.04\ ) \times 10^{-4}$ | | 1719 |
| $\gamma f_2(1270)$ | $(\ 2.73\ ^{+0.29}_{-0.25}\ ) \times 10^{-4}$ | S=1.8 | 1622 |
| $\gamma f_0(1370) \rightarrow\ \gamma K \overline{K}$ | $(\ 3.1\ \pm 1.7\ ) \times 10^{-5}$ | | 1588 |
| $\gamma f_0(1500)$ | $(\ 9.3\ \pm 1.9\ ) \times 10^{-5}$ | | 1529 |
| $\gamma f_2'(1525)$ | $(\ 3.3\ \pm 0.8\ ) \times 10^{-5}$ | | 1531 |

| | | | | |
|---|---|---|---|---|
| $\gamma f_0(1710) \rightarrow \gamma\pi\pi$ | ( 3.5 | $\pm 0.6$ ) $\times 10^{-5}$ | | – |
| $\gamma f_0(1710) \rightarrow \gamma K \overline{K}$ | ( 6.6 | $\pm 0.7$ ) $\times 10^{-5}$ | | – |
| $\gamma f_0(2100) \rightarrow \gamma\pi\pi$ | ( 4.8 | $\pm 1.0$ ) $\times 10^{-6}$ | | 1244 |
| $\gamma f_0(2200) \rightarrow \gamma K \overline{K}$ | ( 3.2 | $\pm 1.0$ ) $\times 10^{-6}$ | | 1193 |
| $\gamma f_J(2220) \rightarrow \gamma\pi\pi$ | < 5.8 | $\times 10^{-6}$ | CL=90% | 1168 |
| $\gamma f_J(2220) \rightarrow \gamma K \overline{K}$ | < 9.5 | $\times 10^{-6}$ | CL=90% | 1168 |
| $\gamma\eta$ | ( 9.2 | $\pm 1.8$ ) $\times 10^{-7}$ | | 1802 |
| $\gamma\eta\pi^+\pi^-$ | ( 8.7 | $\pm 2.1$ ) $\times 10^{-4}$ | | 1791 |
| $\gamma\eta(1405) \rightarrow \gamma K \overline{K}\pi$ | < 9 | $\times 10^{-5}$ | CL=90% | 1569 |
| $\gamma\eta(1405) \rightarrow \gamma\eta\pi^+\pi^-$ | ( 3.6 | $\pm 2.5$ ) $\times 10^{-5}$ | | – |
| $\gamma\eta(1405) \rightarrow \gamma f_0(980)\pi^0 \rightarrow$ $\gamma\pi^+\pi^-\pi^0$ | < 5.0 | $\times 10^{-7}$ | CL=90% | – |
| $\gamma\eta(1475) \rightarrow \gamma K \overline{K}\pi$ | < 1.4 | $\times 10^{-4}$ | CL=90% | – |
| $\gamma\eta(1475) \rightarrow \gamma\eta\pi^+\pi^-$ | < 8.8 | $\times 10^{-5}$ | CL=90% | – |
| $\gamma K^{*0} K^+ \pi^- +$ c.c. | ( 3.7 | $\pm 0.9$ ) $\times 10^{-4}$ | | 1674 |
| $\gamma K^{*0} \overline{K}^{*0}$ | ( 2.4 | $\pm 0.7$ ) $\times 10^{-4}$ | | 1613 |
| $\gamma K^0_S K^+ \pi^- +$ c.c. | ( 2.6 | $\pm 0.5$ ) $\times 10^{-4}$ | | 1753 |
| $\gamma K^+ K^- \pi^+\pi^-$ | ( 1.9 | $\pm 0.5$ ) $\times 10^{-4}$ | | 1726 |
| $\gamma K^+ K^- 2(\pi^+\pi^-)$ | < 2.2 | $\times 10^{-4}$ | CL=90% | 1654 |
| $\gamma 2(K^+ K^-)$ | < 4 | $\times 10^{-5}$ | CL=90% | 1499 |
| $\gamma p \overline{p}$ | ( 3.9 | $\pm 0.5$ ) $\times 10^{-5}$ | S=2.0 | 1586 |
| $\gamma f_2(1950) \rightarrow \gamma p \overline{p}$ | ( 1.20 | $\pm 0.22$ ) $\times 10^{-5}$ | | – |
| $\gamma f_2(2150) \rightarrow \gamma p \overline{p}$ | ( 7.2 | $\pm 1.8$ ) $\times 10^{-6}$ | | – |
| $\gamma X(1835) \rightarrow \gamma p \overline{p}$ | ( 4.6 | $^{+1.8}_{-4.0}$ ) $\times 10^{-6}$ | | – |
| $\gamma X \rightarrow \gamma p \overline{p}$ | [h] < 2 | $\times 10^{-6}$ | CL=90% | – |
| $\gamma p \overline{p}\pi^+\pi^-$ | ( 2.8 | $\pm 1.4$ ) $\times 10^{-5}$ | | 1491 |
| $\gamma\gamma$ | < 1.5 | $\times 10^{-4}$ | CL=90% | 1843 |
| $\gamma\gamma J/\psi$ | ( 3.1 | $^{+1.0}_{-1.2}$ ) $\times 10^{-4}$ | | 542 |
| $e^+ e^- \eta'$ | ( 1.90 | $\pm 0.26$ ) $\times 10^{-6}$ | | 1719 |
| $e^+ e^- \eta_c(1S)$ | ( 3.8 | $\pm 0.4$ ) $\times 10^{-5}$ | | 635 |
| $e^+ e^- \chi_{c0}(1P)$ | ( 1.06 | $\pm 0.24$ ) $\times 10^{-3}$ | | 261 |
| $e^+ e^- \chi_{c1}(1P)$ | ( 8.5 | $\pm 0.6$ ) $\times 10^{-4}$ | | 171 |
| $e^+ e^- \chi_{c2}(1P)$ | ( 7.0 | $\pm 0.8$ ) $\times 10^{-4}$ | | 128 |

### Weak decays

| | | | | |
|---|---|---|---|---|
| $D^0 e^+ e^- +$ c.c. | < 1.4 | $\times 10^{-7}$ | CL=90% | 1371 |
| $\Lambda_c^+ \overline{\Sigma}^- +$ c.c. | < 1.4 | $\times 10^{-5}$ | CL=90% | 586 |

### Other decays

| | | | | |
|---|---|---|---|---|
| invisible | < 1.6 | % | CL=90% | – |

## $\psi(3770)$

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass $m = 3773.7 \pm 0.4$ MeV    (S = 1.4)
Full width $\Gamma = 27.2 \pm 1.0$ MeV

| $\psi(3770)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | Scale factor/ Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|
| $D\overline{D}$ | $(93 \ ^{+8}_{-9} \ )\%$ | S=2.0 | 287 |
| $D^0\overline{D}^0$ | $(52 \ ^{+4}_{-5} \ )\%$ | S=2.0 | 287 |
| $D^+D^-$ | $(41 \ \pm 4 \ )\%$ | S=2.0 | 254 |
| $J/\psi X$ | $( 5.0 \ \pm 2.2 \ ) \times 10^{-3}$ | | – |
| $J/\psi \pi^+\pi^-$ | $( 1.93 \pm 0.28) \times 10^{-3}$ | | 561 |
| $J/\psi \pi^0\pi^0$ | $( 8.0 \ \pm 3.0 \ ) \times 10^{-4}$ | | 565 |
| $J/\psi \eta$ | $( 9 \ \pm 4 \ ) \times 10^{-4}$ | | 361 |
| $J/\psi \pi^0$ | $< 2.8 \ \times 10^{-4}$ | CL=90% | 604 |
| $e^+e^-$ | $( 9.6 \ \pm 0.7 \ ) \times 10^{-6}$ | S=1.3 | 1887 |

### Decays to light hadrons

| | | | |
|---|---|---|---|
| $b_1(1235)\pi$ | $< 1.4 \ \times 10^{-5}$ | CL=90% | 1684 |
| $\phi\eta'$ | $< 7 \ \times 10^{-4}$ | CL=90% | 1607 |
| $\omega\eta'$ | $< 4 \ \times 10^{-4}$ | CL=90% | 1672 |
| $\rho^0\eta'$ | $< 6 \ \times 10^{-4}$ | CL=90% | 1674 |
| $\phi\eta$ | $( 3.1 \ \pm 0.7 \ ) \times 10^{-4}$ | | 1703 |
| $\omega\eta$ | $< 1.4 \ \times 10^{-5}$ | CL=90% | 1762 |
| $\rho^0\eta$ | $< 5 \ \times 10^{-4}$ | CL=90% | 1764 |
| $\phi\pi^0$ | $< 3 \ \times 10^{-5}$ | CL=90% | 1746 |
| $\omega\pi^0$ | $< 6 \ \times 10^{-4}$ | CL=90% | 1803 |
| $\pi^+\pi^-\pi^0$ | $< 5 \ \times 10^{-6}$ | CL=90% | 1874 |
| $\rho\pi$ | $< 5 \ \times 10^{-6}$ | CL=90% | 1805 |
| $K^*(892)^+K^- + $ c.c. | $< 1.4 \ \times 10^{-5}$ | CL=90% | 1745 |
| $K^*(892)^0\overline{K}^0 + $ c.c. | $< 1.2 \ \times 10^{-3}$ | CL=90% | 1745 |
| $K^0_S K^0_L$ | $< 1.2 \ \times 10^{-5}$ | CL=90% | 1820 |
| $2(\pi^+\pi^-)$ | $< 1.12 \ \times 10^{-3}$ | CL=90% | 1861 |
| $2(\pi^+\pi^-)\pi^0$ | $< 1.06 \ \times 10^{-3}$ | CL=90% | 1844 |
| $2(\pi^+\pi^-\pi^0)$ | $< 5.85 \ \%$ | CL=90% | 1821 |
| $\omega\pi^+\pi^-$ | $< 6.0 \ \times 10^{-4}$ | CL=90% | 1794 |
| $3(\pi^+\pi^-)$ | $< 9.1 \ \times 10^{-3}$ | CL=90% | 1820 |
| $3(\pi^+\pi^-)\pi^0$ | $< 1.37 \ \%$ | CL=90% | 1792 |
| $3(\pi^+\pi^-)2\pi^0$ | $< 11.74 \ \%$ | CL=90% | 1760 |
| $\eta\pi^+\pi^-$ | $< 1.24 \ \times 10^{-3}$ | CL=90% | 1836 |
| $\pi^+\pi^-2\pi^0$ | $< 8.9 \ \times 10^{-3}$ | CL=90% | 1862 |
| $\rho^0\pi^+\pi^-$ | $< 6.9 \ \times 10^{-3}$ | CL=90% | 1796 |
| $\eta 3\pi$ | $< 1.34 \ \times 10^{-3}$ | CL=90% | 1824 |
| $\eta 2(\pi^+\pi^-)$ | $< 2.43 \ \%$ | CL=90% | 1804 |

| | | | | |
|---|---|---|---|---|
| $\eta \rho^0 \pi^+ \pi^-$ | $< 1.45$ | $\%$ | CL=90% | 1708 |
| $\eta' 3\pi$ | $< 2.44$ | $\times 10^{-3}$ | CL=90% | 1741 |
| $K^+ K^- \pi^+ \pi^-$ | $< 9.0$ | $\times 10^{-4}$ | CL=90% | 1773 |
| $\phi \pi^+ \pi^-$ | $< 4.1$ | $\times 10^{-4}$ | CL=90% | 1737 |
| $K^+ K^- 2\pi^0$ | $< 4.2$ | $\times 10^{-3}$ | CL=90% | 1774 |
| $4(\pi^+ \pi^-)$ | $< 1.67$ | $\%$ | CL=90% | 1757 |
| $4(\pi^+ \pi^-)\pi^0$ | $< 3.06$ | $\%$ | CL=90% | 1720 |
| $\phi f_0(980)$ | $< 4.5$ | $\times 10^{-4}$ | CL=90% | 1597 |
| $K^+ K^- \pi^+ \pi^- \pi^0$ | $< 2.36$ | $\times 10^{-3}$ | CL=90% | 1741 |
| $K^+ K^- \rho^0 \pi^0$ | $< 8$ | $\times 10^{-4}$ | CL=90% | 1624 |
| $K^+ K^- \rho^+ \pi^-$ | $< 1.46$ | $\%$ | CL=90% | 1623 |
| $\omega K^+ K^-$ | $< 3.4$ | $\times 10^{-4}$ | CL=90% | 1664 |
| $\phi \pi^+ \pi^- \pi^0$ | $< 3.8$ | $\times 10^{-3}$ | CL=90% | 1723 |
| $K^{*0} K^- \pi^+ \pi^0 +$ c.c. | $< 1.62$ | $\%$ | CL=90% | 1694 |
| $K^{*+} K^- \pi^+ \pi^- +$ c.c. | $< 3.23$ | $\%$ | CL=90% | 1693 |
| $K^+ K^- \pi^+ \pi^- 2\pi^0$ | $< 2.67$ | $\%$ | CL=90% | 1705 |
| $K^+ K^- 2(\pi^+ \pi^-)$ | $< 1.03$ | $\%$ | CL=90% | 1702 |
| $K^+ K^- 2(\pi^+ \pi^-)\pi^0$ | $< 3.60$ | $\%$ | CL=90% | 1661 |
| $\eta K^+ K^-$ | $< 4.1$ | $\times 10^{-4}$ | CL=90% | 1712 |
| $\eta K^+ K^- \pi^+ \pi^-$ | $< 1.24$ | $\%$ | CL=90% | 1624 |
| $\rho^0 K^+ K^-$ | $< 5.0$ | $\times 10^{-3}$ | CL=90% | 1666 |
| $2(K^+ K^-)$ | $< 6.0$ | $\times 10^{-4}$ | CL=90% | 1552 |
| $\phi K^+ K^-$ | $< 7.5$ | $\times 10^{-4}$ | CL=90% | 1598 |
| $2(K^+ K^-)\pi^0$ | $< 2.9$ | $\times 10^{-4}$ | CL=90% | 1494 |
| $2(K^+ K^-)\pi^+ \pi^-$ | $< 3.2$ | $\times 10^{-3}$ | CL=90% | 1426 |
| $K^0_S K^- \pi^+$ | $< 3.2$ | $\times 10^{-3}$ | CL=90% | 1799 |
| $K^0_S K^- \pi^+ \pi^0$ | $< 1.33$ | $\%$ | CL=90% | 1773 |
| $K^0_S K^- \rho^+$ | $< 6.6$ | $\times 10^{-3}$ | CL=90% | 1665 |
| $K^0_S K^- 2\pi^+ \pi^-$ | $< 8.7$ | $\times 10^{-3}$ | CL=90% | 1740 |
| $K^0_S K^- \pi^+ \rho^0$ | $< 1.6$ | $\%$ | CL=90% | 1621 |
| $K^0_S K^- \pi^+ \eta$ | $< 1.3$ | $\%$ | CL=90% | 1670 |
| $K^0_S K^- 2\pi^+ \pi^- \pi^0$ | $< 4.18$ | $\%$ | CL=90% | 1703 |
| $K^0_S K^- 2\pi^+ \pi^- \eta$ | $< 4.8$ | $\%$ | CL=90% | 1570 |
| $K^0_S K^- \pi^+ 2(\pi^+ \pi^-)$ | $< 1.22$ | $\%$ | CL=90% | 1658 |
| $K^0_S K^- \pi^+ 2\pi^0$ | $< 2.65$ | $\%$ | CL=90% | 1742 |
| $K^0_S K^- K^+ K^- \pi^+$ | $< 4.9$ | $\times 10^{-3}$ | CL=90% | 1491 |
| $K^0_S K^- K^+ K^- \pi^+ \pi^0$ | $< 3.0$ | $\%$ | CL=90% | 1427 |
| $K^0_S K^- K^+ K^- \pi^+ \eta$ | $< 2.2$ | $\%$ | CL=90% | 1214 |
| $K^{*0} K^- \pi^+ +$ c.c. | $< 9.7$ | $\times 10^{-3}$ | CL=90% | 1722 |
| $p \overline{p} \pi^0$ | $< 4$ | $\times 10^{-5}$ | CL=90% | 1595 |
| $p \overline{p} \pi^+ \pi^-$ | $< 5.8$ | $\times 10^{-4}$ | CL=90% | 1544 |
| $\Lambda \overline{\Lambda}$ | $< 1.2$ | $\times 10^{-4}$ | CL=90% | 1522 |
| $p \overline{p} \pi^+ \pi^- \pi^0$ | $< 1.85$ | $\times 10^{-3}$ | CL=90% | 1490 |

| | | | | |
|---|---|---|---|---|
| $\omega p \overline{p}$ | < 2.9 | $\times 10^{-4}$ | CL=90% | 1310 |
| $\Lambda \overline{\Lambda} \pi^0$ | < 7 | $\times 10^{-5}$ | CL=90% | 1469 |
| $p \overline{p} 2(\pi^+ \pi^-)$ | < 2.6 | $\times 10^{-3}$ | CL=90% | 1426 |
| $\eta p \overline{p}$ | < 5.4 | $\times 10^{-4}$ | CL=90% | 1431 |
| $\eta p \overline{p} \pi^+ \pi^-$ | < 3.3 | $\times 10^{-3}$ | CL=90% | 1284 |
| $\rho^0 p \overline{p}$ | < 1.7 | $\times 10^{-3}$ | CL=90% | 1314 |
| $p \overline{p} K^+ K^-$ | < 3.2 | $\times 10^{-4}$ | CL=90% | 1186 |
| $\eta p \overline{p} K^+ K^-$ | < 6.9 | $\times 10^{-3}$ | CL=90% | 737 |
| $\pi^0 p \overline{p} K^+ K^-$ | < 1.2 | $\times 10^{-3}$ | CL=90% | 1094 |
| $\phi p \overline{p}$ | < 1.3 | $\times 10^{-4}$ | CL=90% | 1178 |
| $\Lambda \overline{\Lambda} \pi^+ \pi^-$ | < 2.5 | $\times 10^{-4}$ | CL=90% | 1405 |
| $\Lambda \overline{p} K^+$ | < 2.8 | $\times 10^{-4}$ | CL=90% | 1387 |
| $\Lambda \overline{p} K^+ \pi^+ \pi^-$ | < 6.3 | $\times 10^{-4}$ | CL=90% | 1234 |
| $\Lambda \overline{\Lambda} \eta$ | < 1.9 | $\times 10^{-4}$ | CL=90% | 1263 |
| $\Sigma^+ \overline{\Sigma}^-$ | < 1.0 | $\times 10^{-4}$ | CL=90% | 1465 |
| $\Sigma^0 \overline{\Sigma}^0$ | < 4 | $\times 10^{-5}$ | CL=90% | 1462 |
| $\Xi^+ \overline{\Xi}^-$ | < 1.5 | $\times 10^{-4}$ | CL=90% | 1347 |
| $\Xi^0 \overline{\Xi}^0$ | < 1.4 | $\times 10^{-4}$ | CL=90% | 1353 |

## Radiative decays

| | | | | |
|---|---|---|---|---|
| $\gamma \chi_{c2}$ | < 6.4 | $\times 10^{-4}$ | CL=90% | 211 |
| $\gamma \chi_{c1}$ | ( 2.49±0.23) $\times 10^{-3}$ | | | 254 |
| $\gamma \chi_{c0}$ | ( 6.9 ±0.6 ) $\times 10^{-3}$ | | | 342 |
| $\gamma \eta_c$ | < 7 | $\times 10^{-4}$ | CL=90% | 707 |
| $\gamma \eta_c(2S)$ | < 9 | $\times 10^{-4}$ | CL=90% | 134 |
| $\gamma \eta'$ | < 1.8 | $\times 10^{-4}$ | CL=90% | 1765 |
| $\gamma \eta$ | < 1.5 | $\times 10^{-4}$ | CL=90% | 1847 |
| $\gamma \pi^0$ | < 2 | $\times 10^{-4}$ | CL=90% | 1884 |

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## $\psi_2(3823)$

$I^G(J^{PC}) = 0^-(2^{--})$
*I, J, P* need confirmation.

was $\psi(3823)$, $X(3823)$

Mass $m = 3823.5 \pm 0.5$ MeV  (S = 1.4)
Full width $\Gamma$ < 2.9 MeV, CL = 90%

Branching fractions are given relative to the one **DEFINED AS 1**.

| $\psi_2(3823)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|
| $J/\psi(1S) \pi^+ \pi^-$ | <0.06 | 90% | 607 |
| $J/\psi(1S) \pi^0 \pi^0$ | <0.11 | 90% | 610 |
| $J/\psi(1S) \pi^0$ | <0.030 | 90% | 646 |
| $J/\psi(1S) \eta$ | <0.14 | 90% | 431 |
| $\chi_{c0} \gamma$ | <0.24 | 90% | 387 |
| $\chi_{c1} \gamma$ | **DEFINED AS 1** | | 300 |

| | | |
|---|---|---|
| $\chi_{c2}\gamma$ | $0.28\ ^{+0.14}_{-0.11}$ | 258 |

## $\psi_3(3842)$

$$I^G(J^{PC}) = 0^-(3^{--})$$
$J,\ P$ need confirmation.

Seen by a single experiment only.

Mass $m = 3842.71 \pm 0.20$ MeV

Full width $\Gamma = 2.8 \pm 0.6$ MeV

| $\psi_3(3842)$ DECAY MODES | Fraction $(\Gamma_i/\Gamma)$ | $p$ (MeV/$c$) |
|---|---|---|
| $D^+D^-$ | seen | 443 |
| $D^0\overline{D}^0$ | seen | 463 |

## $\chi_{c1}(3872)$

$$I^G(J^{PC}) = 0^+(1^{++})$$

also known as $X(3872)$

Mass $m = 3871.65 \pm 0.06$ MeV

$m_{\chi_{c1}(3872)} - m_{J/\psi} = 775 \pm 4$ MeV

Full width $\Gamma = 1.19 \pm 0.21$ MeV    ($S = 1.1$)

| $\chi_{c1}(3872)$ DECAY MODES | Fraction $(\Gamma_i/\Gamma)$ | Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|
| $e^+e^-$ | $< 2.8 \times 10^{-6}$ | 90% | 1936 |
| $\pi^+\pi^-\pi^0$ | $< 9 \times 10^{-3}$ | 90% | 1924 |
| $\pi^+\pi^- J/\psi(1S)$ | $(3.8\pm 1.2)\%$ | | 650 |
| $\pi^+\pi^-\pi^0 J/\psi(1S)$ | not seen | | 588 |
| $\omega\eta_c(1S)$ | $< 33\%$ | 90% | 368 |
| $\omega J/\psi(1S)$ | $(4.3\pm 2.1)\%$ | | † |
| $\phi\phi$ | not seen | | 1646 |
| $D^0\overline{D}^0\pi^0$ | $(49\ ^{+18}_{-20})\%$ | | 116 |
| $\overline{D}^{*0}D^0$ | $(37\ \pm 9\ )\%$ | | † |
| $\gamma\gamma$ | $< 11\%$ | 90% | 1936 |
| $D^0\overline{D}^0$ | $< 29\%$ | 90% | 519 |
| $D^+D^-$ | $< 19\%$ | 90% | 502 |
| $\pi^0\chi_{c2}$ | $< 4\%$ | 90% | 273 |
| $\pi^0\chi_{c1}$ | $(3.4\pm 1.6)\%$ | | 319 |
| $\pi^0\chi_{c0}$ | $< 14\%$ | 90% | – |
| $\pi^+\pi^-\eta_c(1S)$ | $< 14\%$ | 90% | 745 |
| $\pi^0\pi^0\chi_{c0}$ | $< 7\%$ | 90% | 347 |
| $\pi^+\pi^-\chi_{c0}$ | $< 2.1\%$ | 90% | 340 |
| $\pi^+\pi^-\chi_{c1}$ | $< 7 \times 10^{-3}$ | 90% | 218 |
| $p\overline{p}$ | $< 2.4 \times 10^{-5}$ | 95% | 1693 |

### Radiative decays

| | | | | |
|---|---|---|---|---|
| $\gamma D^+ D^-$ | < 4 | % | 90% | 502 |
| $\gamma \overline{D}^0 D^0$ | < 6 | % | 90% | 519 |
| $\gamma J/\psi$ | $( 8 \pm 4 ) \times 10^{-3}$ | | | 697 |
| $\gamma \chi_{c1}$ | < 9 | $\times 10^{-3}$ | 90% | 344 |
| $\gamma \chi_{c2}$ | < 3.2 | % | 90% | 303 |
| $\gamma \psi(2S)$ | $( 4.5 \pm 2.0) \%$ | | | 181 |

### C-violating decays

| | | | | |
|---|---|---|---|---|
| $\eta J/\psi$ | < 1.8 | % | 90% | 491 |

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## $\chi_{c0}(3915)$ $\qquad\qquad I^G(J^{PC}) = 0^+(0^{++})$

was $X(3915)$

Mass $m = 3921.7 \pm 1.8$ MeV  (S = 1.5)
Full width $\Gamma = 18.8 \pm 3.5$ MeV

| $\chi_{c0}(3915)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | $p$ (MeV/$c$) |
|---|---|---|
| $\omega J/\psi$ | seen | 231 |
| $\overline{D}^{*0} D^0$ | not seen | 312 |
| $D^+ D^-$ | seen | 591 |
| $\pi^+ \pi^- \eta_c(1S)$ | not seen | 788 |
| $\eta_c \eta$ | not seen | 668 |
| $\eta_c \pi^0$ | not seen | 817 |
| $K \overline{K}$ | not seen | 1898 |
| $\gamma\gamma$ | seen | 1961 |
| $\pi^0 \chi_{c1}$ | not seen | 368 |

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## $\chi_{c2}(3930)$ $\qquad\qquad I^G(J^{PC}) = 0^+(2^{++})$

Mass $m = 3922.5 \pm 1.0$ MeV  (S = 1.7)
Full width $\Gamma = 35.2 \pm 2.2$ MeV  (S = 1.2)

| $\chi_{c2}(3930)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | $p$ (MeV/$c$) |
|---|---|---|
| $\gamma\gamma$ | seen | 1961 |
| $D \overline{D}$ | seen | 607 |
| $\quad D^+ D^-$ | seen | 592 |
| $\quad D^0 \overline{D}^0$ | seen | 607 |
| $\pi^+ \pi^- \eta_c(1S)$ | not seen | 788 |
| $K \overline{K}$ | not seen | 1898 |

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## $\psi(4040)$ [i]

$$I^G(J^{PC}) = 0^-(1^{--})$$

Mass $m = 4039 \pm 1$ MeV

Full width $\Gamma = 80 \pm 10$ MeV

Due to the complexity of the $c\overline{c}$ threshold region, in this listing, "seen" ("not seen") means that a cross section for the mode in question has been measured at effective $\sqrt{s}$ near this particle's central mass value, more (less) than $2\sigma$ above zero, without regard to any peaking behavior in $\sqrt{s}$ or absence thereof. See mode listing(s) for details and references.

| $\psi(4040)$ DECAY MODES | Fraction $(\Gamma_i/\Gamma)$ | | Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|---|
| $e^+ e^-$ | $(1.07 \pm 0.16) \times 10^{-5}$ | | | 2019 |
| $D\overline{D}$ | seen | | | 775 |
| $\quad D^0\overline{D}^0$ | seen | | | 775 |
| $\quad D^+ D^-$ | seen | | | 763 |
| $D^*\overline{D}+$ c.c. | seen | | | 569 |
| $\quad D^*(2007)^0\overline{D}^0 +$ c.c. | seen | | | 575 |
| $\quad D^*(2010)^+ D^- +$ c.c. | seen | | | 561 |
| $D^*\overline{D}^*$ | seen | | | 193 |
| $\quad D^*(2007)^0\overline{D}^*(2007)^0$ | seen | | | 226 |
| $\quad D^*(2010)^+ D^*(2010)^-$ | seen | | | 193 |
| $D^0 D^- \pi^+ +$c.c. (excl. $D^*(2007)^0\overline{D}^0$ +c.c., $D^*(2010)^+ D^-$ +c.c.) | not seen | | | – |
| $D\overline{D}^*\pi$ (excl. $D^*\overline{D}^*$) | not seen | | | – |
| $\quad D^0\overline{D}^{*-}\pi^+ +$c.c. (excl. $D^*(2010)^+ D^*(2010)^-$) | seen | | | – |
| $D_s^+ D_s^-$ | seen | | | 452 |
| $J/\psi\pi^+\pi^-$ | $< 4$ | $\times 10^{-3}$ | 90% | 794 |
| $J/\psi\pi^0\pi^0$ | $< 2$ | $\times 10^{-3}$ | 90% | 797 |
| $J/\psi\eta$ | $(5.2 \pm 0.7) \times 10^{-3}$ | | | 675 |
| $J/\psi\pi^0$ | $< 2.8$ | $\times 10^{-4}$ | 90% | 823 |
| $J/\psi\pi^+\pi^-\pi^0$ | $< 2$ | $\times 10^{-3}$ | 90% | 746 |
| $\chi_{c1}\gamma$ | $< 3.4$ | $\times 10^{-3}$ | 90% | 494 |
| $\chi_{c2}\gamma$ | $< 5$ | $\times 10^{-3}$ | 90% | 454 |
| $\chi_{c1}\pi^+\pi^-\pi^0$ | $< 1.1$ | % | 90% | 306 |
| $\chi_{c2}\pi^+\pi^-\pi^0$ | $< 3.2$ | % | 90% | 233 |
| $h_c(1P)\pi^+\pi^-$ | $< 3$ | $\times 10^{-3}$ | 90% | 403 |
| $\phi\pi^+\pi^-$ | $< 3$ | $\times 10^{-3}$ | 90% | 1880 |
| $\Lambda\overline{\Lambda}\pi^+\pi^-$ | $< 2.9$ | $\times 10^{-4}$ | 90% | 1578 |
| $\Lambda\overline{\Lambda}\pi^0$ | $< 9$ | $\times 10^{-5}$ | 90% | 1636 |
| $\Lambda\overline{\Lambda}\eta$ | $< 3.0$ | $\times 10^{-4}$ | 90% | 1452 |
| $\Lambda\overline{\Lambda}$ | $< 6$ | $\times 10^{-6}$ | 90% | 1683 |

| | | | | |
|---|---|---|---|---|
| $\Sigma^+ \overline{\Sigma}^-$ | $< 1.3$ | $\times 10^{-4}$ | 90% | 1632 |
| $\Sigma^0 \overline{\Sigma}^0$ | $< 7$ | $\times 10^{-5}$ | 90% | 1630 |
| $\Xi^+ \overline{\Xi}^-$ | $< 1.6$ | $\times 10^{-4}$ | 90% | 1527 |
| $\Xi^0 \overline{\Xi}^0$ | $< 1.8$ | $\times 10^{-4}$ | 90% | 1533 |
| $\mu^+ \mu^-$ | $(9 \pm 6) \times 10^{-6}$ | | | 2017 |

## $\chi_{c1}(4140)$ $\qquad\qquad I^G(J^{PC}) = 0^+(1^{++})$

was $X(4140)$

Mass $m = 4146.5 \pm 3.0$ MeV  (S = 1.3)
Full width $\Gamma = 19^{+7}_{-5}$ MeV

| $\chi_{c1}(4140)$ DECAY MODES | Fraction $(\Gamma_i/\Gamma)$ | $p$ (MeV/c) |
|---|---|---|
| $J/\psi\,\phi$ | seen | 216 |
| $\gamma\gamma$ | not seen | 2073 |

## $\psi(4160)$ [i] $\qquad\qquad I^G(J^{PC}) = 0^-(1^{--})$

Mass $m = 4191 \pm 5$ MeV
Full width $\Gamma = 70 \pm 10$ MeV

Due to the complexity of the $c\overline{c}$ threshold region, in this listing, "seen" ("not seen") means that a cross section for the mode in question has been measured at effective $\sqrt{s}$ near this particle's central mass value, more (less) than $2\sigma$ above zero, without regard to any peaking behavior in $\sqrt{s}$ or absence thereof. See mode listing(s) for details and references.

| $\psi(4160)$ DECAY MODES | Fraction $(\Gamma_i/\Gamma)$ | Confidence level | $p$ (MeV/c) |
|---|---|---|---|
| $e^+ e^-$ | $(6.9 \pm 3.3) \times 10^{-6}$ | | 2096 |
| $\mu^+ \mu^-$ | seen | | 2093 |
| $D\overline{D}$ | seen | | 956 |
| $\quad D^0 \overline{D}^0$ | seen | | 956 |
| $\quad D^+ D^-$ | seen | | 947 |
| $D^* \overline{D} +$ c.c. | seen | | 798 |
| $\quad D^*(2007)^0 \overline{D}^0 +$ c.c. | seen | | 802 |
| $\quad D^*(2010)^+ D^- +$ c.c. | seen | | 792 |
| $D^* \overline{D}^*$ | seen | | 592 |
| $\quad D^*(2007)^0 \overline{D}^*(2007)^0$ | seen | | 604 |
| $\quad D^*(2010)^+ D^*(2010)^-$ | seen | | 592 |
| $D^0 D^- \pi^+ +$c.c. (excl. $\quad D^*(2007)^0 \overline{D}^0$ +c.c., $\quad D^*(2010)^+ D^-$ +c.c.) | not seen | | — |

| | | | | |
|---|---|---|---|---|
| $D\overline{D}^*\pi$ +c.c. (excl. $D^*\overline{D}^*$) | seen | | | − |
| $D^0 D^{*-}\pi^+$ +c.c. (excl. $D^*(2010)^+ D^*(2010)^-$) | not seen | | | − |
| $D_s^+ D_s^-$ | not seen | | | 719 |
| $D_s^{*+} D_s^-$ +c.c. | seen | | | 385 |
| $J/\psi\pi^+\pi^-$ | < 3 | $\times 10^{-3}$ | 90% | 919 |
| $J/\psi\pi^0\pi^0$ | < 3 | $\times 10^{-3}$ | 90% | 922 |
| $J/\psi K^+ K^-$ | < 2 | $\times 10^{-3}$ | 90% | 407 |
| $J/\psi\eta$ | < 8 | $\times 10^{-3}$ | 90% | 822 |
| $J/\psi\pi^0$ | < 1 | $\times 10^{-3}$ | 90% | 944 |
| $J/\psi\eta'$ | < 5 | $\times 10^{-3}$ | 90% | 457 |
| $J/\psi\pi^+\pi^-\pi^0$ | < 1 | $\times 10^{-3}$ | 90% | 879 |
| $\psi(2S)\pi^+\pi^-$ | < 4 | $\times 10^{-3}$ | 90% | 396 |
| $\chi_{c1}\gamma$ | < 5 | $\times 10^{-3}$ | 90% | 625 |
| $\chi_{c2}\gamma$ | < 1.3 | % | 90% | 587 |
| $\chi_{c1}\pi^+\pi^-\pi^0$ | < 2 | $\times 10^{-3}$ | 90% | 496 |
| $\chi_{c2}\pi^+\pi^-\pi^0$ | < 8 | $\times 10^{-3}$ | 90% | 445 |
| $h_c(1P)\pi^+\pi^-$ | < 5 | $\times 10^{-3}$ | 90% | 556 |
| $h_c(1P)\pi^0\pi^0$ | < 2 | $\times 10^{-3}$ | 90% | 560 |
| $h_c(1P)\eta$ | < 2 | $\times 10^{-3}$ | 90% | 348 |
| $h_c(1P)\pi^0$ | < 4 | $\times 10^{-4}$ | 90% | 600 |
| $\phi\pi^+\pi^-$ | < 2 | $\times 10^{-3}$ | 90% | 1961 |
| $\gamma\chi_{c1}(3872)$ | < 1.8 | $\times 10^{-3}$ | 90% | 308 |
| $\gamma\chi_{c0}(3915) \to \gamma J/\psi\pi^+\pi^-$ | < 1.36 | $\times 10^{-4}$ | 90% | − |
| $\gamma X(3930) \to \gamma J/\psi\pi^+\pi^-$ | < 1.18 | $\times 10^{-4}$ | 90% | − |
| $\gamma X(3940) \to \gamma J/\psi\pi^+\pi^-$ | < 1.47 | $\times 10^{-4}$ | 90% | − |
| $\gamma\chi_{c0}(3915) \to \gamma\gamma J/\psi$ | < 1.26 | $\times 10^{-4}$ | 90% | − |
| $\gamma X(3930) \to \gamma\gamma J/\psi$ | < 8.8 | $\times 10^{-5}$ | 90% | − |
| $\gamma X(3940) \to \gamma\gamma J/\psi$ | < 1.79 | $\times 10^{-4}$ | 90% | − |
| $\omega\pi^0$ | not seen | | | 2020 |
| $\omega\eta$ | not seen | | | 1984 |
| $p\overline{p}p\overline{p}$ | not seen | | | 834 |
| $\Lambda\overline{\Lambda}$ | < 1.5 | $\times 10^{-6}$ | 90% | 1774 |

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## $\psi(4230)$ $\qquad\qquad\qquad I^G(J^{PC}) = 0^-(1^{--})$

also known as $Y(4230)$; was $\psi(4260)$

Mass $m = 4222.5 \pm 2.4$ MeV  (S = 1.7)
Full width $\Gamma = 48 \pm 8$ MeV  (S = 3.6)

| $\psi(4230)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | $p$ (MeV/$c$) |
|---|---|---|
| $\mu^+\mu^-$ | $(3.2\pm 2.9)\times 10^{-5}$ | 2107 |
| $\eta_c(1S)\pi^+\pi^-$ | not seen | 1027 |

| | | |
|---|---|---:|
| $\eta_c(1S)\pi^+\pi^-\pi^0$ | seen | 992 |
| $J/\psi\pi^+\pi^-$ | seen | 942 |
| $\quad J/\psi f_0(980),\ f_0(980)\to\ \pi^+\pi^-$ | seen | — |
| $\quad Z_c(3900)^\pm\pi^\mp,\ Z_c^\pm\to\ J/\psi\pi^\pm$ | seen | — |
| $J/\psi\pi^0\pi^0$ | seen | 944 |
| $J/\psi K^+K^-$ | seen | 460 |
| $J/\psi K_S^0 K_S^0$ | not seen | 447 |
| $J/\psi\eta$ | seen | 848 |
| $J/\psi\pi^0$ | not seen | 966 |
| $J/\psi\eta'$ | seen | 504 |
| $J/\psi\pi^+\pi^-\pi^0$ | not seen | 904 |
| $J/\psi\eta\pi^0$ | not seen | 770 |
| $J/\psi\eta\eta$ | not seen | 211 |
| $\psi(2S)\pi^+\pi^-$ | seen | 426 |
| $\psi(2S)\eta$ | not seen | † |
| $\chi_{c0}\omega$ | seen | 171 |
| $\chi_{c1}\pi^+\pi^-\pi^0$ | not seen | 527 |
| $\chi_{c2}\pi^+\pi^-\pi^0$ | not seen | 477 |
| $h_c(1P)\pi^+\pi^-$ | seen | 583 |
| $\phi\pi^+\pi^-$ | not seen | 1976 |
| $\quad \phi f_0(980)\to\ \phi\pi^+\pi^-$ | not seen | — |
| $D\overline{D}$ | not seen | 987 |
| $\quad D^0\overline{D}^0$ | not seen | 987 |
| $\quad D^+D^-$ | not seen | 978 |
| $D^*\overline{D}+$c.c. | not seen | 887 |
| $\quad D^*(2007)^0\overline{D}^0+$c.c. | not seen | — |
| $\quad D^*(2010)^+D^-+$c.c. | not seen | — |
| $\quad D^*(2007)^0\overline{D}^*(2007)^0$ | not seen | 652 |
| $\quad D^*(2010)^+D^*(2010)^-$ | not seen | 641 |
| $\quad D^0D^-\pi^++$c.c. (excl. $D^*(2007)^0\overline{D}^{*0}+$c.c., $D^*(2010)^+D^-+$c.c.) | not seen | — |
| $D\overline{D}^*\pi+$c.c. (excl. $D^*\overline{D}^*$) | not seen | 723 |
| $D^0D^{*-}\pi^++$c.c. (excl. $D^*(2010)^+D^*(2010)^-$) | not seen | — |
| $\quad D^0D^*(2010)^-\pi^++$c.c. | seen | 716 |
| $D_1(2420)\overline{D}+$ c.c. | not seen | † |
| $D^*\overline{D}^*\pi$ | not seen | 367 |
| $D_s^+D_s^-$ | not seen | 760 |
| $D_s^{*+}D_s^-+$c.c. | not seen | 615 |
| $D_s^{*+}D_s^{*-}$ | not seen | † |
| $p\overline{p}$ | not seen | 1890 |
| $p\overline{p}\pi^0$ | not seen | 1854 |
| $p\overline{p}\eta$ | not seen | 1712 |

| | | |
|---|---|---|
| $p\overline{p}\omega$ | not seen | 1610 |
| $\Xi^-\,\overline{\Xi}^+$ | not seen | 1645 |
| $\pi^+\pi^+\pi^-\pi^-$ | not seen | 2087 |
| $\pi^+\pi^+\pi^-\pi^-\pi^0$ | not seen | 2071 |
| $\omega\pi^0$ | not seen | 2035 |
| $\omega\eta$ | not seen | 1999 |
| $K^0_S K^\pm \pi^\mp$ | not seen | 2032 |
| $K^0_S K^\pm \pi^\mp \pi^0$ | not seen | 2009 |
| $K^0_S K^\pm \pi^\mp \eta$ | not seen | 1917 |
| $K^+ K^- \pi^0$ | not seen | 2033 |
| $K^+ K^- \pi^+ \pi^-$ | not seen | 2008 |
| $K^+ K^- \pi^+ \pi^- \pi^0$ | not seen | 1981 |
| $K^+ K^+ K^- K^-$ | not seen | 1813 |
| $K^+ K^+ K^- K^- \pi^0$ | not seen | 1762 |
| $p\overline{p}\pi^+\pi^-$ | not seen | 1810 |
| $p\overline{p}\pi^+\pi^-\pi^0$ | not seen | 1764 |
| $p\overline{p}p\overline{p}$ | not seen | 864 |
| $\Lambda\overline{\Lambda}$ | not seen | 1791 |

### Radiative decays

| | | |
|---|---|---|
| $\eta_c(1S)\gamma$ | possibly seen | 1055 |
| $\eta_c(1S)\pi^0\gamma$ | not seen | 1049 |
| $\chi_{c1}\gamma$ | not seen | 650 |
| $\chi_{c2}\gamma$ | not seen | 612 |
| $\chi_{c1}(3872)\gamma$ | seen | 334 |

## $\chi_{c1}(4274)$ $\qquad\qquad I^G(J^{PC}) = 0^+(1^{++})$

was $X(4274)$

Mass $m = 4286^{+8}_{-9}$ MeV   (S = 1.7)
Full width $\Gamma = 51 \pm 7$ MeV

| $\chi_{c1}(4274)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | $p$ (MeV/$c$) |
|---|---|---|
| $J/\psi\,\phi$ | seen | 522 |

## $\psi(4360)$                    $I^G(J^{PC}) = 0^-(1^{--})$

also known as $Y(4360)$; was $X(4360)$

$\psi(4360)$ MASS = $4374 \pm 7$ MeV    (S = 2.4)
$\psi(4360)$ WIDTH = $118 \pm 12$ MeV    (S = 2.1)

| $\psi(4360)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | $p$ (MeV/$c$) |
|---|---|---|
| $h_c \pi^+ \pi^-$ | seen | 723 |
| $\psi(2S) \pi^+ \pi^-$ | seen | 579 |
| $\psi(3770) \pi^+ \pi^-$ | possibly seen | 495 |
| $\psi_2(3823) \pi^+ \pi^-$ | seen | 444 |
| $J/\psi \eta$ | seen | 983 |
| $D^+ D^- \pi^+ \pi^-$ | seen | 862 |
| $D_1(2420)\overline{D}+$ c.c. | possibly seen | 431 |
| $\omega \pi^0$ | not seen | 2115 |
| $\omega \eta$ | not seen | 2080 |
| $p\overline{p}\eta$ | not seen | 1806 |
| $p\overline{p}\omega$ | not seen | 1708 |

## $\psi(4415)$ [i]                    $I^G(J^{PC}) = 0^-(1^{--})$

Mass $m = 4421 \pm 4$ MeV
Full width $\Gamma = 62 \pm 20$ MeV

Due to the complexity of the $c\overline{c}$ threshold region, in this listing, "seen" ("not seen") means that a cross section for the mode in question has been measured at effective $\sqrt{s}$ near this particle's central mass value, more (less) than $2\sigma$ above zero, without regard to any peaking behavior in $\sqrt{s}$ or absence thereof. See mode listing(s) for details and references.

| $\psi(4415)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | | Confidence level | $p$ (MeV/$c$) |
|---|---|---|---|---|
| $D\overline{D}$ | seen | | | 1187 |
| $\quad D^0 \overline{D}^0$ | seen | | | 1187 |
| $\quad D^+ D^-$ | seen | | | 1179 |
| $D^* \overline{D}+$ c.c. | seen | | | 1063 |
| $\quad D^*(2007)^0 \overline{D}^0 +$ c.c. | seen | | | 1067 |
| $\quad D^*(2010)^+ D^- +$ c.c. | seen | | | 1059 |
| $D^* \overline{D}^*$ | seen | | | 919 |
| $\quad D^*(2007)^0 \overline{D}^*(2007)^0 +$ c.c. | seen | | | 927 |
| $\quad D^*(2010)^+ D^*(2010)^- +$ c.c. | seen | | | 919 |
| $D^0 D^- \pi^+ (\text{excl. } D^*(2007)^0 \overline{D}^0$ $+$c.c., $D^*(2010)^+ D^-$ +c.c. | $< 2.3$ % | | 90% | — |
| $D\overline{D}_2^*(2460) \to D^0 D^- \pi^+$ +c.c. | $(10 \pm 4)$ % | | | — |

| | | | | |
|---|---|---|---|---|
| $D^0 D^{*-} \pi^+$ +c.c. | < 11 | % | 90% | 926 |
| $D_1(2420)\overline{D}$+ c.c. | possibly seen | | | 537 |
| $D_s^+ D_s^-$ | not seen | | | 1006 |
| $\omega \chi_{c2}$ | possibly seen | | | 330 |
| $D_s^{*+} D_s^-$ +c.c. | seen | | | − |
| $D_s^{*+} D_s^{*-}$ | not seen | | | 652 |
| $\psi_2(3823)\pi^+\pi^-$ | possibly seen | | | 492 |
| $\psi(3770)\pi^+\pi^-$ | possibly seen | | | 541 |
| $J/\psi\eta$ | < 6 | $\times 10^{-3}$ | 90% | 1022 |
| $\chi_{c1}\gamma$ | < 8 | $\times 10^{-4}$ | 90% | 817 |
| $\chi_{c2}\gamma$ | < 4 | $\times 10^{-3}$ | 90% | 780 |
| $\Lambda\overline{\Lambda}$ | < 3.1 | $\times 10^{-6}$ | 90% | 1908 |
| $\omega\pi^0$ | not seen | | | 2139 |
| $\omega\eta$ | not seen | | | 2105 |
| $e^+ e^-$ | ( 9.4±3.2) $\times 10^{-6}$ | | | 2210 |
| $\mu^+\mu^-$ | ( 2.0±1.0) $\times 10^{-5}$ | | | 2208 |

## $\psi(4660)$ $\qquad\qquad I^G(J^{PC}) = 0^-(1^{--})$

also known as $Y(4660)$; was $X(4660)$

$$\psi(4660) \text{ MASS} = 4630 \pm 6 \text{ MeV} \quad (S = 1.4)$$
$$\psi(4660) \text{ WIDTH} = 72^{+14}_{-12} \text{ MeV} \quad (S = 1.7)$$

| $\psi(4660)$ DECAY MODES | Fraction ($\Gamma_i/\Gamma$) | $p$ (MeV/$c$) |
|---|---|---|
| $e^+ e^-$ | not seen | 2315 |
| $\psi(2S)\pi^+\pi^-$ | seen | 809 |
| $J/\psi\eta$ | not seen | 1192 |
| $D^0 D^{*-}\pi^+$ | not seen | 1153 |
| $\psi_2(3823)\pi^+\pi^-$ | seen | 691 |
| $\chi_{c1}\gamma$ | not seen | 984 |
| $\chi_{c2}\gamma$ | not seen | 949 |
| $\Lambda_c^+ \Lambda_c^-$ | seen | 363 |
| $D_s^+ D_{s1}(2536)^-$ | seen | 534 |
| $\omega\pi^0$ | not seen | 2247 |
| $\omega\eta$ | not seen | 2215 |

NOTES

[a] For $E_\gamma > 100$ MeV.

[b] The value is for the sum of the charge states or particle/antiparticle states indicated.

[c] $\Theta(1540)$ is a hypothetical pentaquark state of 1.54 GeV/c$^2$ mass and a width of less than 25 MeV/c$^2$.

[d] Includes $p\overline{p}\pi^+\pi^-\gamma$ and excludes $p\overline{p}\eta$, $p\overline{p}\omega$, $p\overline{p}\eta'$.

[e] For a narrow state $A$ with mass less than 960 MeV.

[f] For a narrow scalar or pseudoscalar $A^0$ with mass 0.21–3.0 GeV.

[g] For a dark photon $U$ with mass between 100 and 2100 MeV.

[h] For a narrow resonance in the range $2.2 < M(X) < 2.8$ GeV.

[i] $J^{PC}$ known by production in $e^+e^-$ via single photon annihilation. $I^G$ is not known; interpretation of this state as a single resonance is unclear because of the expectation of substantial threshold effects in this energy region.