

# c $\bar{c}$ MESONS

**$\eta_c(1S)$**

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

Mass  $m = 2983.6 \pm 0.6$  MeV (S = 1.2)

Full width  $\Gamma = 31.8 \pm 0.8$  MeV

<b><math>\eta_c(1S)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$\rho$ (MeV/c)
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**Decays involving hadronic resonances**

$\eta'(958)\pi\pi$	( 4.1 $\pm$ 1.7 ) %		1323
$\rho\rho$	( 1.8 $\pm$ 0.5 ) %		1275
$K^*(892)^0 K^- \pi^+ + \text{c.c.}$	( 2.0 $\pm$ 0.7 ) %		1277
$K^*(892)\bar{K}^*(892)$	( 7.0 $\pm$ 1.3 ) $\times 10^{-3}$		1196
$K^*(892)^0 \bar{K}^*(892)^0 \pi^+ \pi^-$	( 1.1 $\pm$ 0.5 ) %		1073
$\phi K^+ K^-$	( 2.9 $\pm$ 1.4 ) $\times 10^{-3}$		1104
$\phi\phi$	( 1.75 $\pm$ 0.20 ) $\times 10^{-3}$		1089
$\phi 2(\pi^+ \pi^-)$	< 4 $\times 10^{-3}$	90%	1251
$a_0(980)\pi$	< 2 %	90%	1327
$a_2(1320)\pi$	< 2 %	90%	1196
$K^*(892)\bar{K} + \text{c.c.}$	< 1.28 %	90%	1309
$f_2(1270)\eta$	< 1.1 %	90%	1145
$\omega\omega$	< 3.1 $\times 10^{-3}$	90%	1270
$\omega\phi$	< 1.7 $\times 10^{-3}$	90%	1185
$f_2(1270)f_2(1270)$	( 9.8 $\pm$ 2.5 ) $\times 10^{-3}$		774
$f_2(1270)f'_2(1525)$	( 9.7 $\pm$ 3.2 ) $\times 10^{-3}$		513
$f_0(980)\eta$	seen		1264
$f_0(1500)\eta$	seen		1026
$f_0(2200)\eta$	seen		496
$a_0(980)\pi$	seen		1327
$a_0(1320)\pi$	seen		—
$a_0(1450)\pi$	seen		1123
$K_0^*(1430)\bar{K}$	seen		—
$K_2^*(1430)\bar{K}$	seen		—
$K_0^*(1950)\bar{K}$	seen		—

**Decays into stable hadrons**

$K\bar{K}\pi$	( 7.3 $\pm$ 0.5 ) %		1381
$K\bar{K}\eta$	( 1.35 $\pm$ 0.16 ) %		1265
$\eta\pi^+\pi^-$	( 1.7 $\pm$ 0.5 ) %		1428
$\eta 2(\pi^+ \pi^-)$	( 4.4 $\pm$ 1.3 ) %		1385
$K^+ K^- \pi^+ \pi^-$	( 6.9 $\pm$ 1.1 ) $\times 10^{-3}$		1345
$K^+ K^- \pi^+ \pi^- \pi^0$	( 3.5 $\pm$ 0.6 ) %		1304

$K^0 K^- \pi^+ \pi^- \pi^+ + c.c.$	( 5.6 ± 1.5 ) %	—
$K^+ K^- 2(\pi^+ \pi^-)$	( 7.5 ± 2.4 ) × 10 <sup>-3</sup>	1253
$2(K^+ K^-)$	( 1.46 ± 0.30 ) × 10 <sup>-3</sup>	1055
$\pi^+ \pi^- \pi^0 \pi^0$	( 4.7 ± 1.0 ) %	1460
$2(\pi^+ \pi^-)$	( 9.7 ± 1.2 ) × 10 <sup>-3</sup>	1459
$2(\pi^+ \pi^- \pi^0)$	(17.4 ± 3.3 ) %	1409
$3(\pi^+ \pi^-)$	( 1.8 ± 0.4 ) %	1407
$p\bar{p}$	( 1.50 ± 0.16 ) × 10 <sup>-3</sup>	1160
$p\bar{p}\pi^0$	( 3.6 ± 1.3 ) × 10 <sup>-3</sup>	1101
$\Lambda\bar{\Lambda}$	( 1.09 ± 0.24 ) × 10 <sup>-3</sup>	990
$\Sigma^+ \bar{\Sigma}^-$	( 2.1 ± 0.6 ) × 10 <sup>-3</sup>	900
$\Xi^- \bar{\Xi}^+$	( 8.9 ± 2.7 ) × 10 <sup>-4</sup>	692
$\pi^+ \pi^- p\bar{p}$	( 5.3 ± 1.8 ) × 10 <sup>-3</sup>	1027

**Radiative decays**

$\gamma\gamma$	( 1.59 ± 0.12 ) × 10 <sup>-4</sup>	1492
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**Charge conjugation (C), Parity (P),  
Lepton family number (LF) violating modes**

$\pi^+ \pi^-$	$P, CP < 1.1$	× 10 <sup>-4</sup>	90%	1485
$\pi^0 \pi^0$	$P, CP < 4$	× 10 <sup>-5</sup>	90%	1486
$K^+ K^-$	$P, CP < 6$	× 10 <sup>-4</sup>	90%	1408
$K_S^0 K_S^0$	$P, CP < 3.1$	× 10 <sup>-4</sup>	90%	1406

**J/ψ(1S)**

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

Mass  $m = 3096.916 \pm 0.011$  MeV  
 Full width  $\Gamma = 92.9 \pm 2.8$  keV (S = 1.1)  
 $\Gamma_{ee} = 5.55 \pm 0.14 \pm 0.02$  keV

<b>J/ψ(1S) DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level (MeV/c)	$p$
hadrons	(87.7 ± 0.5 ) %		—
virtual $\gamma \rightarrow$ hadrons	(13.50 ± 0.30 ) %		—
$ggg$	(64.1 ± 1.0 ) %		—
$\gamma gg$	( 8.8 ± 1.1 ) %		—
$e^+ e^-$	( 5.971 ± 0.032 ) %		1548
$e^+ e^- \gamma$	[a] ( 8.8 ± 1.4 ) × 10 <sup>-3</sup>		1548
$\mu^+ \mu^-$	( 5.961 ± 0.033 ) %		1545

**Decays involving hadronic resonances**

$\rho\pi$	( 1.69 ± 0.15 ) %	S=2.4	1448
$\rho^0\pi^0$	( 5.6 ± 0.7 ) × 10 <sup>-3</sup>		1448
$a_2(1320)\rho$	( 1.09 ± 0.22 ) %		1123
$\omega\pi^+\pi^+\pi^-\pi^-$	( 8.5 ± 3.4 ) × 10 <sup>-3</sup>		1392
$\omega\pi^+\pi^-\pi^0$	( 4.0 ± 0.7 ) × 10 <sup>-3</sup>		1418
$\omega\pi^+\pi^-$	( 8.6 ± 0.7 ) × 10 <sup>-3</sup>	S=1.1	1435
$\omega f_2(1270)$	( 4.3 ± 0.6 ) × 10 <sup>-3</sup>		1142
$K^*(892)^0\bar{K}^*(892)^0$	( 2.3 ± 0.7 ) × 10 <sup>-4</sup>		1266
$K^*(892)^\pm K^*(892)^\mp$	( 1.00 <sup>+0.22</sup> <sub>-0.40</sub> ) × 10 <sup>-3</sup>		1266
$K^*(892)^\pm K^*(800)^\mp$	( 1.1 <sup>+1.0</sup> <sub>-0.6</sub> ) × 10 <sup>-3</sup>		—
$\eta K^*(892)^0\bar{K}^*(892)^0$	( 1.15 ± 0.26 ) × 10 <sup>-3</sup>		1003
$K^*(892)^0\bar{K}_2^*(1430)^0 + \text{c.c.}$	( 6.0 ± 0.6 ) × 10 <sup>-3</sup>		1012
$K^*(892)^0\bar{K}_2^*(1770)^0 + \text{c.c.} \rightarrow$ $K^*(892)^0 K^-\pi^+ + \text{c.c.}$	( 6.9 ± 0.9 ) × 10 <sup>-4</sup>		—
$\omega K^*(892)\bar{K} + \text{c.c.}$	( 6.1 ± 0.9 ) × 10 <sup>-3</sup>		1097
$K^+K^*(892)^- + \text{c.c.}$	( 5.12 ± 0.30 ) × 10 <sup>-3</sup>		1373
$K^+K^*(892)^- + \text{c.c.} \rightarrow$ $K^+K^-\pi^0$	( 1.97 ± 0.20 ) × 10 <sup>-3</sup>		—
$K^+K^*(892)^- + \text{c.c.} \rightarrow$ $K^0K^\pm\pi^\mp + \text{c.c.}$	( 3.0 ± 0.4 ) × 10 <sup>-3</sup>		—
$K^0\bar{K}^*(892)^0 + \text{c.c.}$	( 4.39 ± 0.31 ) × 10 <sup>-3</sup>		1373
$K^0\bar{K}^*(892)^0 + \text{c.c.} \rightarrow$ $K^0K^\pm\pi^\mp + \text{c.c.}$	( 3.2 ± 0.4 ) × 10 <sup>-3</sup>		—
$K_1(1400)^\pm K^\mp$	( 3.8 ± 1.4 ) × 10 <sup>-3</sup>		1170
$\bar{K}^*(892)^0 K^+\pi^- + \text{c.c.}$	seen		1343
$\omega\pi^0\pi^0$	( 3.4 ± 0.8 ) × 10 <sup>-3</sup>		1436
$b_1(1235)^\pm\pi^\mp$	[b] ( 3.0 ± 0.5 ) × 10 <sup>-3</sup>		1300
$\omega K^\pm K_S^0\pi^\mp$	[b] ( 3.4 ± 0.5 ) × 10 <sup>-3</sup>		1210
$b_1(1235)^0\pi^0$	( 2.3 ± 0.6 ) × 10 <sup>-3</sup>		1300
$\eta K^\pm K_S^0\pi^\mp$	[b] ( 2.2 ± 0.4 ) × 10 <sup>-3</sup>		1278
$\phi K^*(892)\bar{K} + \text{c.c.}$	( 2.18 ± 0.23 ) × 10 <sup>-3</sup>		969
$\omega K\bar{K}$	( 1.70 ± 0.32 ) × 10 <sup>-3</sup>		1268
$\omega f_0(1710) \rightarrow \omega K\bar{K}$	( 4.8 ± 1.1 ) × 10 <sup>-4</sup>		878
$\phi 2(\pi^+\pi^-)$	( 1.66 ± 0.23 ) × 10 <sup>-3</sup>		1318
$\Delta(1232)^{++}\bar{p}\pi^-$	( 1.6 ± 0.5 ) × 10 <sup>-3</sup>		1030
$\omega\eta$	( 1.74 ± 0.20 ) × 10 <sup>-3</sup>	S=1.6	1394
$\phi K\bar{K}$	( 1.83 ± 0.24 ) × 10 <sup>-3</sup>	S=1.5	1179
$\phi f_0(1710) \rightarrow \phi K\bar{K}$	( 3.6 ± 0.6 ) × 10 <sup>-4</sup>		875
$\phi f_2(1270)$	( 7.2 ± 1.3 ) × 10 <sup>-4</sup>		1036
$\Delta(1232)^{++}\bar{\Delta}(1232)^{--}$	( 1.10 ± 0.29 ) × 10 <sup>-3</sup>		938
$\Sigma(1385)^-\bar{\Sigma}(1385)^+ (\text{or c.c.})$	[b] ( 1.10 ± 0.12 ) × 10 <sup>-3</sup>		697
$\phi f_2'(1525)$	( 8 ± 4 ) × 10 <sup>-4</sup>	S=2.7	871

$\phi\pi^+\pi^-$		$(9.4 \pm 0.9) \times 10^{-4}$	S=1.2	1365
$\phi\pi^0\pi^0$		$(5.6 \pm 1.6) \times 10^{-4}$		1366
$\phi K^\pm K_S^0 \pi^\mp$	[b]	$(7.2 \pm 0.8) \times 10^{-4}$		1114
$\omega f_1(1420)$		$(6.8 \pm 2.4) \times 10^{-4}$		1062
$\phi\eta$		$(7.5 \pm 0.8) \times 10^{-4}$	S=1.5	1320
$\Xi^0 \Xi^0$		$(1.20 \pm 0.24) \times 10^{-3}$		818
$\Xi(1530)^- \Xi^+$		$(5.9 \pm 1.5) \times 10^{-4}$		600
$\rho K^- \bar{\Sigma}(1385)^0$		$(5.1 \pm 3.2) \times 10^{-4}$		646
$\omega\pi^0$		$(4.5 \pm 0.5) \times 10^{-4}$	S=1.4	1446
$\phi\eta'(958)$		$(4.0 \pm 0.7) \times 10^{-4}$	S=2.1	1192
$\phi f_0(980)$		$(3.2 \pm 0.9) \times 10^{-4}$	S=1.9	1178
$\phi f_0(980) \rightarrow \phi\pi^+\pi^-$		$(1.8 \pm 0.4) \times 10^{-4}$		—
$\phi f_0(980) \rightarrow \phi\pi^0\pi^0$		$(1.7 \pm 0.7) \times 10^{-4}$		—
$\eta\phi f_0(980) \rightarrow \eta\phi\pi^+\pi^-$		$(3.2 \pm 1.0) \times 10^{-4}$		—
$\phi a_0(980)^0 \rightarrow \phi\eta\pi^0$		$(5 \pm 4) \times 10^{-6}$		—
$\Xi(1530)^0 \Xi^0$		$(3.2 \pm 1.4) \times 10^{-4}$		608
$\Sigma(1385)^- \bar{\Sigma}^+ \text{ (or c.c.)}$	[b]	$(3.1 \pm 0.5) \times 10^{-4}$		855
$\phi f_1(1285)$		$(2.6 \pm 0.5) \times 10^{-4}$	S=1.1	1032
$\eta\pi^+\pi^-$		$(4.0 \pm 1.7) \times 10^{-4}$		1487
$\rho\eta$		$(1.93 \pm 0.23) \times 10^{-4}$		1396
$\omega\eta'(958)$		$(1.82 \pm 0.21) \times 10^{-4}$		1279
$\omega f_0(980)$		$(1.4 \pm 0.5) \times 10^{-4}$		1267
$\rho\eta'(958)$		$(1.05 \pm 0.18) \times 10^{-4}$		1281
$a_2(1320)^\pm \pi^\mp$	[b]	$< 4.3 \times 10^{-3}$	CL=90%	1263
$K \bar{K}_2^*(1430) + \text{c.c.}$		$< 4.0 \times 10^{-3}$	CL=90%	1159
$K_1(1270)^\pm K^\mp$		$< 3.0 \times 10^{-3}$	CL=90%	1231
$K_2^*(1430)^0 \bar{K}_2^*(1430)^0$		$< 2.9 \times 10^{-3}$	CL=90%	604
$\phi\pi^0$		$< 6.4 \times 10^{-6}$	CL=90%	1377
$\phi\eta(1405) \rightarrow \phi\eta\pi\pi$		$< 2.5 \times 10^{-4}$	CL=90%	946
$\omega f_2'(1525)$		$< 2.2 \times 10^{-4}$	CL=90%	1003
$\omega X(1835) \rightarrow \omega p \bar{p}$		$< 3.9 \times 10^{-6}$	CL=95%	—
$\eta\phi(2170) \rightarrow$		$< 2.52 \times 10^{-4}$	CL=90%	—
$\eta K^*(892)^0 \bar{K}^*(892)^0$				
$\Sigma(1385)^0 \bar{\Lambda} + \text{c.c.}$		$< 8.2 \times 10^{-6}$	CL=90%	912
$\Delta(1232)^+ \bar{p}$		$< 1 \times 10^{-4}$	CL=90%	1100
$\Lambda(1520) \bar{\Lambda} + \text{c.c.} \rightarrow \gamma \Lambda \bar{\Lambda}$		$< 4.1 \times 10^{-6}$	CL=90%	—
$\Theta(1540) \bar{\Theta}(1540) \rightarrow$		$< 1.1 \times 10^{-5}$	CL=90%	—
$K_S^0 p K^- \bar{n} + \text{c.c.}$				
$\Theta(1540) K^- \bar{n} \rightarrow K_S^0 p K^- \bar{n}$		$< 2.1 \times 10^{-5}$	CL=90%	—
$\Theta(1540) K_S^0 \bar{p} \rightarrow K_S^0 \bar{p} K^+ n$		$< 1.6 \times 10^{-5}$	CL=90%	—
$\bar{\Theta}(1540) K^+ n \rightarrow K_S^0 \bar{p} K^+ n$		$< 5.6 \times 10^{-5}$	CL=90%	—
$\bar{\Theta}(1540) K_S^0 p \rightarrow K_S^0 p K^- \bar{n}$		$< 1.1 \times 10^{-5}$	CL=90%	—
$\Sigma^0 \bar{\Lambda}$		$< 9 \times 10^{-5}$	CL=90%	1032

**Decays into stable hadrons**

$2(\pi^+\pi^-)\pi^0$	( 4.1 ±0.5 ) %	S=2.4	1496
$3(\pi^+\pi^-)\pi^0$	( 2.9 ±0.6 ) %		1433
$\pi^+\pi^-\pi^0$	( 2.11 ±0.07 ) %	S=1.5	1533
$\pi^+\pi^-\pi^0 K^+ K^-$	( 1.79 ±0.29 ) %	S=2.2	1368
$4(\pi^+\pi^-)\pi^0$	( 9.0 ±3.0 ) × 10 <sup>-3</sup>		1345
$\pi^+\pi^- K^+ K^-$	( 6.6 ±0.5 ) × 10 <sup>-3</sup>		1407
$\pi^+\pi^- K^+ K^- \eta$	( 1.84 ±0.28 ) × 10 <sup>-3</sup>		1221
$\pi^0\pi^0 K^+ K^-$	( 2.45 ±0.31 ) × 10 <sup>-3</sup>		1410
$K\bar{K}\pi$	( 6.1 ±1.0 ) × 10 <sup>-3</sup>		1442
$2(\pi^+\pi^-)$	( 3.57 ±0.30 ) × 10 <sup>-3</sup>		1517
$3(\pi^+\pi^-)$	( 4.3 ±0.4 ) × 10 <sup>-3</sup>		1466
$2(\pi^+\pi^-\pi^0)$	( 1.62 ±0.21 ) %		1468
$2(\pi^+\pi^-)\eta$	( 2.29 ±0.24 ) × 10 <sup>-3</sup>		1446
$3(\pi^+\pi^-)\eta$	( 7.2 ±1.5 ) × 10 <sup>-4</sup>		1379
$\rho\bar{\rho}$	( 2.120±0.029 ) × 10 <sup>-3</sup>		1232
$\rho\bar{\rho}\pi^0$	( 1.19 ±0.08 ) × 10 <sup>-3</sup>	S=1.1	1176
$\rho\bar{\rho}\pi^+\pi^-$	( 6.0 ±0.5 ) × 10 <sup>-3</sup>	S=1.3	1107
$\rho\bar{\rho}\pi^+\pi^-\pi^0$	[c] ( 2.3 ±0.9 ) × 10 <sup>-3</sup>	S=1.9	1033
$\rho\bar{\rho}\eta$	( 2.00 ±0.12 ) × 10 <sup>-3</sup>		948
$\rho\bar{\rho}\rho$	< 3.1 × 10 <sup>-4</sup>	CL=90%	774
$\rho\bar{\rho}\omega$	( 9.8 ±1.0 ) × 10 <sup>-4</sup>	S=1.3	768
$\rho\bar{\rho}\eta'(958)$	( 2.1 ±0.4 ) × 10 <sup>-4</sup>		596
$\rho\bar{\rho}a_0(980) \rightarrow \rho\bar{\rho}\pi^0\eta$	( 6.8 ±1.8 ) × 10 <sup>-5</sup>		—
$\rho\bar{\rho}\phi$	( 4.5 ±1.5 ) × 10 <sup>-5</sup>		527
$n\bar{n}$	( 2.09 ±0.16 ) × 10 <sup>-3</sup>		1231
$n\bar{n}\pi^+\pi^-$	( 4 ±4 ) × 10 <sup>-3</sup>		1106
$\Sigma^+\bar{\Sigma}^-$	( 1.50 ±0.24 ) × 10 <sup>-3</sup>		992
$\Sigma^0\bar{\Sigma}^0$	( 1.29 ±0.09 ) × 10 <sup>-3</sup>		988
$2(\pi^+\pi^-)K^+K^-$	( 4.7 ±0.7 ) × 10 <sup>-3</sup>	S=1.3	1320
$\rho\bar{n}\pi^-$	( 2.12 ±0.09 ) × 10 <sup>-3</sup>		1174
$nN(1440)$	seen		984
$nN(1520)$	seen		928
$nN(1535)$	seen		914
$\Xi^-\bar{\Xi}^+$	( 8.6 ±1.1 ) × 10 <sup>-4</sup>	S=1.2	807
$\Lambda\bar{\Lambda}$	( 1.61 ±0.15 ) × 10 <sup>-3</sup>	S=1.9	1074
$\Lambda\bar{\Sigma}^-\pi^+$ (or c.c.)	[b] ( 8.3 ±0.7 ) × 10 <sup>-4</sup>	S=1.2	950
$\rho K^-\bar{\Lambda}$	( 8.9 ±1.6 ) × 10 <sup>-4</sup>		876
$2(K^+K^-)$	( 7.6 ±0.9 ) × 10 <sup>-4</sup>		1131
$\rho K^-\bar{\Sigma}^0$	( 2.9 ±0.8 ) × 10 <sup>-4</sup>		819
$K^+K^-$	( 2.70 ±0.17 ) × 10 <sup>-4</sup>		1468
$K_S^0 K_L^0$	( 2.1 ±0.4 ) × 10 <sup>-4</sup>	S=3.2	1466
$\Lambda\bar{\Lambda}\pi^+\pi^-$	( 4.3 ±1.0 ) × 10 <sup>-3</sup>		903
$\Lambda\bar{\Lambda}\eta$	( 1.62 ±0.17 ) × 10 <sup>-4</sup>		672

$\Lambda\bar{\Lambda}\pi^0$	$( 3.8 \pm 0.4 ) \times 10^{-5}$		998
$\bar{\Lambda}nK_S^0 + \text{c.c.}$	$( 6.5 \pm 1.1 ) \times 10^{-4}$		872
$\pi^+\pi^-$	$( 1.47 \pm 0.14 ) \times 10^{-4}$		1542
$\Lambda\bar{\Sigma} + \text{c.c.}$	$( 2.83 \pm 0.23 ) \times 10^{-5}$		1034
$K_S^0 K_S^0$	$< 1 \times 10^{-6}$	CL=95%	1466

**Radiative decays**

$3\gamma$	$( 1.16 \pm 0.22 ) \times 10^{-5}$		1548
$4\gamma$	$< 9 \times 10^{-6}$	CL=90%	1548
$5\gamma$	$< 1.5 \times 10^{-5}$	CL=90%	1548
$\gamma\eta_c(1S)$	$( 1.7 \pm 0.4 ) \%$	S=1.6	111
$\gamma\eta_c(1S) \rightarrow 3\gamma$	$( 3.8 \begin{smallmatrix} +1.3 \\ -1.0 \end{smallmatrix} ) \times 10^{-6}$	S=1.1	—
$\gamma\pi^+\pi^-2\pi^0$	$( 8.3 \pm 3.1 ) \times 10^{-3}$		1518
$\gamma\eta\pi\pi$	$( 6.1 \pm 1.0 ) \times 10^{-3}$		1487
$\gamma\eta_2(1870) \rightarrow \gamma\eta\pi^+\pi^-$	$( 6.2 \pm 2.4 ) \times 10^{-4}$		—
$\gamma\eta(1405/1475) \rightarrow \gamma K\bar{K}\pi$ [d]	$( 2.8 \pm 0.6 ) \times 10^{-3}$	S=1.6	1223
$\gamma\eta(1405/1475) \rightarrow \gamma\gamma\rho^0$	$( 7.8 \pm 2.0 ) \times 10^{-5}$	S=1.8	1223
$\gamma\eta(1405/1475) \rightarrow \gamma\eta\pi^+\pi^-$	$( 3.0 \pm 0.5 ) \times 10^{-4}$		—
$\gamma\eta(1405/1475) \rightarrow \gamma\gamma\phi$	$< 8.2 \times 10^{-5}$	CL=95%	—
$\gamma\rho\rho$	$( 4.5 \pm 0.8 ) \times 10^{-3}$		1340
$\gamma\rho\omega$	$< 5.4 \times 10^{-4}$	CL=90%	1338
$\gamma\rho\phi$	$< 8.8 \times 10^{-5}$	CL=90%	1258
$\gamma\eta'(958)$	$( 5.15 \pm 0.16 ) \times 10^{-3}$	S=1.2	1400
$\gamma 2\pi^+ 2\pi^-$	$( 2.8 \pm 0.5 ) \times 10^{-3}$	S=1.9	1517
$\gamma f_2(1270) f_2(1270)$	$( 9.5 \pm 1.7 ) \times 10^{-4}$		878
$\gamma f_2(1270) f_2(1270)$ (non resonant)	$( 8.2 \pm 1.9 ) \times 10^{-4}$		—
$\gamma K^+ K^- \pi^+ \pi^-$	$( 2.1 \pm 0.6 ) \times 10^{-3}$		1407
$\gamma f_4(2050)$	$( 2.7 \pm 0.7 ) \times 10^{-3}$		891
$\gamma\omega\omega$	$( 1.61 \pm 0.33 ) \times 10^{-3}$		1336
$\gamma\eta(1405/1475) \rightarrow \gamma\rho^0\rho^0$	$( 1.7 \pm 0.4 ) \times 10^{-3}$	S=1.3	1223
$\gamma f_2(1270)$	$( 1.43 \pm 0.11 ) \times 10^{-3}$		1286
$\gamma f_0(1710) \rightarrow \gamma K\bar{K}$	$( 8.5 \begin{smallmatrix} +1.2 \\ -0.9 \end{smallmatrix} ) \times 10^{-4}$	S=1.2	1075
$\gamma f_0(1710) \rightarrow \gamma\pi\pi$	$( 4.0 \pm 1.0 ) \times 10^{-4}$		—
$\gamma f_0(1710) \rightarrow \gamma\omega\omega$	$( 3.1 \pm 1.0 ) \times 10^{-4}$		—
$\gamma f_0(1710) \rightarrow \gamma\eta\eta$	$( 2.4 \begin{smallmatrix} +1.2 \\ -0.7 \end{smallmatrix} ) \times 10^{-4}$		—
$\gamma\eta$	$( 1.104 \pm 0.034 ) \times 10^{-3}$		1500
$\gamma f_1(1420) \rightarrow \gamma K\bar{K}\pi$	$( 7.9 \pm 1.3 ) \times 10^{-4}$		1220
$\gamma f_1(1285)$	$( 6.1 \pm 0.8 ) \times 10^{-4}$		1283
$\gamma f_1(1510) \rightarrow \gamma\eta\pi^+\pi^-$	$( 4.5 \pm 1.2 ) \times 10^{-4}$		—
$\gamma f_2'(1525)$	$( 4.5 \begin{smallmatrix} +0.7 \\ -0.4 \end{smallmatrix} ) \times 10^{-4}$		1173
$\gamma f_2'(1525) \rightarrow \gamma\eta\eta$	$( 3.4 \pm 1.4 ) \times 10^{-5}$		—

$\gamma f_2(1640) \rightarrow \gamma \omega \omega$	$( 2.8 \pm 1.8 ) \times 10^{-4}$		—
$\gamma f_2(1910) \rightarrow \gamma \omega \omega$	$( 2.0 \pm 1.4 ) \times 10^{-4}$		—
$\gamma f_0(1800) \rightarrow \gamma \omega \phi$	$( 2.5 \pm 0.6 ) \times 10^{-4}$		—
$\gamma f_2(1810) \rightarrow \gamma \eta \eta$	$( 5.4 \begin{smallmatrix} +3.5 \\ -2.4 \end{smallmatrix} ) \times 10^{-5}$		—
$\gamma f_2(1950) \rightarrow$	$( 7.0 \pm 2.2 ) \times 10^{-4}$		—
$\gamma K^*(892) \bar{K}^*(892)$			
$\gamma K^*(892) \bar{K}^*(892)$	$( 4.0 \pm 1.3 ) \times 10^{-3}$		1266
$\gamma \phi \phi$	$( 4.0 \pm 1.2 ) \times 10^{-4}$	S=2.1	1166
$\gamma \rho \bar{\rho}$	$( 3.8 \pm 1.0 ) \times 10^{-4}$		1232
$\gamma \eta(2225)$	$( 3.3 \pm 0.5 ) \times 10^{-4}$		749
$\gamma \eta(1760) \rightarrow \gamma \rho^0 \rho^0$	$( 1.3 \pm 0.9 ) \times 10^{-4}$		1048
$\gamma \eta(1760) \rightarrow \gamma \omega \omega$	$( 1.98 \pm 0.33 ) \times 10^{-3}$		—
$\gamma X(1835) \rightarrow \gamma \pi^+ \pi^- \eta'$	$( 2.6 \pm 0.4 ) \times 10^{-4}$		1006
$\gamma X(1835) \rightarrow \gamma \rho \bar{\rho}$	$( 7.7 \begin{smallmatrix} +1.5 \\ -0.9 \end{smallmatrix} ) \times 10^{-5}$		—
$\gamma X(1840) \rightarrow \gamma 3(\pi^+ \pi^-)$	$( 2.4 \begin{smallmatrix} +0.7 \\ -0.8 \end{smallmatrix} ) \times 10^{-5}$		—
$\gamma (K \bar{K} \pi) [J^{PC} = 0^- +]$	$( 7 \pm 4 ) \times 10^{-4}$	S=2.1	1442
$\gamma \pi^0$	$( 3.49 \begin{smallmatrix} +0.33 \\ -0.30 \end{smallmatrix} ) \times 10^{-5}$		1546
$\gamma \rho \bar{\rho} \pi^+ \pi^-$	$< 7.9 \times 10^{-4}$	CL=90%	1107
$\gamma \Lambda \bar{\Lambda}$	$< 1.3 \times 10^{-4}$	CL=90%	1074
$\gamma f_0(2100) \rightarrow \gamma \eta \eta$	$( 1.13 \begin{smallmatrix} +0.60 \\ -0.30 \end{smallmatrix} ) \times 10^{-4}$		—
$\gamma f_J(2220)$	$> 2.50 \times 10^{-3}$	CL=99.9%	745
$\gamma f_J(2220) \rightarrow \gamma \pi \pi$	$( 8 \pm 4 ) \times 10^{-5}$		—
$\gamma f_J(2220) \rightarrow \gamma K \bar{K}$	$< 3.6 \times 10^{-5}$		—
$\gamma f_J(2220) \rightarrow \gamma \rho \bar{\rho}$	$( 1.5 \pm 0.8 ) \times 10^{-5}$		—
$\gamma f_2(2340) \rightarrow \gamma \eta \eta$	$( 5.6 \begin{smallmatrix} +2.4 \\ -2.2 \end{smallmatrix} ) \times 10^{-5}$		—
$\gamma f_0(1500) \rightarrow \gamma \pi \pi$	$( 1.01 \pm 0.32 ) \times 10^{-4}$		1183
$\gamma f_0(1500) \rightarrow \gamma \eta \eta$	$( 1.7 \begin{smallmatrix} +0.6 \\ -1.4 \end{smallmatrix} ) \times 10^{-5}$		—
$\gamma A \rightarrow \gamma \text{invisible}$	$[e] < 6.3 \times 10^{-6}$	CL=90%	—
$\gamma A^0 \rightarrow \gamma \mu^+ \mu^-$	$[f] < 2.1 \times 10^{-5}$	CL=90%	—

### Dalitz decays

$\pi^0 e^+ e^-$	$( 7.6 \pm 1.4 ) \times 10^{-7}$		1546
$\eta e^+ e^-$	$( 1.16 \pm 0.09 ) \times 10^{-5}$		1500
$\eta'(958) e^+ e^-$	$( 5.81 \pm 0.35 ) \times 10^{-5}$		1400

### Weak decays

$D^- e^+ \nu_e + \text{c.c.}$	$< 1.2 \times 10^{-5}$	CL=90%	984
$\bar{D}^0 e^+ e^- + \text{c.c.}$	$< 1.1 \times 10^{-5}$	CL=90%	987
$D_s^- e^+ \nu_e + \text{c.c.}$	$< 3.6 \times 10^{-5}$	CL=90%	923
$D^- \pi^+ + \text{c.c.}$	$< 7.5 \times 10^{-5}$	CL=90%	977

$\bar{D}^0 \bar{K}^0 + \text{c.c.}$	< 1.7	$\times 10^{-4}$	CL=90%	898
$\bar{D}^0 \bar{K}^{*0} + \text{c.c.}$	< 2.5	$\times 10^{-6}$	CL=90%	670
$D_s^- \pi^+ + \text{c.c.}$	< 1.3	$\times 10^{-4}$	CL=90%	916
$D_s^- \rho^+ + \text{c.c.}$	< 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	< 8.3	$\times 10^{-6}$	CL=90%	1039
$\mu^\pm \tau^\mp$	LF	< 2.0	$\times 10^{-6}$	CL=90%	1035

**Other decays**

invisible	< 7	$\times 10^{-4}$	CL=90%	–
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**$\chi_{c0}(1P)$**

$$J^{PC} = 0^+(0^{++})$$

Mass  $m = 3414.75 \pm 0.31$  MeV

Full width  $\Gamma = 10.5 \pm 0.6$  MeV

<b><math>\chi_{c0}(1P)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
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**Hadronic decays**

$2(\pi^+ \pi^-)$	(2.24±0.18) %		1679
$\rho^0 \pi^+ \pi^-$	(8.7 ±2.8 ) $\times 10^{-3}$		1607
$f_0(980) f_0(980)$	(6.5 ±2.1 ) $\times 10^{-4}$		1391
$\pi^+ \pi^- \pi^0 \pi^0$	(3.3 ±0.4 ) %		1680
$\rho^+ \pi^- \pi^0 + \text{c.c.}$	(2.8 ±0.4 ) %		1607
$4\pi^0$	(3.2 ±0.4 ) $\times 10^{-3}$		1681
$\pi^+ \pi^- K^+ K^-$	(1.75±0.14) %		1580
$K_0^*(1430)^0 \bar{K}_0^*(1430)^0 \rightarrow$ $\pi^+ \pi^- K^+ K^-$	(9.6 $\begin{smallmatrix} +3.5 \\ -2.8 \end{smallmatrix}$ ) $\times 10^{-4}$		–
$K_0^*(1430)^0 \bar{K}_2^*(1430)^0 + \text{c.c.} \rightarrow$ $\pi^+ \pi^- K^+ K^-$	(7.8 $\begin{smallmatrix} +1.9 \\ -2.4 \end{smallmatrix}$ ) $\times 10^{-4}$		–
$K_1(1270)^+ K^- + \text{c.c.} \rightarrow$ $\pi^+ \pi^- K^+ K^-$	(6.1 ±1.9 ) $\times 10^{-3}$		–
$K_1(1400)^+ K^- + \text{c.c.} \rightarrow$ $\pi^+ \pi^- K^+ K^-$	< 2.6 $\times 10^{-3}$	CL=90%	–
$f_0(980) f_0(980)$	(1.6 $\begin{smallmatrix} +1.0 \\ -0.9 \end{smallmatrix}$ ) $\times 10^{-4}$		1391
$f_0(980) f_0(2200)$	(7.8 $\begin{smallmatrix} +2.0 \\ -2.5 \end{smallmatrix}$ ) $\times 10^{-4}$		584
$f_0(1370) f_0(1370)$	< 2.7 $\times 10^{-4}$	CL=90%	1019
$f_0(1370) f_0(1500)$	< 1.7 $\times 10^{-4}$	CL=90%	921



$f_0(1370)f_0(1710)$	$(6.6^{+3.5}_{-2.3}) \times 10^{-4}$		720
$f_0(1500)f_0(1370)$	$< 1.3 \times 10^{-4}$	CL=90%	921
$f_0(1500)f_0(1500)$	$< 5 \times 10^{-5}$	CL=90%	807
$f_0(1500)f_0(1710)$	$< 7 \times 10^{-5}$	CL=90%	557
$K^+K^-\pi^+\pi^-\pi^0$	$(1.11 \pm 0.26) \%$		1545
$K^+K^-\pi^0\pi^0$	$(5.4 \pm 0.9) \times 10^{-3}$		1582
$K^+\pi^-\bar{K}^0\pi^0 + \text{c.c.}$	$(2.44 \pm 0.33) \%$		1581
$\rho^+K^-K^0 + \text{c.c.}$	$(1.18 \pm 0.21) \%$		1458
$K^*(892)^-K^+\pi^0 \rightarrow$ $K^+\pi^-\bar{K}^0\pi^0 + \text{c.c.}$	$(4.5 \pm 1.1) \times 10^{-3}$		—
$K_S^0K_S^0\pi^+\pi^-$	$(5.6 \pm 1.0) \times 10^{-3}$		1579
$K^+K^-\eta\pi^0$	$(3.0 \pm 0.7) \times 10^{-3}$		1468
$3(\pi^+\pi^-)$	$(1.20 \pm 0.18) \%$		1633
$K^+\bar{K}^*(892)^0\pi^- + \text{c.c.}$	$(7.2 \pm 1.6) \times 10^{-3}$		1523
$K^*(892)^0\bar{K}^*(892)^0$	$(1.7 \pm 0.6) \times 10^{-3}$		1456
$\pi\pi$	$(8.33 \pm 0.35) \times 10^{-3}$		1702
$\pi^0\eta$	$< 1.8 \times 10^{-4}$		1661
$\pi^0\eta'$	$< 1.1 \times 10^{-3}$		1570
$\eta\eta$	$(2.95 \pm 0.19) \times 10^{-3}$		1617
$\eta\eta'$	$< 2.3 \times 10^{-4}$	CL=90%	1521
$\eta'\eta'$	$(1.96 \pm 0.21) \times 10^{-3}$		1413
$\omega\omega$	$(9.5 \pm 1.1) \times 10^{-4}$		1517
$\omega\phi$	$(1.16 \pm 0.21) \times 10^{-4}$		1447
$K^+K^-$	$(5.91 \pm 0.32) \times 10^{-3}$		1634
$K_S^0K_S^0$	$(3.10 \pm 0.18) \times 10^{-3}$		1633
$\pi^+\pi^-\eta$	$< 1.9 \times 10^{-4}$	CL=90%	1651
$\pi^+\pi^-\eta'$	$< 3.5 \times 10^{-4}$	CL=90%	1560
$\bar{K}^0K^+\pi^- + \text{c.c.}$	$< 9 \times 10^{-5}$	CL=90%	1610
$K^+K^-\pi^0$	$< 6 \times 10^{-5}$	CL=90%	1611
$K^+K^-\eta$	$< 2.2 \times 10^{-4}$	CL=90%	1512
$K^+K^-K_S^0K_S^0$	$(1.4 \pm 0.5) \times 10^{-3}$		1331
$K^+K^-K^+K^-$	$(2.75 \pm 0.28) \times 10^{-3}$		1333
$K^+K^-\phi$	$(9.5 \pm 2.4) \times 10^{-4}$		1381
$\phi\phi$	$(7.7 \pm 0.7) \times 10^{-4}$		1370
$p\bar{p}$	$(2.25 \pm 0.09) \times 10^{-4}$		1426
$p\bar{p}\pi^0$	$(6.8 \pm 0.7) \times 10^{-4}$	S=1.3	1379
$p\bar{p}\eta$	$(3.5 \pm 0.4) \times 10^{-4}$		1187
$p\bar{p}\omega$	$(5.1 \pm 0.6) \times 10^{-4}$		1043
$p\bar{p}\phi$	$(5.9 \pm 1.4) \times 10^{-5}$		876
$p\bar{p}\pi^+\pi^-$	$(2.1 \pm 0.7) \times 10^{-3}$	S=1.4	1320
$p\bar{p}\pi^0\pi^0$	$(1.02 \pm 0.27) \times 10^{-3}$		1324
$p\bar{p}K^+K^-$ (non-resonant)	$(1.19 \pm 0.26) \times 10^{-4}$		890
$p\bar{p}K_S^0K_S^0$	$< 8.8 \times 10^{-4}$	CL=90%	884

$p\bar{n}\pi^-$	$(1.24 \pm 0.11) \times 10^{-3}$		1376
$\bar{p}n\pi^+$	$(1.34 \pm 0.12) \times 10^{-3}$		1376
$p\bar{n}\pi^-\pi^0$	$(2.29 \pm 0.21) \times 10^{-3}$		1321
$\bar{p}n\pi^+\pi^0$	$(2.16 \pm 0.18) \times 10^{-3}$		1321
$\Lambda\bar{\Lambda}$	$(3.21 \pm 0.25) \times 10^{-4}$		1292
$\Lambda\bar{\Lambda}\pi^+\pi^-$	$(1.15 \pm 0.13) \times 10^{-3}$		1153
$\Lambda\bar{\Lambda}\pi^+\pi^-$ (non-resonant)	$< 5 \times 10^{-4}$	CL=90%	1153
$\Sigma(1385)^+\bar{\Lambda}\pi^- + \text{c.c.}$	$< 5 \times 10^{-4}$	CL=90%	1083
$\Sigma(1385)^-\bar{\Lambda}\pi^+ + \text{c.c.}$	$< 5 \times 10^{-4}$	CL=90%	1083
$K^+\bar{p}\Lambda + \text{c.c.}$	$(1.22 \pm 0.12) \times 10^{-3}$	S=1.3	1132
$K^+\bar{p}\Lambda(1520) + \text{c.c.}$	$(2.9 \pm 0.7) \times 10^{-4}$		858
$\Lambda(1520)\bar{\Lambda}(1520)$	$(3.1 \pm 1.2) \times 10^{-4}$		779
$\Sigma^0\bar{\Sigma}^0$	$(4.4 \pm 0.4) \times 10^{-4}$		1222
$\Sigma^+\bar{\Sigma}^-$	$(3.9 \pm 0.7) \times 10^{-4}$	S=1.7	1225
$\Sigma(1385)^+\bar{\Sigma}(1385)^-$	$(1.6 \pm 0.6) \times 10^{-4}$		1001
$\Sigma(1385)^-\bar{\Sigma}(1385)^+$	$(2.3 \pm 0.6) \times 10^{-4}$		1001
$\Xi^0\bar{\Xi}^0$	$(3.1 \pm 0.8) \times 10^{-4}$		1089
$\Xi^-\bar{\Xi}^+$	$(4.7 \pm 0.7) \times 10^{-4}$		1081

### Radiative decays

$\gamma J/\psi(1S)$	$(1.27 \pm 0.06) \%$		303
$\gamma\rho^0$	$< 9 \times 10^{-6}$	CL=90%	1619
$\gamma\omega$	$< 8 \times 10^{-6}$	CL=90%	1618
$\gamma\phi$	$< 6 \times 10^{-6}$	CL=90%	1555
$\gamma\gamma$	$(2.23 \pm 0.13) \times 10^{-4}$		1707

**$\chi_{c1}(1P)$**

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

Mass  $m = 3510.66 \pm 0.07$  MeV (S = 1.5)

Full width  $\Gamma = 0.84 \pm 0.04$  MeV

<b><math>\chi_{c1}(1P)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
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### 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
$\pi^+\pi^-\pi^0\pi^0$	$(1.22 \pm 0.16) \%$		1729
$\rho^+\pi^-\pi^0 + \text{c.c.}$	$(1.48 \pm 0.25) \%$		1658
$\rho^0\pi^+\pi^-$	$(3.9 \pm 3.5) \times 10^{-3}$		1657
$4\pi^0$	$(5.5 \pm 0.8) \times 10^{-4}$		1729
$\pi^+\pi^-K^+K^-$	$(4.5 \pm 1.0) \times 10^{-3}$		1632
$K^+K^-\pi^0\pi^0$	$(1.14 \pm 0.28) \times 10^{-3}$		1634

$K^+ \pi^- \bar{K}^0 \pi^0 + \text{c.c.}$	$( 8.7 \pm 1.4 ) \times 10^{-3}$		1632
$\rho^- K^+ \bar{K}^0 + \text{c.c.}$	$( 5.1 \pm 1.2 ) \times 10^{-3}$		1514
$K^*(892)^0 \bar{K}^0 \pi^0 \rightarrow$ $K^+ \pi^- \bar{K}^0 \pi^0 + \text{c.c.}$	$( 2.4 \pm 0.7 ) \times 10^{-3}$		—
$K^+ K^- \eta \pi^0$	$( 1.14 \pm 0.35 ) \times 10^{-3}$		1523
$\pi^+ \pi^- K_S^0 K_S^0$	$( 7.0 \pm 3.0 ) \times 10^{-4}$		1630
$K^+ K^- \eta$	$( 3.2 \pm 1.0 ) \times 10^{-4}$		1566
$\bar{K}^0 K^+ \pi^- + \text{c.c.}$	$( 7.1 \pm 0.6 ) \times 10^{-3}$		1661
$K^*(892)^0 \bar{K}^0 + \text{c.c.}$	$( 1.0 \pm 0.4 ) \times 10^{-3}$		1602
$K^*(892)^+ K^- + \text{c.c.}$	$( 1.5 \pm 0.7 ) \times 10^{-3}$		1602
$K_J^*(1430)^0 \bar{K}^0 + \text{c.c.} \rightarrow$ $K_S^0 K^+ \pi^- + \text{c.c.}$	$< 8 \times 10^{-4}$	CL=90%	—
$K_J^*(1430)^+ K^- + \text{c.c.} \rightarrow$ $K_S^0 K^+ \pi^- + \text{c.c.}$	$< 2.2 \times 10^{-3}$	CL=90%	—
$K^+ K^- \pi^0$	$( 1.85 \pm 0.25 ) \times 10^{-3}$		1662
$\eta \pi^+ \pi^-$	$( 4.9 \pm 0.5 ) \times 10^{-3}$		1701
$a_0(980)^+ \pi^- + \text{c.c.} \rightarrow \eta \pi^+ \pi^-$	$( 1.8 \pm 0.6 ) \times 10^{-3}$		—
$f_2(1270) \eta$	$( 2.7 \pm 0.8 ) \times 10^{-3}$		1467
$\pi^+ \pi^- \eta'$	$( 2.3 \pm 0.5 ) \times 10^{-3}$		1612
$\pi^0 f_0(980) \rightarrow \pi^0 \pi^+ \pi^-$	$< 6 \times 10^{-6}$	CL=90%	—
$K^+ \bar{K}^*(892)^0 \pi^- + \text{c.c.}$	$( 3.2 \pm 2.1 ) \times 10^{-3}$		1577
$K^*(892)^0 \bar{K}^*(892)^0$	$( 1.5 \pm 0.4 ) \times 10^{-3}$		1512
$K^+ K^- K_S^0 K_S^0$	$< 4 \times 10^{-4}$	CL=90%	1390
$K^+ K^- K^+ K^-$	$( 5.5 \pm 1.1 ) \times 10^{-4}$		1393
$K^+ K^- \phi$	$( 4.2 \pm 1.6 ) \times 10^{-4}$		1440
$\omega \omega$	$( 5.8 \pm 0.7 ) \times 10^{-4}$		1571
$\omega \phi$	$( 2.1 \pm 0.6 ) \times 10^{-5}$		1503
$\phi \phi$	$( 4.2 \pm 0.5 ) \times 10^{-4}$		1429
$\rho \bar{\rho}$	$( 7.72 \pm 0.35 ) \times 10^{-5}$		1484
$\rho \bar{\rho} \pi^0$	$( 1.59 \pm 0.19 ) \times 10^{-4}$		1438
$\rho \bar{\rho} \eta$	$( 1.48 \pm 0.25 ) \times 10^{-4}$		1254
$\rho \bar{\rho} \omega$	$( 2.16 \pm 0.31 ) \times 10^{-4}$		1117
$\rho \bar{\rho} \phi$	$< 1.8 \times 10^{-5}$	CL=90%	962
$\rho \bar{\rho} \pi^+ \pi^-$	$( 5.0 \pm 1.9 ) \times 10^{-4}$		1381
$\rho \bar{\rho} K^+ K^- (\text{non-resonant})$	$( 1.30 \pm 0.23 ) \times 10^{-4}$		974
$\rho \bar{\rho} K_S^0 K_S^0$	$< 4.5 \times 10^{-4}$	CL=90%	968
$\rho \bar{n} \pi^-$	$( 3.9 \pm 0.5 ) \times 10^{-4}$		1435
$\bar{\rho} n \pi^+$	$( 4.0 \pm 0.5 ) \times 10^{-4}$		1435
$\rho \bar{n} \pi^- \pi^0$	$( 1.05 \pm 0.12 ) \times 10^{-3}$		1383
$\bar{\rho} n \pi^+ \pi^0$	$( 1.03 \pm 0.12 ) \times 10^{-3}$		1383
$\Lambda \bar{\Lambda}$	$( 1.16 \pm 0.12 ) \times 10^{-4}$		1355
$\Lambda \bar{\Lambda} \pi^+ \pi^-$	$( 3.0 \pm 0.5 ) \times 10^{-4}$		1223
$\Lambda \bar{\Lambda} \pi^+ \pi^- (\text{non-resonant})$	$( 2.5 \pm 0.6 ) \times 10^{-4}$		1223

$\Sigma(1385)^+ \bar{\Lambda} \pi^- + \text{c.c.}$	$< 1.3$	$\times 10^{-4}$	CL=90%	1157
$\Sigma(1385)^- \bar{\Lambda} \pi^+ + \text{c.c.}$	$< 1.3$	$\times 10^{-4}$	CL=90%	1157
$K^+ \bar{p} \Lambda$	$( 4.2 \pm 0.4 )$	$\times 10^{-4}$	S=1.1	1203
$K^+ \bar{p} \Lambda(1520) + \text{c.c.}$	$( 1.7 \pm 0.5 )$	$\times 10^{-4}$		950
$\Lambda(1520) \bar{\Lambda}(1520)$	$< 1.0$	$\times 10^{-4}$	CL=90%	879
$\Sigma^0 \bar{\Sigma}^0$	$< 4$	$\times 10^{-5}$	CL=90%	1288
$\Sigma^+ \bar{\Sigma}^-$	$< 6$	$\times 10^{-5}$	CL=90%	1291
$\Sigma(1385)^+ \bar{\Sigma}(1385)^-$	$< 1.0$	$\times 10^{-4}$	CL=90%	1081
$\Sigma(1385)^- \bar{\Sigma}(1385)^+$	$< 5$	$\times 10^{-5}$	CL=90%	1081
$\Xi^0 \bar{\Xi}^0$	$< 6$	$\times 10^{-5}$	CL=90%	1163
$\Xi^- \bar{\Xi}^+$	$( 8.2 \pm 2.2 )$	$\times 10^{-5}$		1155
$\pi^+ \pi^- + K^+ K^-$	$< 2.1$	$\times 10^{-3}$		—
$K_S^0 \bar{K}_S^0$	$< 6$	$\times 10^{-5}$	CL=90%	1683

**Radiative decays**

$\gamma J/\psi(1S)$	$( 33.9 \pm 1.2 ) \%$	389
$\gamma \rho^0$	$( 2.20 \pm 0.18 ) \times 10^{-4}$	1670
$\gamma \omega$	$( 6.9 \pm 0.8 ) \times 10^{-5}$	1668
$\gamma \phi$	$( 2.5 \pm 0.5 ) \times 10^{-5}$	1607

**$h_c(1P)$**

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

Mass  $m = 3525.38 \pm 0.11$  MeV

Full width  $\Gamma = 0.7 \pm 0.4$  MeV

<b><math>h_c(1P)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$\rho$ (MeV/c)
$J/\psi(1S) \pi \pi$	not seen		312
$p \bar{p}$	$< 1.5 \times 10^{-4}$	90%	1492
$\eta_c(1S) \gamma$	$( 51 \pm 6 ) \%$		500
$\pi^+ \pi^- \pi^0$	$< 2.2 \times 10^{-3}$		1749
$2\pi^+ 2\pi^- \pi^0$	$( 2.2_{-0.7}^{+0.8} ) \%$		1716
$3\pi^+ 3\pi^- \pi^0$	$< 2.9 \%$		1661

**$\chi_{c2}(1P)$**

$$J^{PC} = 0^+(2^{++})$$

Mass  $m = 3556.20 \pm 0.09$  MeV

Full width  $\Gamma = 1.93 \pm 0.11$  MeV

$\chi_{c2}(1P)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$P$ (MeV/c)
<b>Hadronic decays</b>			
$2(\pi^+\pi^-)$	( 1.07±0.10 ) %		1751
$\pi^+\pi^-\pi^0\pi^0$	( 1.92±0.25 ) %		1752
$\rho^+\pi^-\pi^0 + \text{c.c.}$	( 2.3 ±0.4 ) %		1682
$4\pi^0$	( 1.16±0.16 ) × 10 <sup>-3</sup>		1752
$K^+K^-\pi^0\pi^0$	( 2.2 ±0.4 ) × 10 <sup>-3</sup>		1658
$K^+\pi^-\bar{K}^0\pi^0 + \text{c.c.}$	( 1.44±0.21 ) %		1657
$\rho^-K^+\bar{K}^0 + \text{c.c.}$	( 4.3 ±1.3 ) × 10 <sup>-3</sup>		1540
$K^*(892)^0K^-\pi^+ \rightarrow$ $K^-\pi^+K^0\pi^0 + \text{c.c.}$	( 3.1 ±0.8 ) × 10 <sup>-3</sup>		–
$K^*(892)^0\bar{K}^0\pi^0 \rightarrow$ $K^+\pi^-\bar{K}^0\pi^0 + \text{c.c.}$	( 4.0 ±0.9 ) × 10 <sup>-3</sup>		–
$K^*(892)^-K^+\pi^0 \rightarrow$ $K^+\pi^-\bar{K}^0\pi^0 + \text{c.c.}$	( 3.9 ±0.9 ) × 10 <sup>-3</sup>		–
$K^*(892)^+\bar{K}^0\pi^- \rightarrow$ $K^+\pi^-\bar{K}^0\pi^0 + \text{c.c.}$	( 3.1 ±0.8 ) × 10 <sup>-3</sup>		–
$K^+K^-\eta\pi^0$	( 1.3 ±0.5 ) × 10 <sup>-3</sup>		1549
$K^+K^-\pi^+\pi^-$	( 8.9 ±1.0 ) × 10 <sup>-3</sup>		1656
$K^+K^-\pi^+\pi^-\pi^0$	( 1.23±0.34 ) %		1623
$K^+\bar{K}^*(892)^0\pi^- + \text{c.c.}$	( 2.2 ±1.1 ) × 10 <sup>-3</sup>		1602
$K^*(892)^0\bar{K}^*(892)^0$	( 2.4 ±0.5 ) × 10 <sup>-3</sup>		1538
$3(\pi^+\pi^-)$	( 8.6 ±1.8 ) × 10 <sup>-3</sup>		1707
$\phi\phi$	( 1.12±0.10 ) × 10 <sup>-3</sup>		1457
$\omega\omega$	( 8.8 ±1.1 ) × 10 <sup>-4</sup>		1597
$\pi\pi$	( 2.33±0.12 ) × 10 <sup>-3</sup>		1773
$\rho^0\pi^+\pi^-$	( 3.8 ±1.6 ) × 10 <sup>-3</sup>		1682
$\pi^+\pi^-\eta$	( 5.0 ±1.3 ) × 10 <sup>-4</sup>		1724
$\pi^+\pi^-\eta'$	( 5.2 ±1.9 ) × 10 <sup>-4</sup>		1636
$\eta\eta$	( 5.7 ±0.5 ) × 10 <sup>-4</sup>		1692
$K^+K^-$	( 1.05±0.07 ) × 10 <sup>-3</sup>		1708
$K_S^0K_S^0$	( 5.5 ±0.4 ) × 10 <sup>-4</sup>		1707
$\bar{K}^0K^+\pi^- + \text{c.c.}$	( 1.34±0.19 ) × 10 <sup>-3</sup>		1685
$K^+K^-\pi^0$	( 3.2 ±0.8 ) × 10 <sup>-4</sup>		1686
$K^+K^-\eta$	< 3.4 × 10 <sup>-4</sup>	90%	1592
$\eta\eta'$	< 6 × 10 <sup>-5</sup>	90%	1600
$\eta'\eta'$	< 1.0 × 10 <sup>-4</sup>	90%	1498
$\pi^+\pi^-K_S^0K_S^0$	( 2.3 ±0.6 ) × 10 <sup>-3</sup>		1655

$K^+ K^- K_S^0 K_S^0$	$< 4 \times 10^{-4}$	90%	1418
$K^+ K^- K^+ K^-$	$(1.73 \pm 0.21) \times 10^{-3}$		1421
$K^+ K^- \phi$	$(1.48 \pm 0.31) \times 10^{-3}$		1468
$p \bar{p}$	$(7.5 \pm 0.4) \times 10^{-5}$		1510
$p \bar{p} \pi^0$	$(4.9 \pm 0.4) \times 10^{-4}$		1465
$p \bar{p} \eta$	$(1.82 \pm 0.26) \times 10^{-4}$		1285
$p \bar{p} \omega$	$(3.8 \pm 0.5) \times 10^{-4}$		1152
$p \bar{p} \phi$	$(2.9 \pm 0.9) \times 10^{-5}$		1002
$p \bar{p} \pi^+ \pi^-$	$(1.32 \pm 0.34) \times 10^{-3}$		1410
$p \bar{p} \pi^0 \pi^0$	$(8.2 \pm 2.5) \times 10^{-4}$		1414
$p \bar{p} K^+ K^-$ (non-resonant)	$(2.00 \pm 0.34) \times 10^{-4}$		1013
$p \bar{p} K_S^0 K_S^0$	$< 7.9 \times 10^{-4}$	90%	1007
$p \bar{n} \pi^-$	$(8.9 \pm 1.0) \times 10^{-4}$		1463
$\bar{p} n \pi^+$	$(9.3 \pm 0.9) \times 10^{-4}$		1463
$p \bar{n} \pi^- \pi^0$	$(2.27 \pm 0.19) \times 10^{-3}$		1411
$\bar{p} n \pi^+ \pi^0$	$(2.21 \pm 0.20) \times 10^{-3}$		1411
$\Lambda \bar{\Lambda}$	$(1.92 \pm 0.16) \times 10^{-4}$		1385
$\Lambda \bar{\Lambda} \pi^+ \pi^-$	$(1.31 \pm 0.17) \times 10^{-3}$		1255
$\Lambda \bar{\Lambda} \pi^+ \pi^-$ (non-resonant)	$(6.9 \pm 1.6) \times 10^{-4}$		1255
$\Sigma(1385)^+ \bar{\Lambda} \pi^- + \text{c.c.}$	$< 4 \times 10^{-4}$	90%	1192
$\Sigma(1385)^- \bar{\Lambda} \pi^+ + \text{c.c.}$	$< 6 \times 10^{-4}$	90%	1192
$K^+ \bar{p} \Lambda + \text{c.c.}$	$(8.1 \pm 0.6) \times 10^{-4}$		1236
$K^+ \bar{p} \Lambda(1520) + \text{c.c.}$	$(2.9 \pm 0.7) \times 10^{-4}$		992
$\Lambda(1520) \bar{\Lambda}(1520)$	$(4.8 \pm 1.5) \times 10^{-4}$		923
$\Sigma^0 \bar{\Sigma}^0$	$< 6 \times 10^{-5}$	90%	1319
$\Sigma^+ \bar{\Sigma}^-$	$< 7 \times 10^{-5}$	90%	1322
$\Sigma(1385)^+ \bar{\Sigma}(1385)^-$	$< 1.6 \times 10^{-4}$	90%	1118
$\Sigma(1385)^- \bar{\Sigma}(1385)^+$	$< 8 \times 10^{-5}$	90%	1118
$\Xi^0 \bar{\Xi}^0$	$< 1.1 \times 10^{-4}$	90%	1197
$\Xi^- \bar{\Xi}^+$	$(1.48 \pm 0.33) \times 10^{-4}$		1189
$J/\psi(1S) \pi^+ \pi^- \pi^0$	$< 1.5 \%$	90%	185
$\eta_c(1S) \pi^+ \pi^-$	$< 2.2 \%$	90%	459

### Radiative decays

$\gamma J/\psi(1S)$	$(19.2 \pm 0.7) \%$		430
$\gamma \rho^0$	$< 2.0 \times 10^{-5}$	90%	1694
$\gamma \omega$	$< 6 \times 10^{-6}$	90%	1692
$\gamma \phi$	$< 8 \times 10^{-6}$	90%	1632
$\gamma \gamma$	$(2.74 \pm 0.14) \times 10^{-4}$		1778

**$\eta_c(2S)$**

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

Quantum numbers are quark model predictions.

$$\text{Mass } m = 3639.2 \pm 1.2 \text{ MeV}$$

$$\text{Full width } \Gamma = 11.3^{+3.2}_{-2.9} \text{ MeV}$$

<b><math>\eta_c(2S)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
hadrons	not seen		—
$K\bar{K}\pi$	( 1.9±1.2 ) %		1730
$K\bar{K}\eta$	( 5 ±4 ) × 10 <sup>-3</sup>		1638
$2\pi^+2\pi^-$	not seen		1793
$\rho^0\rho^0$	not seen		1646
$3\pi^+3\pi^-$	not seen		1750
$K^+K^-\pi^+\pi^-$	not seen		1701
$K^{*0}\bar{K}^{*0}$	not seen		1586
$K^+K^-\pi^+\pi^-\pi^0$	( 1.4±1.0 ) %		1668
$K^+K^-2\pi^+2\pi^-$	not seen		1628
$K_S^0K^-2\pi^+\pi^- + \text{c.c.}$	seen		1667
$2K^+2K^-$	not seen		1471
$\phi\phi$	not seen		1507
$p\bar{p}$	< 2.0 × 10 <sup>-3</sup>	90%	1559
$\gamma\gamma$	( 1.9±1.3 ) × 10 <sup>-4</sup>		1820
$\pi^+\pi^-\eta$	not seen		1767
$\pi^+\pi^-\eta'$	not seen		1681
$\pi^+\pi^-\eta_c(1S)$	< 25 %	90%	539

**$\psi(2S)$**

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

$$\text{Mass } m = 3686.109^{+0.012}_{-0.014} \text{ MeV}$$

$$\text{Full width } \Gamma = 298 \pm 8 \text{ keV}$$

$$\Gamma_{ee} = 2.35 \pm 0.04 \text{ keV}$$

<b><math>\psi(2S)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
hadrons	(97.85 ±0.13 ) %		—
virtual $\gamma \rightarrow$ hadrons	( 1.73 ±0.14 ) %	S=1.5	—
$ggg$	(10.6 ±1.6 ) %		—
$\gamma gg$	( 1.03 ±0.29 ) %		—
light hadrons	(15.4 ±1.5 ) %		—
$e^+e^-$	( 7.89 ±0.17 ) × 10 <sup>-3</sup>		1843
$\mu^+\mu^-$	( 7.9 ±0.9 ) × 10 <sup>-3</sup>		1840
$\tau^+\tau^-$	( 3.1 ±0.4 ) × 10 <sup>-3</sup>		490

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

$J/\psi(1S)$ anything	(61.0 ± 0.6 ) %	–
$J/\psi(1S)$ neutrals	(25.11 ± 0.33 ) %	–
$J/\psi(1S)\pi^+\pi^-$	(34.46 ± 0.30 ) %	477
$J/\psi(1S)\pi^0\pi^0$	(18.14 ± 0.31 ) %	481
$J/\psi(1S)\eta$	( 3.36 ± 0.05 ) %	199
$J/\psi(1S)\pi^0$	( 1.268 ± 0.032 ) × 10 <sup>-3</sup>	528

### Hadronic decays

$\pi^0 h_c(1P)$	( 8.6 ± 1.3 ) × 10 <sup>-4</sup>	85
$3(\pi^+\pi^-)\pi^0$	( 3.5 ± 1.6 ) × 10 <sup>-3</sup>	1746
$2(\pi^+\pi^-)\pi^0$	( 2.9 ± 1.0 ) × 10 <sup>-3</sup>	S=4.7 1799
$\rho a_2(1320)$	( 2.6 ± 0.9 ) × 10 <sup>-4</sup>	1500
$p\bar{p}$	( 2.87 ± 0.09 ) × 10 <sup>-4</sup>	1586
$\Delta^{++}\bar{\Delta}^{--}$	( 1.28 ± 0.35 ) × 10 <sup>-4</sup>	1371
$\Lambda\bar{\Lambda}\pi^0$	< 2.9 × 10 <sup>-6</sup>	CL=90% 1412
$\Lambda\bar{\Lambda}\eta$	( 2.5 ± 0.4 ) × 10 <sup>-5</sup>	1197
$\Lambda\bar{p}K^+$	( 1.00 ± 0.14 ) × 10 <sup>-4</sup>	1327
$\Lambda\bar{p}K^+\pi^+\pi^-$	( 1.8 ± 0.4 ) × 10 <sup>-4</sup>	1167
$\Lambda\bar{\Lambda}\pi^+\pi^-$	( 2.8 ± 0.6 ) × 10 <sup>-4</sup>	1346
$\Lambda\bar{\Lambda}$	( 3.57 ± 0.18 ) × 10 <sup>-4</sup>	1467
$\Lambda\bar{\Sigma}^+\pi^- + c.c.$	( 1.40 ± 0.13 ) × 10 <sup>-4</sup>	1376
$\Lambda\bar{\Sigma}^-\pi^+ + c.c.$	( 1.54 ± 0.14 ) × 10 <sup>-4</sup>	1379
$\Sigma^0\bar{p}K^+ + c.c.$	( 1.67 ± 0.18 ) × 10 <sup>-5</sup>	1291
$\Sigma^+\bar{\Sigma}^-$	( 2.51 ± 0.21 ) × 10 <sup>-4</sup>	1408
$\Sigma^0\bar{\Sigma}^0$	( 2.32 ± 0.16 ) × 10 <sup>-4</sup>	1405
$\Sigma(1385)^+\bar{\Sigma}(1385)^-$	( 1.1 ± 0.4 ) × 10 <sup>-4</sup>	1218
$\Xi^-\bar{\Xi}^+$	( 2.64 ± 0.18 ) × 10 <sup>-4</sup>	1284
$\Xi^0\bar{\Xi}^0$	( 2.07 ± 0.23 ) × 10 <sup>-4</sup>	1292
$\Xi(1530)^0\bar{\Xi}(1530)^0$	( 5.2 <sup>+3.2</sup> / <sub>-1.2</sub> ) × 10 <sup>-5</sup>	1025
$\Omega^-\bar{\Omega}^+$	( 4.7 ± 1.0 ) × 10 <sup>-5</sup>	774
$\pi^0 p\bar{p}$	( 1.53 ± 0.07 ) × 10 <sup>-4</sup>	1543
$N(940)\bar{p} + c.c. \rightarrow \pi^0 p\bar{p}$	( 6.4 <sup>+1.8</sup> / <sub>-1.3</sub> ) × 10 <sup>-5</sup>	–
$N(1440)\bar{p} + c.c. \rightarrow \pi^0 p\bar{p}$	( 7.3 <sup>+1.7</sup> / <sub>-1.5</sub> ) × 10 <sup>-5</sup>	S=2.5 –
$N(1520)\bar{p} + c.c. \rightarrow \pi^0 p\bar{p}$	( 6.4 <sup>+2.3</sup> / <sub>-1.8</sub> ) × 10 <sup>-6</sup>	–
$N(1535)\bar{p} + c.c. \rightarrow \pi^0 p\bar{p}$	( 2.5 ± 1.0 ) × 10 <sup>-5</sup>	–
$N(1650)\bar{p} + c.c. \rightarrow \pi^0 p\bar{p}$	( 3.8 <sup>+1.4</sup> / <sub>-1.7</sub> ) × 10 <sup>-5</sup>	–
$N(1720)\bar{p} + c.c. \rightarrow \pi^0 p\bar{p}$	( 1.79 <sup>+0.26</sup> / <sub>-0.70</sub> ) × 10 <sup>-5</sup>	–
$N(2300)\bar{p} + c.c. \rightarrow \pi^0 p\bar{p}$	( 2.6 <sup>+1.2</sup> / <sub>-0.7</sub> ) × 10 <sup>-5</sup>	–
$N(2570)\bar{p} + c.c. \rightarrow \pi^0 p\bar{p}$	( 2.13 <sup>+0.40</sup> / <sub>-0.31</sub> ) × 10 <sup>-5</sup>	–



$\pi^0 f_0(2100) \rightarrow \pi^0 p \bar{p}$	$( 1.1 \pm 0.4 ) \times 10^{-5}$	—
$\eta p \bar{p}$	$( 6.0 \pm 0.4 ) \times 10^{-5}$	1373
$\eta f_0(2100) \rightarrow \eta p \bar{p}$	$( 1.2 \pm 0.4 ) \times 10^{-5}$	—
$N(1535) \bar{p} \rightarrow \eta p \bar{p}$	$( 4.4 \pm 0.7 ) \times 10^{-5}$	—
$\omega p \bar{p}$	$( 6.9 \pm 2.1 ) \times 10^{-5}$	1247
$\phi p \bar{p}$	$< 2.4 \times 10^{-5}$	CL=90% 1109
$\pi^+ \pi^- p \bar{p}$	$( 6.0 \pm 0.4 ) \times 10^{-4}$	1491
$p \bar{n} \pi^-$ or c.c.	$( 2.48 \pm 0.17 ) \times 10^{-4}$	—
$p \bar{n} \pi^- \pi^0$	$( 3.2 \pm 0.7 ) \times 10^{-4}$	1492
$2(\pi^+ \pi^- \pi^0)$	$( 4.8 \pm 1.5 ) \times 10^{-3}$	1776
$\eta \pi^+ \pi^-$	$< 1.6 \times 10^{-4}$	CL=90% 1791
$\eta \pi^+ \pi^- \pi^0$	$( 9.5 \pm 1.7 ) \times 10^{-4}$	1778
$2(\pi^+ \pi^-) \eta$	$( 1.2 \pm 0.6 ) \times 10^{-3}$	1758
$\eta' \pi^+ \pi^- \pi^0$	$( 4.5 \pm 2.1 ) \times 10^{-4}$	1692
$\omega \pi^+ \pi^-$	$( 7.3 \pm 1.2 ) \times 10^{-4}$	S=2.1 1748
$b_1^\pm \pi^\mp$	$( 4.0 \pm 0.6 ) \times 10^{-4}$	S=1.1 1635
$b_1^0 \pi^0$	$( 2.4 \pm 0.6 ) \times 10^{-4}$	—
$\omega f_2(1270)$	$( 2.2 \pm 0.4 ) \times 10^{-4}$	1515
$\pi^+ \pi^- K^+ K^-$	$( 7.5 \pm 0.9 ) \times 10^{-4}$	S=1.9 1726
$\rho^0 K^+ K^-$	$( 2.2 \pm 0.4 ) \times 10^{-4}$	1616
$K^*(892)^0 \bar{K}_2^*(1430)^0$	$( 1.9 \pm 0.5 ) \times 10^{-4}$	1418
$K^+ K^- \pi^+ \pi^- \eta$	$( 1.3 \pm 0.7 ) \times 10^{-3}$	1574
$K^+ K^- 2(\pi^+ \pi^-) \pi^0$	$( 1.00 \pm 0.31 ) \times 10^{-3}$	1611
$K^+ K^- 2(\pi^+ \pi^-)$	$( 1.9 \pm 0.9 ) \times 10^{-3}$	1654
$K_1(1270)^\pm K^\mp$	$( 1.00 \pm 0.28 ) \times 10^{-3}$	1581
$K_S^0 K_S^0 \pi^+ \pi^-$	$( 2.2 \pm 0.4 ) \times 10^{-4}$	1724
$\rho^0 p \bar{p}$	$( 5.0 \pm 2.2 ) \times 10^{-5}$	1252
$K^+ \bar{K}^*(892)^0 \pi^- + \text{c.c.}$	$( 6.7 \pm 2.5 ) \times 10^{-4}$	1674
$2(\pi^+ \pi^-)$	$( 2.4 \pm 0.6 ) \times 10^{-4}$	S=2.2 1817
$\rho^0 \pi^+ \pi^-$	$( 2.2 \pm 0.6 ) \times 10^{-4}$	S=1.4 1750
$K^+ K^- \pi^+ \pi^- \pi^0$	$( 1.26 \pm 0.09 ) \times 10^{-3}$	1694
$\omega f_0(1710) \rightarrow \omega K^+ K^-$	$( 5.9 \pm 2.2 ) \times 10^{-5}$	—
$K^*(892)^0 K^- \pi^+ \pi^0 + \text{c.c.}$	$( 8.6 \pm 2.2 ) \times 10^{-4}$	—
$K^*(892)^+ K^- \pi^+ \pi^- + \text{c.c.}$	$( 9.6 \pm 2.8 ) \times 10^{-4}$	—
$K^*(892)^+ K^- \rho^0 + \text{c.c.}$	$( 7.3 \pm 2.6 ) \times 10^{-4}$	—
$K^*(892)^0 K^- \rho^+ + \text{c.c.}$	$( 6.1 \pm 1.8 ) \times 10^{-4}$	—
$\eta K^+ K^-$ , no $\eta \phi$	$( 3.1 \pm 0.4 ) \times 10^{-5}$	1664
$\omega K^+ K^-$	$( 1.62 \pm 0.11 ) \times 10^{-4}$	S=1.1 1614
$\omega K^*(892)^+ K^- + \text{c.c.}$	$( 2.07 \pm 0.26 ) \times 10^{-4}$	1482
$\omega K_2^*(1430)^+ K^- + \text{c.c.}$	$( 6.1 \pm 1.2 ) \times 10^{-5}$	1253
$\omega \bar{K}^*(892)^0 K^0$	$( 1.68 \pm 0.30 ) \times 10^{-4}$	1481
$\omega \bar{K}_2^*(1430)^0 K^0$	$( 5.8 \pm 2.2 ) \times 10^{-5}$	1251
$\omega X(1440) \rightarrow \omega K_S^0 K^- \pi^+ + \text{c.c.}$	$( 1.6 \pm 0.4 ) \times 10^{-5}$	—

$\omega X(1440) \rightarrow \omega K^+ K^- \pi^0$	$( 1.09 \pm 0.26 ) \times 10^{-5}$		—
$\omega f_1(1285) \rightarrow \omega K_S^0 K^- \pi^+ +$ c.c.	$( 3.0 \pm 1.0 ) \times 10^{-6}$		—
$\omega f_1(1285) \rightarrow \omega K^+ K^- \pi^0$	$( 1.2 \pm 0.7 ) \times 10^{-6}$		—
$3(\pi^+ \pi^-)$	$( 3.5 \pm 2.0 ) \times 10^{-4}$	S=2.8	1774
$p\bar{p}\pi^+ \pi^- \pi^0$	$( 7.3 \pm 0.7 ) \times 10^{-4}$		1435
$K^+ K^-$	$( 7.1 \pm 0.5 ) \times 10^{-5}$	S=1.5	1776
$K_S^0 K_L^0$	$( 5.34 \pm 0.33 ) \times 10^{-5}$		1775
$\pi^+ \pi^- \pi^0$	$( 2.01 \pm 0.17 ) \times 10^{-4}$	S=1.7	1830
$\rho(2150)\pi \rightarrow \pi^+ \pi^- \pi^0$	$( 1.9 \begin{smallmatrix} +1.2 \\ -0.4 \end{smallmatrix} ) \times 10^{-4}$		—
$\rho(770)\pi \rightarrow \pi^+ \pi^- \pi^0$	$( 3.2 \pm 1.2 ) \times 10^{-5}$	S=1.8	—
$\pi^+ \pi^-$	$( 7.8 \pm 2.6 ) \times 10^{-6}$		1838
$K_1(1400)^\pm K^\mp$	$< 3.1 \times 10^{-4}$	CL=90%	1532
$K_2^*(1430)^\pm K^\mp$	$( 7.1 \begin{smallmatrix} +1.3 \\ -0.9 \end{smallmatrix} ) \times 10^{-5}$		—
$K^+ K^- \pi^0$	$( 4.07 \pm 0.31 ) \times 10^{-5}$		1754
$K^+ K^*(892)^- + \text{c.c.}$	$( 2.9 \pm 0.4 ) \times 10^{-5}$	S=1.2	1698
$K^*(892)^0 \bar{K}^0 + \text{c.c.}$	$( 1.09 \pm 0.20 ) \times 10^{-4}$		1697
$\phi \pi^+ \pi^-$	$( 1.17 \pm 0.29 ) \times 10^{-4}$	S=1.7	1690
$\phi f_0(980) \rightarrow \pi^+ \pi^-$	$( 6.8 \pm 2.4 ) \times 10^{-5}$	S=1.1	—
$2(K^+ K^-)$	$( 6.0 \pm 1.4 ) \times 10^{-5}$		1499
$\phi K^+ K^-$	$( 7.0 \pm 1.6 ) \times 10^{-5}$		1546
$2(K^+ K^-)\pi^0$	$( 1.10 \pm 0.28 ) \times 10^{-4}$		1440
$\phi \eta$	$( 3.10 \pm 0.31 ) \times 10^{-5}$		1654
$\phi \eta'$	$( 3.1 \pm 1.6 ) \times 10^{-5}$		1555
$\omega \eta'$	$( 3.2 \begin{smallmatrix} +2.5 \\ -2.1 \end{smallmatrix} ) \times 10^{-5}$		1623
$\omega \pi^0$	$( 2.1 \pm 0.6 ) \times 10^{-5}$		1757
$\rho \eta'$	$( 1.9 \begin{smallmatrix} +1.7 \\ -1.2 \end{smallmatrix} ) \times 10^{-5}$		1625
$\rho \eta$	$( 2.2 \pm 0.6 ) \times 10^{-5}$	S=1.1	1717
$\omega \eta$	$< 1.1 \times 10^{-5}$	CL=90%	1715
$\phi \pi^0$	$< 4 \times 10^{-7}$	CL=90%	1699
$\eta_c \pi^+ \pi^- \pi^0$	$< 1.0 \times 10^{-3}$	CL=90%	512
$p\bar{p}K^+ K^-$	$( 2.7 \pm 0.7 ) \times 10^{-5}$		1118
$\bar{\Lambda} n K_S^0 + \text{c.c.}$	$( 8.1 \pm 1.8 ) \times 10^{-5}$		1324
$\phi f_2'(1525)$	$( 4.4 \pm 1.6 ) \times 10^{-5}$		1321
$\Theta(1540) \bar{\Theta}(1540) \rightarrow$ $K_S^0 p K^- \bar{n} + \text{c.c.}$	$< 8.8 \times 10^{-6}$	CL=90%	—
$\Theta(1540) K^- \bar{n} \rightarrow K_S^0 p K^- \bar{n}$	$< 1.0 \times 10^{-5}$	CL=90%	—
$\Theta(1540) K_S^0 \bar{p} \rightarrow K_S^0 \bar{p} K^+ n$	$< 7.0 \times 10^{-6}$	CL=90%	—
$\bar{\Theta}(1540) K^+ n \rightarrow K_S^0 \bar{p} K^+ n$	$< 2.6 \times 10^{-5}$	CL=90%	—
$\bar{\Theta}(1540) K_S^0 p \rightarrow K_S^0 p K^- \bar{n}$	$< 6.0 \times 10^{-6}$	CL=90%	—
$K_S^0 K_S^0$	$< 4.6 \times 10^{-6}$		1775

### Radiative decays

$\gamma\chi_{c0}(1P)$	( 9.99 ± 0.27 ) %		261
$\gamma\chi_{c1}(1P)$	( 9.55 ± 0.31 ) %		171
$\gamma\chi_{c2}(1P)$	( 9.11 ± 0.31 ) %		128
$\gamma\eta_c(1S)$	( 3.4 ± 0.5 ) × 10 <sup>-3</sup>	S=1.3	636
$\gamma\eta_c(2S)$	( 7 ± 5 ) × 10 <sup>-4</sup>		47
$\gamma\pi^0$	( 1.6 ± 0.4 ) × 10 <sup>-6</sup>		1841
$\gamma\eta'(958)$	( 1.23 ± 0.06 ) × 10 <sup>-4</sup>		1719
$\gamma f_2(1270)$	( 2.1 ± 0.4 ) × 10 <sup>-4</sup>		1622
$\gamma f_0(1710) \rightarrow \gamma\pi\pi$	( 3.0 ± 1.3 ) × 10 <sup>-5</sup>		—
$\gamma f_0(1710) \rightarrow \gamma K\bar{K}$	( 6.0 ± 1.6 ) × 10 <sup>-5</sup>		—
$\gamma\gamma$	< 1.4 × 10 <sup>-4</sup>	CL=90%	1843
$\gamma\eta$	( 1.4 ± 0.5 ) × 10 <sup>-6</sup>		1802
$\gamma\eta\pi^+\pi^-$	( 8.7 ± 2.1 ) × 10 <sup>-4</sup>		1791
$\gamma\eta(1405) \rightarrow \gamma K\bar{K}\pi$	< 9 × 10 <sup>-5</sup>	CL=90%	1569
$\gamma\eta(1405) \rightarrow \eta\pi^+\pi^-$	( 3.6 ± 2.5 ) × 10 <sup>-5</sup>		—
$\gamma\eta(1475) \rightarrow K\bar{K}\pi$	< 1.4 × 10 <sup>-4</sup>	CL=90%	—
$\gamma\eta(1475) \rightarrow \eta\pi^+\pi^-$	< 8.8 × 10 <sup>-5</sup>	CL=90%	—
$\gamma 2(\pi^+\pi^-)$	( 4.0 ± 0.6 ) × 10 <sup>-4</sup>		1817
$\gamma K^{*0}K^+\pi^- + c.c.$	( 3.7 ± 0.9 ) × 10 <sup>-4</sup>		1674
$\gamma K^{*0}\bar{K}^{*0}$	( 2.4 ± 0.7 ) × 10 <sup>-4</sup>		1613
$\gamma K_S^0K^+\pi^- + c.c.$	( 2.6 ± 0.5 ) × 10 <sup>-4</sup>		1753
$\gamma K^+K^-\pi^+\pi^-$	( 1.9 ± 0.5 ) × 10 <sup>-4</sup>		1726
$\gamma p\bar{p}$	( 3.9 ± 0.5 ) × 10 <sup>-5</sup>	S=2.0	1586
$\gamma f_2(1950) \rightarrow \gamma p\bar{p}$	( 1.20 ± 0.22 ) × 10 <sup>-5</sup>		—
$\gamma f_2(2150) \rightarrow \gamma p\bar{p}$	( 7.2 ± 1.8 ) × 10 <sup>-6</sup>		—
$\gamma X(1835) \rightarrow \gamma p\bar{p}$	( 4.6 <sup>+1.8</sup> <sub>-4.0</sub> ) × 10 <sup>-6</sup>		—
$\gamma X \rightarrow \gamma p\bar{p}$	[g] < 2 × 10 <sup>-6</sup>	CL=90%	—
$\gamma\pi^+\pi^-p\bar{p}$	( 2.8 ± 1.4 ) × 10 <sup>-5</sup>		1491
$\gamma 2(\pi^+\pi^-)K^+K^-$	< 2.2 × 10 <sup>-4</sup>	CL=90%	1654
$\gamma 3(\pi^+\pi^-)$	< 1.7 × 10 <sup>-4</sup>	CL=90%	1774
$\gamma K^+K^-K^+K^-$	< 4 × 10 <sup>-5</sup>	CL=90%	1499
$\gamma\gamma J/\psi$	( 3.1 <sup>+1.0</sup> <sub>-1.2</sub> ) × 10 <sup>-4</sup>		542

### Other decays

invisible	< 1.6	%	CL=90%	—
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**$\psi(3770)$**

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

Mass  $m = 3773.15 \pm 0.33$  MeV

Full width  $\Gamma = 27.2 \pm 1.0$  MeV

$\Gamma_{ee} = 0.262 \pm 0.018$  keV ( $S = 1.4$ )

In addition to the dominant decay mode to  $D\bar{D}$ ,  $\psi(3770)$  was found to decay into the final states containing the  $J/\psi$  (BAI 05, ADAM 06). ADAMS 06 and HUANG 06A searched for various decay modes with light hadrons and found a statistically significant signal for the decay to  $\phi\eta$  only (ADAMS 06).

$\psi(3770)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$\rho$ (MeV/c)
$D\bar{D}$	(93 $^{+8}_{-9}$ ) %	S=2.0	286
$D^0\bar{D}^0$	(52 $\pm 5$ ) %	S=2.0	286
$D^+D^-$	(41 $\pm 4$ ) %	S=2.0	252
$J/\psi\pi^+\pi^-$	( $1.93 \pm 0.28$ ) $\times 10^{-3}$		560
$J/\psi\pi^0\pi^0$	( $8.0 \pm 3.0$ ) $\times 10^{-4}$		564
$J/\psi\eta$	( $9 \pm 4$ ) $\times 10^{-4}$		360
$J/\psi\pi^0$	< 2.8 $\times 10^{-4}$	CL=90%	603
$e^+e^-$	( $9.6 \pm 0.7$ ) $\times 10^{-6}$	S=1.3	1887

**Decays to light hadrons**

$b_1(1235)\pi$	< 1.4 $\times 10^{-5}$	CL=90%	1683
$\phi\eta'$	< 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%	1804
$K^*(892)^+K^- + c.c.$	< 1.4 $\times 10^{-5}$	CL=90%	1745
$K^*(892)^0\bar{K}^0 + c.c.$	< 1.2 $\times 10^{-3}$	CL=90%	1744
$K_S^0K_L^0$	< 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%	1843
$2(\pi^+\pi^-\pi^0)$	< 5.85 %	CL=90%	1821
$\omega\pi^+\pi^-$	< 6.0 $\times 10^{-4}$	CL=90%	1794
$3(\pi^+\pi^-)$	< 9.1 $\times 10^{-3}$		1819
$3(\pi^+\pi^-)\pi^0$	< 1.37 %		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
$\eta3\pi$	< 1.34	$\times 10^{-3}$	CL=90%	1824
$\eta2(\pi^+\pi^-)$	< 2.43	%		1804
$\eta\rho^0\pi^+\pi^-$	< 1.45	%	CL=90%	1708
$\eta'3\pi$	< 2.44	$\times 10^{-3}$	CL=90%	1740
$K^+K^-\pi^+\pi^-$	< 9.0	$\times 10^{-4}$	CL=90%	1772
$\phi\pi^+\pi^-$	< 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%	1622
$\omega K^+K^-$	< 3.4	$\times 10^{-4}$	CL=90%	1664
$\phi\pi^+\pi^-\pi^0$	< 3.8	$\times 10^{-3}$	CL=90%	1722
$K^{*0}K^-\pi^+\pi^0 + \text{c.c.}$	< 1.62	%	CL=90%	1693
$K^{*+}K^-\pi^+\pi^- + \text{c.c.}$	< 3.23	%	CL=90%	1692
$K^+K^-\pi^+\pi^-2\pi^0$	< 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%	1660
$\eta K^+K^-$	< 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%	1665
$2(K^+K^-)$	< 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%	1493
$2(K^+K^-)\pi^+\pi^-$	< 3.2	$\times 10^{-3}$	CL=90%	1425
$K_S^0 K^-\pi^+$	< 3.2	$\times 10^{-3}$	CL=90%	1799
$K_S^0 K^-\pi^+\pi^0$	< 1.33	%	CL=90%	1773
$K_S^0 K^-\rho^+$	< 6.6	$\times 10^{-3}$	CL=90%	1664
$K_S^0 K^-2\pi^+\pi^-$	< 8.7	$\times 10^{-3}$	CL=90%	1739
$K_S^0 K^-\pi^+\rho^0$	< 1.6	%	CL=90%	1621
$K_S^0 K^-\pi^+\eta$	< 1.3	%	CL=90%	1669
$K_S^0 K^-2\pi^+\pi^-\pi^0$	< 4.18	%	CL=90%	1703
$K_S^0 K^-2\pi^+\pi^-\eta$	< 4.8	%	CL=90%	1570
$K_S^0 K^-\pi^+2(\pi^+\pi^-)$	< 1.22	%	CL=90%	1658
$K_S^0 K^-\pi^+2\pi^0$	< 2.65	%	CL=90%	1742
$K_S^0 K^-K^+K^-\pi^+$	< 4.9	$\times 10^{-3}$	CL=90%	1490
$K_S^0 K^-K^+K^-\pi^+\pi^0$	< 3.0	%	CL=90%	1427
$K_S^0 K^-K^+K^-\pi^+\eta$	< 2.2	%	CL=90%	1214

$K^{*0} K^- \pi^+ + \text{c.c.}$	< 9.7	$\times 10^{-3}$	CL=90%	1722
$p\bar{p}\pi^0$	< 4	$\times 10^{-5}$	CL=90%	1595
$p\bar{p}\pi^+\pi^-$	< 5.8	$\times 10^{-4}$	CL=90%	1544
$\Lambda\bar{\Lambda}$	< 1.2	$\times 10^{-4}$	CL=90%	1521
$p\bar{p}\pi^+\pi^-\pi^0$	< 1.85	$\times 10^{-3}$	CL=90%	1490
$\omega p\bar{p}$	< 2.9	$\times 10^{-4}$	CL=90%	1309
$\Lambda\bar{\Lambda}\pi^0$	< 7	$\times 10^{-5}$	CL=90%	1469
$p\bar{p}2(\pi^+\pi^-)$	< 2.6	$\times 10^{-3}$	CL=90%	1425
$\eta p\bar{p}$	< 5.4	$\times 10^{-4}$	CL=90%	1430
$\eta p\bar{p}\pi^+\pi^-$	< 3.3	$\times 10^{-3}$	CL=90%	1284
$\rho^0 p\bar{p}$	< 1.7	$\times 10^{-3}$	CL=90%	1313
$p\bar{p}K^+K^-$	< 3.2	$\times 10^{-4}$	CL=90%	1185
$\eta p\bar{p}K^+K^-$	< 6.9	$\times 10^{-3}$	CL=90%	736
$\pi^0 p\bar{p}K^+K^-$	< 1.2	$\times 10^{-3}$	CL=90%	1093
$\phi p\bar{p}$	< 1.3	$\times 10^{-4}$	CL=90%	1178
$\Lambda\bar{\Lambda}\pi^+\pi^-$	< 2.5	$\times 10^{-4}$	CL=90%	1405
$\Lambda\bar{p}K^+$	< 2.8	$\times 10^{-4}$	CL=90%	1387
$\Lambda\bar{p}K^+\pi^+\pi^-$	< 6.3	$\times 10^{-4}$	CL=90%	1234
$\Lambda\bar{\Lambda}\eta$	< 1.9	$\times 10^{-4}$	CL=90%	1262
$\Sigma^+\bar{\Sigma}^-$	< 1.0	$\times 10^{-4}$	CL=90%	1464
$\Sigma^0\bar{\Sigma}^0$	< 4	$\times 10^{-5}$	CL=90%	1462
$\Xi^+\bar{\Xi}^-$	< 1.5	$\times 10^{-4}$	CL=90%	1346
$\Xi^0\bar{\Xi}^0$	< 1.4	$\times 10^{-4}$	CL=90%	1353

### Radiative decays

$\gamma\chi_{c2}$	< 9	$\times 10^{-4}$	CL=90%	211
$\gamma\chi_{c1}$	( 2.7 $\pm$ 0.5 )	$\times 10^{-3}$		253
$\gamma\chi_{c0}$	( 7.3 $\pm$ 0.9 )	$\times 10^{-3}$		341
$\gamma\eta_c$	< 7	$\times 10^{-4}$	CL=90%	707
$\gamma\eta_c(2S)$	< 9	$\times 10^{-4}$	CL=90%	132
$\gamma\eta'$	< 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

**X(3872)**

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

Mass  $m = 3871.69 \pm 0.17$  MeV $m_{X(3872)} - m_{J/\psi} = 775 \pm 4$  MeV $m_{X(3872)} - m_{\psi(2S)}$ Full width  $\Gamma < 1.2$  MeV, CL = 90%

<b>X(3872) DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi^+\pi^-J/\psi(1S)$	> 2.6 %	650
$\omega J/\psi(1S)$	> 1.9 %	†
$D^0\bar{D}^0\pi^0$	>32 %	117
$\bar{D}^{*0}D^0$	>24 %	†
$\gamma J/\psi$	> $6 \times 10^{-3}$	697
$\gamma\psi(2S)$	> 3.0 %	181
$\pi^+\pi^-\eta_c(1S)$	not seen	746
$p\bar{p}$	not seen	1693

**X(3900) $^\pm$** 

$$I(J^P) = ?(1^+)$$

Mass  $m = 3888.7 \pm 3.4$  MeV ( $S = 1.3$ )Full width  $\Gamma = 35 \pm 7$  MeV

<b>X(3900)<math>^\pm</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$J/\psi\pi^\pm$	seen	700
$h_c\pi^\pm$	not seen	—
$(D\bar{D}^*)^\pm$	seen	—

 **$\chi_{c0}(3915)$   
was  $\chi_{c0}(2P)$** 

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

Mass  $m = 3918.4 \pm 1.9$  MeVFull width  $\Gamma = 20 \pm 5$  MeV ( $S = 1.1$ )

<b><math>\chi_{c0}(3915)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\omega J/\psi$	seen	222
$\pi^+\pi^-\eta_c(1S)$	not seen	785
$K\bar{K}$	not seen	1896
$\gamma\gamma$	seen	1959

**$\chi_{c2}(2P)$**

$$J^{PC} = 0^{+}(2^{++})$$

Mass  $m = 3927.2 \pm 2.6$  MeV

Full width  $\Gamma = 24 \pm 6$  MeV

<b><math>\chi_{c2}(2P)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\gamma\gamma$	seen	1964
$D\bar{D}$	seen	615
$D^+D^-$	seen	600
$D^0\bar{D}^0$	seen	615
$\pi^+\pi^-\eta_c(1S)$	not seen	792
$K\bar{K}$	not seen	1901

**$\psi(4040)$  <sup>[h]</sup>**

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

Mass  $m = 4039 \pm 1$  MeV

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

$\Gamma_{ee} = 0.86 \pm 0.07$  keV

Due to the complexity of the  $c\bar{c}$  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.

<b><math>\psi(4040)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$e^+e^-$	$(1.07 \pm 0.16) \times 10^{-5}$		2019
$D\bar{D}$	seen		775
$D^0\bar{D}^0$	seen		775
$D^+D^-$	seen		763
$D^*\bar{D} + c.c.$	seen		569
$D^*(2007)^0\bar{D}^0 + c.c.$	seen		575
$D^*(2010)^+D^- + c.c.$	seen		561
$D^*\bar{D}^*$	seen		193
$D^*(2007)^0\bar{D}^*(2007)^0$	seen		225
$D^*(2010)^+D^*(2010)^-$	seen		193
$D^0D^-\pi^+ + c.c.$ (excl. $D^*(2007)^0\bar{D}^0 + c.c.$ , $D^*(2010)^+D^- + c.c.$ )	not seen		–
$D\bar{D}^*\pi$ (excl. $D^*\bar{D}^*$ )	not seen		–
$D^0\bar{D}^{*-}\pi^+ + c.c.$ (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
$\chi_{c1} \gamma$	$< 1.1$	%	90%	494
$\chi_{c2} \gamma$	$< 1.7$	%	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
$\Lambda \bar{\Lambda} \pi^+ \pi^-$	$< 2.9$	$\times 10^{-4}$	90%	1578
$\Lambda \bar{\Lambda} \pi^0$	$< 9$	$\times 10^{-5}$	90%	1636
$\Lambda \bar{\Lambda} \eta$	$< 3.0$	$\times 10^{-4}$	90%	1452
$\Sigma^+ \bar{\Sigma}^-$	$< 1.3$	$\times 10^{-4}$	90%	1632
$\Sigma^0 \bar{\Sigma}^0$	$< 7$	$\times 10^{-5}$	90%	1630
$\Xi^+ \bar{\Xi}^-$	$< 1.6$	$\times 10^{-4}$	90%	1527
$\Xi^0 \bar{\Xi}^0$	$< 1.8$	$\times 10^{-4}$	90%	1533

**$\psi(4160)$**  <sup>[h]</sup>

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

Mass  $m = 4191 \pm 5$  MeV

Full width  $\Gamma = 70 \pm 10$  MeV

$\Gamma_{ee} = 0.48 \pm 0.22$  keV

Due to the complexity of the  $c\bar{c}$  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.

<b><math>\psi(4160)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	<sup>P</sup> (MeV/c)
$e^+ e^-$	$(6.9 \pm 3.3) \times 10^{-6}$		2096
$\mu^+ \mu^-$	seen		2093
$D \bar{D}$	seen		956
$D^0 \bar{D}^0$	seen		956
$D^+ D^-$	seen		947
$D^* \bar{D}^* + \text{c.c.}$	seen		798
$D^*(2007)^0 \bar{D}^0 + \text{c.c.}$	seen		802
$D^*(2010)^+ D^- + \text{c.c.}$	seen		792
$D^* \bar{D}^*$	seen		592
$D^*(2007)^0 \bar{D}^*(2007)^0$	seen		603
$D^*(2010)^+ D^*(2010)^-$	seen		592

$D^0 D^- \pi^+ + \text{c.c.}$ (excl. $D^*(2007)^0 \bar{D}^0 + \text{c.c.}$ , $D^*(2010)^+ D^- + \text{c.c.}$ )	not seen			—
$D \bar{D}^* \pi + \text{c.c.}$ (excl. $D^* \bar{D}^*$ )	seen			—
$D^0 D^{*-} \pi^+ + \text{c.c.}$ (excl. $D^*(2010)^+ D^*(2010)^-$ )	not seen			—
$D_s^+ D_s^-$	not seen			720
$D_s^{*+} D_s^- + \text{c.c.}$	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%	821
$J/\psi \pi^0$	$< 1$	$\times 10^{-3}$	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
$\chi_{c1} \gamma$	$< 7$	$\times 10^{-3}$	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

**X(4260)**

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

Mass  $m = 4251 \pm 9$  MeV (S = 1.6)

Full width  $\Gamma = 120 \pm 12$  MeV (S = 1.1)

<b>X(4260) DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$J/\psi \pi^+ \pi^-$	seen	967
$J/\psi f_0(980), f_0(980) \rightarrow \pi^+ \pi^-$	seen	—
$X(3900)^\pm \pi^\mp, X^\pm \rightarrow J/\psi \pi^\pm$	seen	—
$J/\psi \pi^0 \pi^0$	seen	969
$J/\psi K^+ K^-$	seen	512
$J/\psi K_S^0 K_S^0$	not seen	501
$X(3872) \gamma$	seen	363
$J/\psi \eta$	not seen	876
$J/\psi \pi^0$	not seen	991
$J/\psi \eta'$	not seen	552

$J/\psi \pi^+ \pi^- \pi^0$	not seen	930
$J/\psi \eta \eta$	not seen	311
$\psi(2S) \pi^+ \pi^-$	not seen	459
$\psi(2S) \eta$	not seen	129
$\chi_{c0} \omega$	not seen	265
$\chi_{c1} \gamma$	not seen	676
$\chi_{c2} \gamma$	not seen	638
$\chi_{c1} \pi^+ \pi^- \pi^0$	not seen	560
$\chi_{c2} \pi^+ \pi^- \pi^0$	not seen	512
$h_c(1P) \pi^+ \pi^-$	not seen	613
$\phi \pi^+ \pi^-$	not seen	1993
$\phi f_0(980) \rightarrow \phi \pi^+ \pi^-$	not seen	—
$D \bar{D}$	not seen	1020
$D^0 \bar{D}^0$	not seen	1020
$D^+ D^-$	not seen	1011
$D^* \bar{D}^* + c.c.$	not seen	887
$D^*(2007)^0 \bar{D}^0 + c.c.$	not seen	—
$D^*(2010)^+ D^- + c.c.$	not seen	—
$D^* \bar{D}^*$	not seen	691
$D^*(2007)^0 \bar{D}^*(2007)^0$	not seen	700
$D^*(2010)^+ D^*(2010)^-$	not seen	691
$D^0 D^- \pi^+ + c.c. (excl.$	not seen	—
$D^*(2007)^0 \bar{D}^{*0} + c.c.,$		
$D^*(2010)^+ D^- + c.c.)$		
$D \bar{D}^* \pi + c.c. (excl. D^* \bar{D}^*)$	not seen	723
$D^0 D^{*-} \pi^+ + c.c. (excl.$	not seen	—
$D^*(2010)^+ D^*(2010)^-$		
$D^0 D^*(2010)^- \pi^+ + c.c.$	not seen	716
$D^* \bar{D}^* \pi$	not seen	448
$D_s^+ D_s^-$	not seen	803
$D_s^{*+} D_s^- + c.c.$	not seen	615
$D_s^{*+} D_s^{*-}$	not seen	239
$p \bar{p}$	not seen	1907
$K_S^0 K^\pm \pi^\mp$	not seen	2048
$K^+ K^- \pi^0$	not seen	2049

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**X(4360)**

$$J^{PC} = ??(1^{--})$$

X(4360) MASS =  $4354 \pm 10$  MeV

X(4360) WIDTH =  $78 \pm 16$  MeV

<b>X(4360) DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\psi(2S)\pi^+\pi^-$	seen	560

**$\psi(4415)$  [*h*]**

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

Mass  $m = 4421 \pm 4$  MeV

Full width  $\Gamma = 62 \pm 20$  MeV

$\Gamma_{ee} = 0.58 \pm 0.07$  keV

Due to the complexity of the  $c\bar{c}$  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.

<b><math>\psi(4415)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$D\bar{D}$	not seen		1187
$D^0\bar{D}^0$	seen		1187
$D^+D^-$	seen		1179
$D^*\bar{D} + \text{c.c.}$	not seen		1063
$D^*(2007)^0\bar{D}^0 + \text{c.c.}$	seen		1066
$D^*(2010)^+D^- + \text{c.c.}$	seen		1059
$D^*\bar{D}^*$	not seen		919
$D^*(2007)^0\bar{D}^*(2007)^0 + \text{c.c.}$	seen		926
$D^*(2010)^+D^*(2010)^- + \text{c.c.}$	seen		919
$D^0D^-\pi^+$ (excl. $D^*(2007)^0\bar{D}^0$ +c.c., $D^*(2010)^+D^-$ +c.c.)	< 2.3 %	90%	—
$D\bar{D}_2^*(2460) \rightarrow D^0D^-\pi^+ + \text{c.c.}$	( $10 \pm 4$ ) %		—
$D^0D^{*-}\pi^+ + \text{c.c.}$	< 11 %	90%	926
$D_s^+D_s^-$	not seen		1006
$D_s^{*+}D_s^- + \text{c.c.}$	seen		—
$D_s^{*+}D_s^{*-}$	not seen		652
$J/\psi\eta$	< 6 $\times 10^{-3}$	90%	1022
$e^+e^-$	( $9.4 \pm 3.2$ ) $\times 10^{-6}$		2210

**X(4430)<sup>±</sup>**

$$I(J^P) = ?(1^+)$$

Quantum numbers not established.

$$\text{Mass } m = 4478^{+15}_{-18} \text{ MeV}$$

$$\text{Full width } \Gamma = 181 \pm 31 \text{ MeV}$$

<b>X(4430)<sup>±</sup> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi^+ \psi(2S)$	seen	711
$\pi^+ J/\psi$	not seen	1162

**X(4660)**

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

$$X(4660) \text{ MASS} = 4665 \pm 10 \text{ MeV}$$

$$X(4660) \text{ WIDTH} = 53 \pm 16 \text{ MeV} \quad (S = 1.1)$$

<b>X(4660) DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\psi(2S) \pi^+ \pi^-$	seen	840

## NOTES

- [a] For  $E_\gamma > 100$  MeV.
- [b] The value is for the sum of the charge states or particle/antiparticle states indicated.
- [c] Includes  $p\bar{p}\pi^+\pi^-\gamma$  and excludes  $p\bar{p}\eta$ ,  $p\bar{p}\omega$ ,  $p\bar{p}\eta'$ .
- [d] See the "Note on the  $\eta(1405)$ " in the  $\eta(1405)$  Particle Listings.
- [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 narrow resonance in the range  $2.2 < M(X) < 2.8$  GeV.
- [h]  $J^{PC}$  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.