

$c\bar{c}$ MESONS

 $\eta_c(1S)$

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

 Mass $m = 2980.3 \pm 1.2$ MeV ($S = 1.6$)

 Full width $\Gamma = 28.6 \pm 2.2$ MeV ($S = 2.0$)

$\eta_c(1S)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	P (MeV/c)
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Decays involving hadronic resonances

$\eta'(958)\pi\pi$	$(4.1 \pm 1.7) \%$		1321
$\rho\rho$	$(2.0 \pm 0.7) \%$		1272
$K^*(892)^0 K^- \pi^+ + \text{c.c.}$	$(2.0 \pm 0.7) \%$		1276
$K^*(892)\bar{K}^*(892)$	$(9.2 \pm 3.4) \times 10^{-3}$		1194
$K^{*0}\bar{K}^{*0}\pi^+\pi^-$	$(1.1 \pm 0.5) \%$		1071
$\phi K^+ K^-$	$(2.9 \pm 1.4) \times 10^{-3}$		1102
$\phi\phi$	$(2.7 \pm 0.9) \times 10^{-3}$		1087
$\phi 2(\pi^+\pi^-)$	< 3.5	$\times 10^{-3}$	90% 1249
$a_0(980)\pi$	< 2	$\%$	90% 1325
$a_2(1320)\pi$	< 2	$\%$	90% 1194
$K^*(892)\bar{K} + \text{c.c.}$	< 1.28	$\%$	90% 1308
$f_2(1270)\eta$	< 1.1	$\%$	90% 1143
$\omega\omega$	< 3.1	$\times 10^{-3}$	90% 1268
$\omega\phi$	< 1.7	$\times 10^{-3}$	90% 1183
$f_2(1270)f_2(1270)$	$(7.6^{+3.0}_{-3.4}) \times 10^{-3}$		771
$f_2(1270)f'_2(1525)$	$(2.7 \pm 1.5) \%$		509

Decays into stable hadrons

$K\bar{K}\pi$	$(7.0 \pm 1.2) \%$		1379
$\eta\pi\pi$	$(4.9 \pm 1.8) \%$		1427
$\pi^+\pi^- K^+ K^-$	$(1.5 \pm 0.6) \%$		1343
$K^+ K^- 2(\pi^+\pi^-)$	$(7.1 \pm 2.9) \times 10^{-3}$		1252
$2(K^+ K^-)$	$(1.6 \pm 0.7) \times 10^{-3}$		1053
$2(\pi^+\pi^-)$	$(1.20 \pm 0.30) \%$		1457
$3(\pi^+\pi^-)$	$(1.5 \pm 0.5) \%$		1405
$p\bar{p}$	$(1.3 \pm 0.4) \times 10^{-3}$		1158
$\Lambda\bar{\Lambda}$	$(1.04 \pm 0.31) \times 10^{-3}$		988
$K\bar{K}\eta$	< 3.1	$\%$	90% 1263
$\pi^+\pi^- p\bar{p}$	< 1.2	$\%$	90% 1024

Radiative decays

$\gamma\gamma$	$(6.3 \pm 2.9) \times 10^{-5}$		1490
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**Charge conjugation (C), Parity (P),
Lepton family number (LF) violating modes**

$\pi^+ \pi^-$	P, CP	< 6	$\times 10^{-4}$	90%	1484
$\pi^0 \pi^0$	P, CP	< 4	$\times 10^{-4}$	90%	1484
$K^+ K^-$	P, CP	< 6	$\times 10^{-4}$	90%	1406
$K_S^0 K_S^0$	P, CP	< 3.1	$\times 10^{-4}$	90%	1405

$J/\psi(1S)$

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

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

$J/\psi(1S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
hadrons	(87.7 \pm 0.5) %		—
virtual $\gamma \rightarrow$ hadrons	(13.50 \pm 0.30) %		—
$g g g$	(64.1 \pm 1.0) %		—
$\gamma g g$	(8.8 \pm 0.5) %		—
$e^+ e^-$	(5.94 \pm 0.06) %		1548
$\mu^+ \mu^-$	(5.93 \pm 0.06) %		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
$a_2(1320) \rho$	(1.09 \pm 0.22) %		1123
$\omega \pi^+ \pi^+ \pi^- \pi^-$	(8.5 \pm 3.4) $\times 10^{-3}$		1392
$\omega \pi^+ \pi^- \pi^0$	(4.0 \pm 0.7) $\times 10^{-3}$		1418
$\omega \pi^+ \pi^-$	(8.6 \pm 0.7) $\times 10^{-3}$	$S=1.1$	1435
$\omega f_2(1270)$	(4.3 \pm 0.6) $\times 10^{-3}$		1142
$K^*(892)^0 \bar{K}_2^*(1430)^0 + \text{c.c.}$	(6.0 \pm 0.6) $\times 10^{-3}$		1012
$K^*(892)^0 \bar{K}_2^*(1770)^0 + \text{c.c.} \rightarrow$ $K^*(892)^0 K^- \pi^+ + \text{c.c.}$	(6.9 \pm 0.9) $\times 10^{-4}$		—
$\omega K^*(892) \bar{K} + \text{c.c.}$	(6.1 \pm 0.9) $\times 10^{-3}$		1097
$K^+ \bar{K}^*(892)^- + \text{c.c.}$	(5.12 \pm 0.30) $\times 10^{-3}$		1373
$K^+ \bar{K}^*(892)^- + \text{c.c.} \rightarrow$ $K^+ K^- \pi^0$	(1.97 \pm 0.20) $\times 10^{-3}$		—
$K^+ \bar{K}^*(892)^- + \text{c.c.} \rightarrow$ $K^0 K^\pm \pi^\mp$	(3.0 \pm 0.4) $\times 10^{-3}$		—
$K^0 \bar{K}^*(892)^0 + \text{c.c.}$	(4.39 \pm 0.31) $\times 10^{-3}$		1373
$K^0 \bar{K}^*(892)^0 + \text{c.c.} \rightarrow$ $K^0 K^\pm \pi^\mp$	(3.2 \pm 0.4) $\times 10^{-3}$		—
$K_1(1400)^\pm K^\mp$	(3.8 \pm 1.4) $\times 10^{-3}$		1170
$\bar{K}^*(892)^0 K^+ \pi^- + \text{c.c.}$	seen		1343
$\omega \pi^0 \pi^0$	(3.4 \pm 0.8) $\times 10^{-3}$		1436

$b_1(1235)^\pm \pi^\mp$	[a] (3.0 \pm 0.5) $\times 10^{-3}$		1300
$\omega K^\pm K_S^0 \pi^\mp$	[a] (3.4 \pm 0.5) $\times 10^{-3}$		1210
$b_1(1235)^0 \pi^0$	(2.3 \pm 0.6) $\times 10^{-3}$		1300
$\eta K^\pm K_S^0 \pi^\mp$	[a] (2.2 \pm 0.4) $\times 10^{-3}$		1278
$\phi K^*(892) \bar{K} + \text{c.c.}$	(2.18 \pm 0.23) $\times 10^{-3}$		969
$\omega K \bar{K}$	(1.6 \pm 0.5) $\times 10^{-4}$		1268
$\omega f_0(1710) \rightarrow \omega K \bar{K}$	(4.8 \pm 1.1) $\times 10^{-4}$		878
$\phi 2(\pi^+ \pi^-)$	(1.66 \pm 0.23) $\times 10^{-3}$		1318
$\Delta(1232)^{++} \bar{p} \pi^-$	(1.6 \pm 0.5) $\times 10^{-3}$		1030
$\omega \eta$	(1.74 \pm 0.20) $\times 10^{-3}$	S=1.6	1394
$\phi K \bar{K}$	(1.83 \pm 0.24) $\times 10^{-3}$	S=1.5	1179
$\phi f_0(1710) \rightarrow \phi K \bar{K}$	(3.6 \pm 0.6) $\times 10^{-4}$		875
$\Delta(1232)^{++} \bar{\Delta}(1232)^{--}$	(1.10 \pm 0.29) $\times 10^{-3}$		938
$\Sigma(1385)^- \bar{\Sigma}(1385)^+ (\text{or c.c.})$	[a] (1.03 \pm 0.13) $\times 10^{-3}$		697
$\phi f'_2(1525)$	(8 \pm 4) $\times 10^{-4}$	S=2.7	871
$\phi \pi^+ \pi^-$	(8.7 \pm 0.8) $\times 10^{-4}$		1365
$\phi \pi^0 \pi^0$	(5.6 \pm 1.6) $\times 10^{-4}$		1366
$\phi K^\pm K_S^0 \pi^\mp$	[a] (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
$p K^- \bar{\Sigma}(1385)^0$	(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	1182
$\phi f_0(980) \rightarrow \phi \pi^+ \pi^-$	(2.2 \pm 0.4) $\times 10^{-4}$		—
$\phi f_0(980) \rightarrow \phi \pi^0 \pi^0$	(1.7 \pm 0.7) $\times 10^{-4}$		—
$\Xi(1530)^0 \Xi^0$	(3.2 \pm 1.4) $\times 10^{-4}$		608
$\Sigma(1385)^- \bar{\Sigma}^+ (\text{or c.c.})$	[a] (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) $\times 10^{-4}$		1271
$\rho \eta'(958)$	(1.05 \pm 0.18) $\times 10^{-4}$		1281
$a_2(1320)^\pm \pi^\mp$	[a] < 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
$K^*(892)^0 \bar{K}^*(892)^0$	(2.3 \pm 0.7) $\times 10^{-4}$		1266
$\phi f_2(1270)$	(7.2 \pm 1.3) $\times 10^{-4}$		1036
$\phi \eta(1405) \rightarrow \phi \eta \pi \pi$	< 2.5 $\times 10^{-4}$	CL=90%	946
$\omega f'_2(1525)$	< 2.2 $\times 10^{-4}$	CL=90%	1003

$\Sigma(1385)^0 \bar{\Lambda}$	< 2	$\times 10^{-4}$	CL=90%	912
$\Delta(1232)^+ \bar{p}$	< 1	$\times 10^{-4}$	CL=90%	1100
$\Theta(1540) \bar{\Theta}(1540) \rightarrow$ $K_S^0 p K^- \bar{n} + \text{c.c.}$	< 1.1	$\times 10^{-5}$	CL=90%	—
$\Theta(1540) K^- \bar{n} \rightarrow K_S^0 p K^- \bar{n}$	< 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
$\phi \pi^0$	< 6.4	$\times 10^{-6}$	CL=90%	1377

Decays into stable hadrons

$2(\pi^+ \pi^-) \pi^0$	(5.5 \pm 0.4) %		1496
$3(\pi^+ \pi^-) \pi^0$	(2.9 \pm 0.6) %		1433
$\pi^+ \pi^- \pi^0$	(2.07 \pm 0.12) %	S=1.6	1533
$\pi^+ \pi^- \pi^0 K^+ K^-$	(1.94 \pm 0.15) %		1368
$4(\pi^+ \pi^-) \pi^0$	(9.0 \pm 3.0) $\times 10^{-3}$		1345
$\pi^+ \pi^- K^+ K^-$	(6.6 \pm 0.5) $\times 10^{-3}$		1407
$\pi^+ \pi^- K^+ K^- \eta$	(1.84 \pm 0.28) $\times 10^{-3}$		1221
$\pi^0 \pi^0 K^+ K^-$	(2.45 \pm 0.31) $\times 10^{-3}$		1410
$\eta \phi f_0(980) \rightarrow \eta \phi \pi^+ \pi^-$	(3.2 \pm 1.0) $\times 10^{-4}$		—
$K \bar{K} \pi$	(6.1 \pm 1.0) $\times 10^{-3}$		1442
$2(\pi^+ \pi^-)$	(3.55 \pm 0.23) $\times 10^{-3}$		1517
$3(\pi^+ \pi^-)$	(4.3 \pm 0.4) $\times 10^{-3}$		1466
$2(\pi^+ \pi^- \pi^0)$	(1.61 \pm 0.21) %		1468
$2(\pi^+ \pi^-) \eta$	(2.29 \pm 0.24) $\times 10^{-3}$		1446
$3(\pi^+ \pi^-) \eta$	(7.2 \pm 1.5) $\times 10^{-4}$		1379
$p \bar{p}$	(2.17 \pm 0.07) $\times 10^{-3}$		1232
$p \bar{p} \pi^0$	(1.19 \pm 0.08) $\times 10^{-3}$	S=1.1	1176
$p \bar{p} \pi^+ \pi^-$	(6.0 \pm 0.5) $\times 10^{-3}$	S=1.3	1107
$p \bar{p} \pi^+ \pi^- \pi^0$	[b] (2.3 \pm 0.9) $\times 10^{-3}$	S=1.9	1033
$p \bar{p} \eta$	(2.00 \pm 0.12) $\times 10^{-3}$		948
$p \bar{p} \rho$	< 3.1	$\times 10^{-4}$ CL=90%	774
$p \bar{p} \omega$	(1.10 \pm 0.15) $\times 10^{-3}$	S=1.3	768
$p \bar{p} \eta'(958)$	(2.1 \pm 0.4) $\times 10^{-4}$		596
$p \bar{p} \phi$	(4.5 \pm 1.5) $\times 10^{-5}$		527
$n \bar{n}$	(2.2 \pm 0.4) $\times 10^{-3}$		1231
$n \bar{n} \pi^+ \pi^-$	(4 \pm 4) $\times 10^{-3}$		1106
$\Sigma^+ \bar{\Sigma}^-$	(1.50 \pm 0.24) $\times 10^{-3}$		992
$\Sigma^0 \bar{\Sigma}^0$	(1.29 \pm 0.09) $\times 10^{-3}$		988
$2(\pi^+ \pi^-) K^+ K^-$	(5.0 \pm 0.5) $\times 10^{-3}$		1320
$p \bar{n} \pi^-$	(2.12 \pm 0.09) $\times 10^{-3}$		1174
$n N(1440)$	seen		978
$n N(1520)$	seen		924

$nN(1535)$	seen		914
$\Xi^- \Xi^+$	$(8.5 \pm 1.6) \times 10^{-4}$	S=1.5	807
$\Lambda \bar{\Lambda}$	$(1.61 \pm 0.15) \times 10^{-3}$	S=1.9	1074
$\Lambda \bar{\Sigma}^- \pi^+$ (or c.c.)	[a] $(8.3 \pm 0.7) \times 10^{-4}$	S=1.2	950
$p K^- \bar{\Lambda}$	$(8.9 \pm 1.6) \times 10^{-4}$		876
$2(K^+ K^-)$	$(7.6 \pm 0.9) \times 10^{-4}$		1131
$p K^- \bar{\Sigma}^0$	$(2.9 \pm 0.8) \times 10^{-4}$		819
$K^+ K^-$	$(2.37 \pm 0.31) \times 10^{-4}$		1468
$K_S^0 K_L^0$	$(1.46 \pm 0.26) \times 10^{-4}$	S=2.7	1466
$\Lambda \bar{\Lambda} \eta$	$(2.6 \pm 0.7) \times 10^{-4}$		672
$\Lambda \bar{\Lambda} \pi^0$	$< 6.4 \times 10^{-5}$	CL=90%	998
$\bar{\Lambda} n K_S^0 + \text{c.c.}$	$(6.5 \pm 1.1) \times 10^{-4}$		872
$\pi^+ \pi^-$	$(1.47 \pm 0.23) \times 10^{-4}$		1542
$\Lambda \bar{\Sigma} + \text{c.c.}$	$< 1.5 \times 10^{-4}$	CL=90%	1034
$K_S^0 K_S^0$	$< 1 \times 10^{-6}$	CL=95%	1466

Radiative decays

3γ	$(1.2 \pm 0.4) \times 10^{-5}$		1548
4γ	$< 9 \times 10^{-6}$	CL=90%	1548
5γ	$< 1.5 \times 10^{-5}$	CL=90%	1548
$\gamma \eta_c(1S)$	$(1.7 \pm 0.4) \%$	S=1.6	114
$\gamma \eta_c(1S) \rightarrow 3\gamma$	$(1.2 \pm_{-1.1}^{+2.7}) \times 10^{-6}$		—
$\gamma \pi^+ \pi^- 2\pi^0$	$(8.3 \pm 3.1) \times 10^{-3}$		1518
$\gamma \eta \pi \pi$	$(6.1 \pm 1.0) \times 10^{-3}$		1487
$\gamma \eta_2(1870) \rightarrow \gamma \eta \pi^+ \pi^-$	$(6.2 \pm 2.4) \times 10^{-4}$		—
$\gamma \eta(1405/1475) \rightarrow \gamma K \bar{K} \pi$	[c] $(2.8 \pm 0.6) \times 10^{-3}$	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
$\gamma \eta'(958)$	$(5.28 \pm 0.15) \times 10^{-3}$		1400
$\gamma 2\pi^+ 2\pi^-$	$(2.8 \pm 0.5) \times 10^{-3}$	S=1.9	1517
$\gamma f_2(1270) f_2(1270)$	$(9.5 \pm 1.7) \times 10^{-4}$		879
$\gamma f_2(1270) f_2(1270)$ (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
$\gamma f_0(1710) \rightarrow \gamma K \bar{K}$	$(8.5 \pm_{-0.9}^{+1.2}) \times 10^{-4}$	S=1.2	1075

$\gamma f_0(1710) \rightarrow \gamma \pi \pi$	$(4.0 \pm 1.0) \times 10^{-4}$	—
$\gamma f_0(1710) \rightarrow \gamma \omega \omega$	$(3.1 \pm 1.0) \times 10^{-4}$	—
$\gamma \eta$	$(1.104 \pm 0.034) \times 10^{-3}$	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
$\gamma f_1(1510) \rightarrow \gamma \eta \pi^+ \pi^-$	$(4.5 \pm 1.2) \times 10^{-4}$	—
$\gamma f'_2(1525)$	$(4.5^{+0.7}_{-0.4}) \times 10^{-4}$	1173
$\gamma f_2(1640) \rightarrow \gamma \omega \omega$	$(2.8 \pm 1.8) \times 10^{-4}$	—
$\gamma f_2(1910) \rightarrow \gamma \omega \omega$	$(2.0 \pm 1.4) \times 10^{-4}$	—
$\gamma f_2(1950) \rightarrow$	$(7.0 \pm 2.2) \times 10^{-4}$	—
$\gamma K^*(892) \bar{K}^*(892)$		
$\gamma K^*(892) \bar{K}^*(892)$	$(4.0 \pm 1.3) \times 10^{-3}$	1266
$\gamma \phi \phi$	$(4.0 \pm 1.2) \times 10^{-4}$	S=2.1 1166
$\gamma p \bar{p}$	$(3.8 \pm 1.0) \times 10^{-4}$	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
$\gamma \eta(1760) \rightarrow \gamma \omega \omega$	$(1.98 \pm 0.33) \times 10^{-3}$	—
$\gamma X(1835)$	$(2.2 \pm 0.6) \times 10^{-4}$	1006
$\gamma (K \bar{K} \pi) [J^{PC} = 0^{-+}]$	$(7 \pm 4) \times 10^{-4}$	S=2.1 1442
$\gamma \pi^0$	$(3.49^{+0.33}_{-0.30}) \times 10^{-5}$	1546
$\gamma p \bar{p} \pi^+ \pi^-$	$< 7.9 \times 10^{-4}$	CL=90% 1107
$\gamma \Lambda \bar{\Lambda}$	$< 1.3 \times 10^{-4}$	CL=90% 1074
$\gamma f_J(2220)$	$> 2.50 \times 10^{-3}$	CL=99.9% 745
$\gamma f_J(2220) \rightarrow \gamma \pi \pi$	$(8 \pm 4) \times 10^{-5}$	—
$\gamma f_J(2220) \rightarrow \gamma K \bar{K}$	$(8.1 \pm 3.0) \times 10^{-5}$	—
$\gamma f_J(2220) \rightarrow \gamma p \bar{p}$	$(1.5 \pm 0.8) \times 10^{-5}$	—
$\gamma f_0(1500)$	$> (5.7 \pm 0.8) \times 10^{-4}$	1183
$\gamma e^+ e^-$	$(8.8 \pm 1.4) \times 10^{-3}$	1548

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
$D_s^- \pi^+ + \text{c.c.}$	< 1.3	$\times 10^{-4}$	CL=90%	915

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

$\gamma \gamma$	C	< 5	$\times 10^{-6}$	CL=90%	1548
$e^\pm \mu^\mp$	LF	< 1.1	$\times 10^{-6}$	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 decaysinvisible $< 7 \times 10^{-4}$ CL=90% — **$\chi_{c0}(1P)$**

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

Mass $m = 3414.75 \pm 0.31$ MeVFull width $\Gamma = 10.3 \pm 0.6$ MeV

$\chi_{c0}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
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Hadronic decays

$2(\pi^+\pi^-)$	$(2.27 \pm 0.19) \%$		1679
$\rho^0\pi^+\pi^-$	$(8.9 \pm 2.8) \times 10^{-3}$		1607
$f_0(980)f_0(980)$	$(6.8 \pm 2.2) \times 10^{-4}$		1398
$\pi^+\pi^-\pi^0\pi^0$	$(3.4 \pm 0.4) \%$		1680
$\rho^+\pi^-\pi^0 + \text{c.c.}$	$(2.9 \pm 0.4) \%$		1607
$\pi^+\pi^-K^+K^-$	$(1.80 \pm 0.15) \%$		1580
$K_0^*(1430)^0\bar{K}_0^*(1430)^0 \rightarrow \pi^+\pi^-K^+K^-$	$(1.00^{+0.40}_{-0.29}) \times 10^{-3}$		—
$K_0^*(1430)^0\bar{K}_2^*(1430)^0 + \text{c.c.} \rightarrow \pi^+\pi^-K^+K^-$	$(8.1^{+2.0}_{-2.5}) \times 10^{-4}$		—
$K_1(1270)^+K^- + \text{c.c.} \rightarrow \pi^+\pi^-K^+K^-$	$(6.4 \pm 1.9) \times 10^{-3}$		—
$K_1(1400)^+K^- + \text{c.c.} \rightarrow \pi^+\pi^-K^+K^-$	$< 2.7 \times 10^{-3}$	CL=90%	—
$f_0(980)f_0(980)$	$(1.7^{+1.1}_{-0.9}) \times 10^{-4}$		1398
$f_0(980)f_0(2200)$	$(8.1^{+2.1}_{-2.6}) \times 10^{-4}$		595
$f_0(1370)f_0(1370)$	$< 2.8 \times 10^{-4}$	CL=90%	1019
$f_0(1370)f_0(1500)$	$< 1.7 \times 10^{-4}$	CL=90%	920
$f_0(1370)f_0(1710)$	$(6.8^{+4.0}_{-2.4}) \times 10^{-4}$		723
$f_0(1500)f_0(1370)$	$< 1.3 \times 10^{-4}$	CL=90%	920
$f_0(1500)f_0(1500)$	$< 5 \times 10^{-5}$	CL=90%	805
$f_0(1500)f_0(1710)$	$< 7 \times 10^{-5}$	CL=90%	559
$K^+K^-\pi^0\pi^0$	$(5.7 \pm 0.9) \times 10^{-3}$		1582
$K^+\pi^-K^0\pi^0 + \text{c.c.}$	$(2.53 \pm 0.34) \%$		1581
$\rho^+K^-K^0 + \text{c.c.}$	$(1.23 \pm 0.22) \%$		1458
$K^*(892)^-K^+\pi^0 \rightarrow K^+\pi^-K^0\pi^0 + \text{c.c.}$	$(4.7 \pm 1.2) \times 10^{-3}$		—
$K_S^0K_S^0\pi^+\pi^-$	$(5.8 \pm 1.1) \times 10^{-3}$		1579
$K^+K^-\eta\pi^0$	$(3.1 \pm 0.7) \times 10^{-3}$		1468
$3(\pi^+\pi^-)$	$(1.20 \pm 0.18) \%$		1633
$K^+\bar{K}^*(892)^0\pi^- + \text{c.c.}$	$(7.3 \pm 1.6) \times 10^{-3}$		1523

$K^*(892)^0 \bar{K}^*(892)^0$	$(1.7 \pm 0.6) \times 10^{-3}$		1456
$\pi\pi$	$(8.4 \pm 0.4) \times 10^{-3}$		1702
$\pi^0\eta$	$< 1.8 \times 10^{-4}$		1661
$\pi^0\eta'$	$< 1.1 \times 10^{-3}$		1570
$\eta\eta$	$(2.68 \pm 0.28) \times 10^{-3}$		1617
$\eta\eta'$	$< 2.4 \times 10^{-4}$	CL=90%	1521
$\eta'\eta'$	$(2.03 \pm 0.22) \times 10^{-3}$		1413
$\omega\omega$	$(2.2 \pm 0.7) \times 10^{-3}$		1517
K^+K^-	$(6.10 \pm 0.35) \times 10^{-3}$		1634
$K_S^0 K_S^0$	$(3.16 \pm 0.18) \times 10^{-3}$		1633
$\pi^+\pi^-\eta$	$< 2.0 \times 10^{-4}$	CL=90%	1651
$\pi^+\pi^-\eta'$	$< 4 \times 10^{-4}$	CL=90%	1560
$\bar{K}^0 K^+ \pi^- + \text{c.c.}$	$< 1.0 \times 10^{-4}$	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
$K^+K^-\bar{K}_S^0 K_S^0$	$(1.4 \pm 0.5) \times 10^{-3}$		1331
$K^+K^-\bar{K}^+K^-$	$(2.81 \pm 0.30) \times 10^{-3}$		1333
$K^+K^-\phi$	$(9.9 \pm 2.5) \times 10^{-4}$		1381
$\phi\phi$	$(9.2 \pm 1.9) \times 10^{-4}$		1370
$p\bar{p}$	$(2.28 \pm 0.13) \times 10^{-4}$		1426
$p\bar{p}\pi^0$	$(5.7 \pm 1.2) \times 10^{-4}$		1379
$p\bar{p}\eta$	$(3.7 \pm 1.1) \times 10^{-4}$		1187
$\pi^+\pi^-\bar{p}p$	$(2.1 \pm 0.7) \times 10^{-3}$	S=1.4	1320
$\pi^0\pi^0\bar{p}p$	$(1.05 \pm 0.28) \times 10^{-3}$		1324
$K_S^0 K_S^0 \bar{p}p$	$< 8.8 \times 10^{-4}$	CL=90%	884
$p\bar{n}\pi^-$	$(1.14 \pm 0.31) \times 10^{-3}$		1376
$\Lambda\bar{\Lambda}$	$(3.3 \pm 0.4) \times 10^{-4}$		1292
$\Lambda\bar{\Lambda}\pi^+\pi^-$	$< 4.0 \times 10^{-3}$	CL=90%	1153
$K^+\bar{p}\Lambda + \text{c.c.}$	$(1.03 \pm 0.20) \times 10^{-3}$		1132
$\Sigma^0 \bar{\Sigma}^0$	$(4.2 \pm 0.7) \times 10^{-4}$		1222
$\Sigma^+ \bar{\Sigma}^-$	$(3.1 \pm 0.7) \times 10^{-4}$		1225
$\Xi^0 \bar{\Xi}^0$	$(3.2 \pm 0.8) \times 10^{-4}$		1089
$\Xi^- \bar{\Xi}^+$	$(4.9 \pm 0.7) \times 10^{-4}$		1081

Radiative decays

$\gamma J/\psi(1S)$	$(1.16 \pm 0.08) \%$		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
$\gamma\gamma$	$(2.22 \pm 0.17) \times 10^{-4}$		1707

$\chi_{c1}(1P)$

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

Mass $m = 3510.66 \pm 0.07$ MeV (S = 1.5)Full width $\Gamma = 0.86 \pm 0.05$ MeV

$\chi_{c1}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
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
$\pi^+\pi^-\pi^0\pi^0$	$(1.26 \pm 0.17) \%$		1729
$\rho^+\pi^-\pi^0 + \text{c.c.}$	$(1.53 \pm 0.26) \%$		1658
$\rho^0\pi^+\pi^-$	$(3.9 \pm 3.5) \times 10^{-3}$		1657
$\pi^+\pi^-K^+K^-$	$(4.5 \pm 1.0) \times 10^{-3}$		1632
$K^+K^-\pi^0\pi^0$	$(1.18 \pm 0.29) \times 10^{-3}$		1634
$K^+\pi^-K^0\pi^0 + \text{c.c.}$	$(9.0 \pm 1.5) \times 10^{-3}$		1632
$\rho^+K^-K^0 + \text{c.c.}$	$(5.3 \pm 1.3) \times 10^{-3}$		1514
$K^*(892)^0K^0\pi^0 \rightarrow$ $K^+\pi^-K^0\pi^0 + \text{c.c.}$	$(2.5 \pm 0.7) \times 10^{-3}$		—
$K^+K^-\eta\pi^0$	$(1.2 \pm 0.4) \times 10^{-3}$		1523
$\pi^+\pi^-K_S^0K_S^0$	$(7.2 \pm 3.1) \times 10^{-4}$		1630
$K^+K^-\eta$	$(3.3 \pm 1.0) \times 10^{-4}$		1566
$K^0K^+\pi^- + \text{c.c.}$	$(7.3 \pm 0.6) \times 10^{-3}$		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
$K_J^*(1430)^0\bar{K}^0 + \text{c.c.} \rightarrow$ $K_S^0K^+\pi^- + \text{c.c.}$	$< 8 \times 10^{-4}$	CL=90%	—
$K_J^*(1430)^+K^- + \text{c.c.} \rightarrow$ $K_S^0K^+\pi^- + \text{c.c.}$	$< 2.3 \times 10^{-3}$	CL=90%	—
$K^+K^-\pi^0$	$(1.91 \pm 0.26) \times 10^{-3}$		1662
$\eta\pi^+\pi^-$	$(5.0 \pm 0.5) \times 10^{-3}$		1701
$a_0(980)^+\pi^- + \text{c.c.} \rightarrow \eta\pi^+\pi^-$	$(1.9 \pm 0.7) \times 10^{-3}$		—
$f_2(1270)\eta$	$(2.8 \pm 0.8) \times 10^{-3}$		1468
$\pi^+\pi^-\eta'$	$(2.4 \pm 0.5) \times 10^{-3}$		1612
$K^+\bar{K}^*(892)^0\pi^- + \text{c.c.}$	$(3.2 \pm 2.1) \times 10^{-3}$		1577
$K^*(892)^0\bar{K}^*(892)^0$	$(1.5 \pm 0.4) \times 10^{-3}$		1512
$K^+K^-K_S^0K_S^0$	$< 5 \times 10^{-4}$	CL=90%	1390
$K^+K^-K^+K^-$	$(5.6 \pm 1.2) \times 10^{-4}$		1393
$K^+K^-\phi$	$(4.3 \pm 1.6) \times 10^{-4}$		1440
$p\bar{p}$	$(7.3 \pm 0.4) \times 10^{-5}$		1484
$p\bar{p}\pi^0$	$(1.2 \pm 0.5) \times 10^{-4}$		1438
$p\bar{p}\eta$	$< 1.6 \times 10^{-4}$	CL=90%	1254
$\pi^+\pi^-p\bar{p}$	$(5.0 \pm 1.9) \times 10^{-4}$		1381

$K_S^0 K_S^0 p \bar{p}$	$< 4.5 \times 10^{-4}$	CL=90%	968
$\Lambda \bar{\Lambda}$	$(1.18 \pm 0.19) \times 10^{-4}$		1355
$\Lambda \bar{\Lambda} \pi^+ \pi^-$	$< 1.5 \times 10^{-3}$	CL=90%	1223
$K^+ \bar{p} \Lambda$	$(3.2 \pm 1.0) \times 10^{-4}$		1203
$\Sigma^0 \bar{\Sigma}^0$	$< 4 \times 10^{-5}$	CL=90%	1288
$\Sigma^+ \bar{\Sigma}^-$	$< 6 \times 10^{-5}$	CL=90%	1291
$\Xi^0 \bar{\Xi}^0$	$< 6 \times 10^{-5}$	CL=90%	1163
$\Xi^- \bar{\Xi}^+$	$(8.4 \pm 2.3) \times 10^{-5}$		1155
$\pi^+ \pi^- + K^+ K^-$	$< 2.1 \times 10^{-3}$		—
$K_S^0 K_S^0$	$< 6 \times 10^{-5}$	CL=90%	1683

Radiative decays

$\gamma J/\psi(1S)$	$(34.4 \pm 1.5) \%$		389
$\gamma \rho^0$	$(2.29 \pm 0.27) \times 10^{-4}$		1670
$\gamma \omega$	$(7.8 \pm 1.8) \times 10^{-5}$		1668
$\gamma \phi$	$< 2.4 \times 10^{-5}$	CL=90%	1607

 $h_c(1P)$

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

Mass $m = 3525.42 \pm 0.29$ MeV (S = 1.7)Full width $\Gamma < 1$ MeV

$h_c(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$J/\psi(1S) \pi \pi$	not seen	312
$\eta_c \gamma$	seen	503
$\pi^+ \pi^- \pi^0$	not seen	1749
$2\pi^+ 2\pi^- \pi^0$	seen	1716
$3\pi^+ 3\pi^- \pi^0$	not seen	1661

 $\chi_{c2}(1P)$

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

Mass $m = 3556.20 \pm 0.09$ MeVFull width $\Gamma = 1.97 \pm 0.11$ MeV

$\chi_{c2}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level $\overset{p}{p}$ (MeV/c)
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Hadronic decays

$2(\pi^+\pi^-)$	(1.11±0.11) %		1751
$\pi^+\pi^-\pi^0\pi^0$	(2.00±0.26) %		1752
$\rho^+\pi^-\pi^0 + \text{c.c.}$	(2.4 ±0.4) %		1682
$K^+K^-\pi^0\pi^0$	(2.2 ±0.4) × 10 ⁻³		1658
$K^+\pi^-K^0\pi^0 + \text{c.c.}$	(1.50±0.22) %		1657
$\rho^+K^-K^0 + \text{c.c.}$	(4.5 ±1.4) × 10 ⁻³		1540
$K^*(892)^0K^+\pi^- \rightarrow$ $K^+\pi^-K^0\pi^0 + \text{c.c.}$	(3.2 ±0.9) × 10 ⁻³		—
$K^*(892)^0K^0\pi^0 \rightarrow$ $K^+\pi^-K^0\pi^0 + \text{c.c.}$	(4.2 ±0.9) × 10 ⁻³		—
$K^*(892)^-K^+\pi^0 \rightarrow$ $K^+\pi^-K^0\pi^0 + \text{c.c.}$	(4.1 ±0.9) × 10 ⁻³		—
$K^*(892)^+K^0\pi^- \rightarrow$ $K^+\pi^-K^0\pi^0 + \text{c.c.}$	(3.2 ±0.9) × 10 ⁻³		—
$K^+K^-\eta\pi^0$	(1.4 ±0.5) × 10 ⁻³		1549
$\pi^+\pi^-K^+K^-$	(9.2 ±1.1) × 10 ⁻³		1656
$K^+\bar{K}^*(892)^0\pi^- + \text{c.c.}$	(2.3 ±1.2) × 10 ⁻³		1602
$K^*(892)^0\bar{K}^*(892)^0$	(2.5 ±0.5) × 10 ⁻³		1538
$3(\pi^+\pi^-)$	(8.6 ±1.8) × 10 ⁻³		1707
$\phi\phi$	(1.48±0.28) × 10 ⁻³		1457
$\omega\omega$	(1.9 ±0.6) × 10 ⁻³		1597
$\pi\pi$	(2.39±0.14) × 10 ⁻³		1773
$\rho^0\pi^+\pi^-$	(4.0 ±1.7) × 10 ⁻³		1681
$\pi^+\pi^-\eta$	(5.2 ±1.4) × 10 ⁻⁴		1724
$\pi^+\pi^-\eta'$	(5.4 ±2.0) × 10 ⁻⁴		1636
$\eta\eta$	(5.4 ±0.8) × 10 ⁻⁴		1692
K^+K^-	(1.09±0.08) × 10 ⁻³		1708
$K_S^0K_S^0$	(5.8 ±0.5) × 10 ⁻⁴		1707
$\bar{K}^0K^+\pi^- + \text{c.c.}$	(1.32±0.20) × 10 ⁻³		1685
$K^+K^-\pi^0$	(3.3 ±0.8) × 10 ⁻⁴		1686
$K^+K^-\eta$	< 3.5 × 10 ⁻⁴	90%	1592
$\eta\eta'$	< 6 × 10 ⁻⁵	90%	1600
$\eta'\eta'$	< 1.1 × 10 ⁻⁴	90%	1498
$\pi^+\pi^-K_S^0K_S^0$	(2.4 ±0.6) × 10 ⁻³		1655
$K^+K^-K_S^0K_S^0$	< 4 × 10 ⁻⁴	90%	1418
$K^+K^-K^+K^-$	(1.78±0.22) × 10 ⁻³		1421
$K^+K^-\phi$	(1.55±0.32) × 10 ⁻³		1468
$K_S^0K_S^0p\bar{p}$	< 7.9 × 10 ⁻⁴	90%	1007
$p\bar{p}$	(7.2 ±0.4) × 10 ⁻⁵		1510
$p\bar{p}\pi^0$	(4.7 ±1.0) × 10 ⁻⁴		1465
$p\bar{p}\eta$	(2.0 ±0.8) × 10 ⁻⁴		1285
$\pi^+\pi^-p\bar{p}$	(1.32±0.34) × 10 ⁻³		1410
$\pi^0\pi^0p\bar{p}$	(8.5 ±2.6) × 10 ⁻⁴		1414

$p\bar{n}\pi^-$	$(1.1 \pm 0.4) \times 10^{-3}$		1463
$\Lambda\bar{\Lambda}$	$(1.86 \pm 0.27) \times 10^{-4}$		1385
$\Lambda\bar{\Lambda}\pi^+\pi^-$	$< 3.5 \times 10^{-3}$	90%	1255
$K^+\bar{p}\Lambda + \text{c.c.}$	$(9.1 \pm 1.8) \times 10^{-4}$		1236
$\Sigma^0\bar{\Sigma}^0$	$< 8 \times 10^{-5}$	90%	1319
$\Sigma^+\bar{\Sigma}^-$	$< 7 \times 10^{-5}$	90%	1322
$\Xi^0\bar{\Xi}^0$	$< 1.1 \times 10^{-4}$	90%	1197
$\Xi^-\bar{\Xi}^+$	$(1.55 \pm 0.35) \times 10^{-4}$		1189
$J/\psi(1S)\pi^+\pi^-\pi^0$	$< 1.5 \%$	90%	185

Radiative decays

$\gamma J/\psi(1S)$	$(19.5 \pm 0.8) \%$		430
$\gamma\rho^0$	$< 5 \times 10^{-5}$	90%	1694
$\gamma\omega$	$< 6 \times 10^{-6}$	90%	1692
$\gamma\phi$	$< 1.2 \times 10^{-5}$	90%	1632
$\gamma\gamma$	$(2.56 \pm 0.16) \times 10^{-4}$		1778

 $\eta_c(2S)$

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

Quantum numbers are quark model predictions.

Mass $m = 3637 \pm 4$ MeV ($S = 1.7$)Full width $\Gamma = 14 \pm 7$ MeV

$\eta_c(2S)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	$\frac{p}{\text{MeV}/c}$
hadrons	not seen		—
$K\bar{K}\pi$	$(1.9 \pm 1.2) \%$		1729
$2\pi^+2\pi^-$	not seen		1792
$3\pi^+3\pi^-$	not seen		1749
$K^+K^-\pi^+\pi^-$	not seen		1700
$K^+K^-\pi^+\pi^-\pi^0$	not seen		1667
$K^+K^-2\pi^+2\pi^-$	not seen		1627
$K_S^0 K^- 2\pi^+\pi^- + \text{c.c.}$	not seen		1666
$2K^+2K^-$	not seen		1470
$p\bar{p}$	not seen		1558
$\gamma\gamma$	$< 5 \times 10^{-4}$	90%	1819
$\pi^+\pi^-\eta$	not seen		1766
$\pi^+\pi^-\eta'$	not seen		1680
$K^+K^-\eta$	not seen		1637
$\pi^+\pi^-\eta_c(1S)$	not seen		541

$\psi(2S)$

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

Mass $m = 3686.09 \pm 0.04$ MeV (S = 1.6)Full width $\Gamma = 304 \pm 9$ keV $\Gamma_{ee} = 2.35 \pm 0.04$ keV

$\psi(2S)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
hadrons	(97.85 \pm 0.13) %		—
virtual $\gamma \rightarrow$ hadrons	(1.73 \pm 0.14) %	S=1.5	—
$g g g$	(10.6 \pm 1.6) %		—
$\gamma g g$	(1.02 \pm 0.29) %		—
light hadrons	(15.4 \pm 1.5) %		—
$e^+ e^-$	(7.72 \pm 0.17) $\times 10^{-3}$		1843
$\mu^+ \mu^-$	(7.7 \pm 0.8) $\times 10^{-3}$		1840
$\tau^+ \tau^-$	(3.0 \pm 0.4) $\times 10^{-3}$		490

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

$J/\psi(1S)$ anything	(59.5 \pm 0.8) %		—
$J/\psi(1S)$ neutrals	(24.5 \pm 0.4) %		—
$J/\psi(1S) \pi^+ \pi^-$	(33.6 \pm 0.4) %		477
$J/\psi(1S) \pi^0 \pi^0$	(17.73 \pm 0.34) %		481
$J/\psi(1S) \eta$	(3.28 \pm 0.07) %		199
$J/\psi(1S) \pi^0$	(1.30 \pm 0.10) $\times 10^{-3}$	S=1.4	528

Hadronic decays

$\pi^0 h_c(1P)$	seen		85
$3(\pi^+ \pi^-) \pi^0$	(3.5 \pm 1.6) $\times 10^{-3}$		1746
$2(\pi^+ \pi^-) \pi^0$	(2.9 \pm 1.0) $\times 10^{-3}$	S=4.6	1799
$\rho a_2(1320)$	(2.6 \pm 0.9) $\times 10^{-4}$		1500
$p \bar{p}$	(2.76 \pm 0.12) $\times 10^{-4}$		1586
$\Delta^{++} \bar{\Delta}^{--}$	(1.28 \pm 0.35) $\times 10^{-4}$		1371
$\Lambda \bar{\Lambda} \pi^0$	< 1.2 $\times 10^{-4}$	CL=90%	1412
$\Lambda \bar{\Lambda} \eta$	< 4.9 $\times 10^{-5}$	CL=90%	1197
$\Lambda \bar{p} K^+$	(1.00 \pm 0.14) $\times 10^{-4}$		1327
$\Lambda \bar{p} K^+ \pi^+ \pi^-$	(1.8 \pm 0.4) $\times 10^{-4}$		1167
$\Lambda \bar{\Lambda} \pi^+ \pi^-$	(2.8 \pm 0.6) $\times 10^{-4}$		1346
$\Lambda \bar{\Lambda}$	(2.8 \pm 0.5) $\times 10^{-4}$	S=2.6	1467
$\Sigma^+ \bar{\Sigma}^-$	(2.6 \pm 0.8) $\times 10^{-4}$		1408
$\Sigma^0 \bar{\Sigma}^0$	(2.2 \pm 0.4) $\times 10^{-4}$	S=1.5	1405
$\Sigma(1385)^+ \bar{\Sigma}(1385)^-$	(1.1 \pm 0.4) $\times 10^{-4}$		1218
$\Xi^- \bar{\Xi}^+$	(1.8 \pm 0.6) $\times 10^{-4}$	S=2.8	1284
$\Xi^0 \bar{\Xi}^0$	(2.8 \pm 0.9) $\times 10^{-4}$		1291
$\Xi(1530)^0 \bar{\Xi}(1530)^0$	< 8.1 $\times 10^{-5}$	CL=90%	1025
$\Omega^- \bar{\Omega}^+$	< 7.3 $\times 10^{-5}$	CL=90%	774

$\pi^0 p \bar{p}$	$(1.33 \pm 0.17) \times 10^{-4}$		1543
$\eta p \bar{p}$	$(6.0 \pm 1.2) \times 10^{-5}$		1373
$\omega p \bar{p}$	$(6.9 \pm 2.1) \times 10^{-5}$		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
$p \bar{p} \pi^-$ or c.c.	$(2.48 \pm 0.17) \times 10^{-4}$		—
$p \bar{p} \pi^- \pi^0$	$(3.2 \pm 0.7) \times 10^{-4}$		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
$\rho^0 p \bar{p}$	$(5.0 \pm 2.2) \times 10^{-5}$		1251
$K^+ \bar{K}^*(892)^0 \pi^- + \text{c.c.}$	$(6.7 \pm 2.5) \times 10^{-4}$		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
$\omega f_0(1710) \rightarrow \omega K^+ K^-$	$(5.9 \pm 2.2) \times 10^{-5}$		—
$K^*(892)^0 K^- \pi^+ \pi^0 + \text{c.c.}$	$(8.6 \pm 2.2) \times 10^{-4}$		—
$K^*(892)^+ K^- \pi^+ \pi^- + \text{c.c.}$	$(9.6 \pm 2.8) \times 10^{-4}$		—
$K^*(892)^+ K^- \rho^0 + \text{c.c.}$	$(7.3 \pm 2.6) \times 10^{-4}$		—
$K^*(892)^0 K^- \rho^+ + \text{c.c.}$	$(6.1 \pm 1.8) \times 10^{-4}$		—
$\eta K^+ K^-$	$< 1.3 \times 10^{-4}$	CL=90%	1664
$\omega K^+ K^-$	$(1.85 \pm 0.25) \times 10^{-4}$	S=1.1	1614
$3(\pi^+ \pi^-)$	$(3.5 \pm 2.0) \times 10^{-4}$	S=2.8	1774
$p \bar{p} \pi^+ \pi^- \pi^0$	$(7.3 \pm 0.7) \times 10^{-4}$		1435
$K^+ K^-$	$(6.3 \pm 0.7) \times 10^{-5}$		1776
$K_S^0 K_L^0$	$(5.4 \pm 0.5) \times 10^{-5}$		1775
$\pi^+ \pi^- \pi^0$	$(1.68 \pm 0.26) \times 10^{-4}$	S=1.4	1830
$\rho(2150) \pi \rightarrow \pi^+ \pi^- \pi^0$	$(1.9 \pm 1.2) \times 10^{-4}$		—
$\rho(770) \pi \rightarrow \pi^+ \pi^- \pi^0$	$(3.2 \pm 1.2) \times 10^{-5}$	S=1.8	—

$\pi^+\pi^-$	$(8 \pm 5) \times 10^{-5}$		1838
$K_1(1400)^\pm K^\mp$	$< 3.1 \times 10^{-4}$	CL=90%	1532
$K^+K^-\pi^0$	$< 2.96 \times 10^{-5}$	CL=90%	1754
$K^+\bar{K}^*(892)^- + \text{c.c.}$	$(1.7^{+0.8}_{-0.7}) \times 10^{-5}$		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
ϕK^+K^-	$(7.0 \pm 1.6) \times 10^{-5}$		1546
$2(K^+K^-)\pi^0$	$(1.10 \pm 0.28) \times 10^{-4}$		1440
$\phi\eta$	$(2.8^{+1.0}_{-0.8}) \times 10^{-5}$		1654
$\phi\eta'$	$(3.1 \pm 1.6) \times 10^{-5}$		1555
$\omega\eta'$	$(3.2^{+2.5}_{-2.1}) \times 10^{-5}$		1623
$\omega\pi^0$	$(2.1 \pm 0.6) \times 10^{-5}$		1757
$\rho\eta'$	$(1.9^{+1.7}_{-1.2}) \times 10^{-5}$		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
$\phi\pi^0$	$< 4 \times 10^{-6}$	CL=90%	1699
$\eta_c\pi^+\pi^-\pi^0$	$< 1.0 \times 10^{-3}$	CL=90%	—
$p\bar{p}K^+K^-$	$(2.7 \pm 0.7) \times 10^{-5}$		1118
$\bar{\Lambda}nK_S^0 + \text{c.c.}$	$(8.1 \pm 1.8) \times 10^{-5}$		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

$\gamma\chi_{c0}(1P)$	$(9.62 \pm 0.31) \%$		261
$\gamma\chi_{c1}(1P)$	$(9.2 \pm 0.4) \%$		171
$\gamma\chi_{c2}(1P)$	$(8.74 \pm 0.35) \%$		128
$\pi^0 h_c \rightarrow \gamma\eta_c(1S)\pi^0$	$(4.2 \pm 0.5) \times 10^{-4}$		—
$\gamma\eta_c(1S)$	$(3.4 \pm 0.5) \times 10^{-3}$	S=1.3	638
$\gamma\eta_c(2S)$	$< 8 \times 10^{-4}$	CL=90%	48
$\gamma\pi^0$	$< 5 \times 10^{-6}$	CL=90%	1841
$\gamma\eta'(958)$	$(1.21 \pm 0.08) \times 10^{-4}$		1719
$\gamma f_2(1270)$	$(2.1 \pm 0.4) \times 10^{-4}$		1622
$\gamma f_0(1710) \rightarrow \gamma\pi\pi$	$(3.0 \pm 1.3) \times 10^{-5}$		—
$\gamma f_0(1710) \rightarrow \gamma K\bar{K}$	$(6.0 \pm 1.6) \times 10^{-5}$		—

$\gamma\gamma$	< 1.4	$\times 10^{-4}$	CL=90%	1843
$\gamma\eta$	< 2	$\times 10^{-6}$	CL=90%	1802
$\gamma\eta\pi^+\pi^-$	(8.7 ± 2.1)	$\times 10^{-4}$		1791
$\gamma\eta(1405) \rightarrow \gamma K \bar{K} \pi$	< 9	$\times 10^{-5}$	CL=90%	1569
$\gamma\eta(1405) \rightarrow \eta\pi^+\pi^-$	(3.6 ± 2.5)	$\times 10^{-5}$		—
$\gamma\eta(1475) \rightarrow K \bar{K} \pi$	< 1.4	$\times 10^{-4}$	CL=90%	—
$\gamma\eta(1475) \rightarrow \eta\pi^+\pi^-$	< 8.8	$\times 10^{-5}$	CL=90%	—
$\gamma 2(\pi^+\pi^-)$	(4.0 ± 0.6)	$\times 10^{-4}$		1817
$\gamma K^{*0} K^+ \pi^- + \text{c.c.}$	(3.7 ± 0.9)	$\times 10^{-4}$		1674
$\gamma K^{*0} \bar{K}^{*0}$	(2.4 ± 0.7)	$\times 10^{-4}$		1613
$\gamma K_S^0 K^+ \pi^- + \text{c.c.}$	(2.6 ± 0.5)	$\times 10^{-4}$		1753
$\gamma K^+ K^- \pi^+ \pi^-$	(1.9 ± 0.5)	$\times 10^{-4}$		1726
$\gamma p \bar{p}$	(2.9 ± 0.6)	$\times 10^{-5}$		1586
$\gamma\pi^+\pi^- p \bar{p}$	(2.8 ± 1.4)	$\times 10^{-5}$		1491
$\gamma 2(\pi^+\pi^-) K^+ K^-$	< 2.2	$\times 10^{-4}$	CL=90%	1654
$\gamma 3(\pi^+\pi^-)$	< 1.7	$\times 10^{-4}$	CL=90%	1774
$\gamma K^+ K^- K^+ K^-$	< 4	$\times 10^{-5}$	CL=90%	1499

 $\psi(3770)$

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

Mass $m = 3772.92 \pm 0.35$ MeV (S = 1.1)

Full width $\Gamma = 27.3 \pm 1.0$ MeV

$\Gamma_{ee} = 0.265 \pm 0.018$ keV (S = 1.3)

In addition to the dominant decay mode to $D\bar{D}$, $\psi(3770)$ was found to decay into the final states containing the J/ψ (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 (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$D\bar{D}$	$(93 \pm 8) \%$	S=2.0	285
$D^0\bar{D}^0$	$(52 \pm 5) \%$	S=2.0	285
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
$J/\psi\eta$	$(9 \pm 4) \times 10^{-4}$		359
$J/\psi\pi^0$	$< 2.8 \times 10^{-4}$	CL=90%	603
$\gamma\chi_{c0}$	$(7.3 \pm 0.9) \times 10^{-3}$		341
$\gamma\chi_{c1}$	$(2.9 \pm 0.6) \times 10^{-3}$		253
$\gamma\chi_{c2}$	$< 9 \times 10^{-4}$	CL=90%	210
e^+e^-	$(9.7 \pm 0.7) \times 10^{-6}$	S=1.2	1886
$K_S^0 K_L^0$	$< 1.2 \times 10^{-5}$	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%	1759
$\eta\pi^+\pi^-$	< 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
$\eta'3\pi$	< 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
$\phi\pi^0$	not seen			1746
$\phi\eta$	$(3.1 \pm 0.7) \times 10^{-4}$			1703
$4(\pi^+\pi^-)$	< 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%	1600
$K^+K^-\pi^+\pi^-\pi^0$	< 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
ωK^+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
ηK^+K^-	< 4.1	$\times 10^{-4}$	CL=90%	1711
$\rho^0 K^+K^-$	< 5.0	$\times 10^{-3}$	CL=90%	1665
$2(K^+K^-)$	< 6.0	$\times 10^{-4}$	CL=90%	1551
ϕK^+K^-	< 7.5	$\times 10^{-4}$	CL=90%	1597
$2(K^+K^-)\pi^0$	< 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%	1741
$K_S^0 K^- K^+ K^- \pi^+$	< 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%	1721
$\rho \bar{p} \pi^0$	< 1.2	$\times 10^{-3}$		1595
$\rho \bar{p} \pi^+ \pi^-$	< 5.8	$\times 10^{-4}$	CL=90%	1544
$\Lambda \bar{\Lambda}$	< 1.2	$\times 10^{-4}$	CL=90%	1521
$\rho \bar{p} \pi^+ \pi^- \pi^0$	< 1.85	$\times 10^{-3}$	CL=90%	1490
$\omega \rho \bar{p}$	< 2.9	$\times 10^{-4}$	CL=90%	1309
$\Lambda \bar{\Lambda} \pi^0$	< 1.2	$\times 10^{-3}$	CL=90%	1468
$\rho \bar{p} 2(\pi^+ \pi^-)$	< 2.6	$\times 10^{-3}$	CL=90%	1425
$\eta \rho \bar{p}$	< 5.4	$\times 10^{-4}$	CL=90%	1430
$\rho^0 \rho \bar{p}$	< 1.7	$\times 10^{-3}$	CL=90%	1313
$\rho \bar{p} K^+ K^-$	< 3.2	$\times 10^{-4}$	CL=90%	1185
$\phi \rho \bar{p}$	< 1.3	$\times 10^{-4}$	CL=90%	1178
$\Lambda \bar{\Lambda} \pi^+ \pi^-$	< 2.5	$\times 10^{-4}$	CL=90%	1404
$\Lambda \bar{p} K^+$	< 2.8	$\times 10^{-4}$	CL=90%	1387
$\Lambda \bar{p} K^+ \pi^+ \pi^-$	< 6.3	$\times 10^{-4}$	CL=90%	1234
$\pi^+ \pi^- \pi^0$	not seen			1874
$\rho \pi$	not seen			1804
$\omega \pi^0$	not seen			1803
$\rho \eta$	not seen			1763
$\omega \eta$	not seen			1762
$\rho \eta'$	not seen			1674
$\omega \eta'$	not seen			1672
$\phi \eta'$	not seen			1606
$K^{*0} \bar{K}^0$	not seen			1744
$K^{*+} K^-$	not seen			1745
$b_1 \pi$	not seen			1683

Radiative decays

$\gamma \pi^0$	< 2	$\times 10^{-4}$	CL=90%	1884
$\gamma \eta$	< 1.5	$\times 10^{-4}$	CL=90%	1847
$\gamma \eta'$	< 1.8	$\times 10^{-4}$	CL=90%	1765

X(3872)

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

Quantum numbers not established.

$$\text{Mass } m = 3871.56 \pm 0.22 \text{ MeV}$$

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

$$m_{X(3872)} - m_{\psi(2S)}$$

$$\text{Full width } \Gamma < 2.3 \text{ MeV, CL} = 90\%$$

X(3872) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi^+ \pi^- J/\psi(1S)$	$> 2.6 \%$	650
$D^0 \bar{D}^0 \pi^0$	$> 3.2 \times 10^{-3}$	116
$\bar{D}^{*0} D^0$	$> 5 \times 10^{-3}$	†
$\gamma J/\psi$	$> 9 \times 10^{-3}$	697
$\gamma \psi(2S)$	$> 3.0 \%$	181

 $\psi(4040)$ ^[d]

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

$$\text{Mass } m = 4039 \pm 1 \text{ MeV}$$

$$\text{Full width } \Gamma = 80 \pm 10 \text{ MeV}$$

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

$\psi(4040)$ DECAY MODES	Fraction (Γ_i/Γ)	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		764
$D^* \bar{D} + \text{c.c.}$	seen		569
$D^*(2007)^0 \bar{D}^0 + \text{c.c.}$	seen		575
$D^*(2010)^+ D^- + \text{c.c.}$	seen		561
$D^* \bar{D}^*$	not seen		193
$D^*(2007)^0 \bar{D}^*(2007)^0$	not seen		225
$D^*(2010)^+ D^*(2010)^-$	not seen		193
$J/\psi \pi^+ \pi^-$	< 4	$\times 10^{-3}$	90% 794
$J/\psi \pi^0 \pi^0$	< 2	$\times 10^{-3}$	90% 797
$J/\psi \eta$	< 7	$\times 10^{-3}$	90% 675
$J/\psi \pi^0$	< 2	$\times 10^{-3}$	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
$\phi \pi^+ \pi^-$	< 3	$\times 10^{-3}$	90%	1880

 $\psi(4160)$ ^[d]

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

Mass $m = 4153 \pm 3$ MeVFull width $\Gamma = 103 \pm 8$ MeV $\Gamma_{ee} = 0.83 \pm 0.07$ keV

$\psi(4160)$ DECAY MODES	Fraction (Γ_i/Γ)		Confidence level	ρ (MeV/c)
$e^+ e^-$	$(8.1 \pm 0.9) \times 10^{-6}$			2076
$D \bar{D}$	not seen			913
$D^0 \bar{D}^0$	not seen			913
$D^+ D^-$	not seen			904
$D^* \bar{D} + \text{c.c.}$	not seen			746
$D^*(2007)^0 \bar{D}^0 + \text{c.c.}$	not seen			751
$D^*(2010)^+ D^- + \text{c.c.}$	not seen			740
$D^* \bar{D}^*$	seen			520
$D^*(2007)^0 \bar{D}^*(2007)^0$	seen			533
$D^*(2010)^+ D^*(2010)^-$	seen			520
$J/\psi \pi^+ \pi^-$	< 3	$\times 10^{-3}$	90%	888
$J/\psi \pi^0 \pi^0$	< 3	$\times 10^{-3}$	90%	891
$J/\psi K^+ K^-$	< 2	$\times 10^{-3}$	90%	324
$J/\psi \eta$	< 8	$\times 10^{-3}$	90%	786
$J/\psi \pi^0$	< 1	$\times 10^{-3}$	90%	914
$J/\psi \eta'$	< 5	$\times 10^{-3}$	90%	385
$J/\psi \pi^+ \pi^- \pi^0$	< 1	$\times 10^{-3}$	90%	847
$\psi(2S) \pi^+ \pi^-$	< 4	$\times 10^{-3}$	90%	353
$\chi_{c1} \gamma$	< 7	$\times 10^{-3}$	90%	593
$\chi_{c2} \gamma$	< 1.3	%	90%	554
$\chi_{c1} \pi^+ \pi^- \pi^0$	< 2	$\times 10^{-3}$	90%	452
$\chi_{c2} \pi^+ \pi^- \pi^0$	< 8	$\times 10^{-3}$	90%	398
$\phi \pi^+ \pi^-$	< 2	$\times 10^{-3}$	90%	1941

 $X(4260)$

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

Mass $m = 4263^{+8}_{-9}$ MeV ($S = 1.1$)Full width $\Gamma = 95 \pm 14$ MeV

X(4260) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$J/\psi \pi^+ \pi^-$	seen	976
$J/\psi \pi^0 \pi^0$	[e] seen	978
$J/\psi K^+ K^-$	[e] seen	530
$J/\psi \eta$	[e] not seen	886
$J/\psi \pi^0$	[e] not seen	999
$J/\psi \eta'$	[e] not seen	569
$J/\psi \pi^+ \pi^- \pi^0$	[e] not seen	939
$J/\psi \eta \eta$	[e] not seen	339
$\psi(2S) \pi^+ \pi^-$	[e] not seen	470
$\psi(2S) \eta$	[e] not seen	167
$\chi_{c0} \omega$	[e] not seen	292
$\chi_{c1} \gamma$	[e] not seen	686
$\chi_{c2} \gamma$	[e] not seen	648
$\chi_{c1} \pi^+ \pi^- \pi^0$	[e] not seen	571
$\chi_{c2} \pi^+ \pi^- \pi^0$	[e] not seen	524
$\phi \pi^+ \pi^-$	[e] not seen	1999
$\phi f_0(980) \rightarrow \phi \pi^+ \pi^-$	not seen	—
$D \bar{D}$	not seen	1032
$D^0 D^{*-} \pi^+$	not seen	716
$D^* \bar{D}$	not seen	887
$D^* \bar{D}^*$	not seen	708
$D^* \bar{D} \pi$	not seen	723
$D^* \bar{D}^* \pi$	not seen	474
$D_s^+ D_s^-$	not seen	817
$D_s^{*+} D_s^-$	not seen	615
$D_s^{*+} D_s^{*-}$	not seen	284
$p \bar{p}$	not seen	1914
$K_S^0 K^\pm \pi^\mp$	not seen	2054
$K^+ K^- \pi^0$	not seen	2055

$\psi(4415)$ ^[d]

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

Mass $m = 4421 \pm 4$ MeVFull width $\Gamma = 62 \pm 20$ MeV $\Gamma_{ee} = 0.58 \pm 0.07$ keV

$\psi(4415)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	ρ (MeV/c)
hadrons	dominant		—
$D\bar{D}$	not seen		1187
$D^0\bar{D}^0$	not seen		1187
D^+D^-	not seen		1179
$D^*\bar{D} + \text{c.c.}$	not seen		1063
$D^*(2007)^0\bar{D}^0 + \text{c.c.}$	not seen		1067
$D^*(2010)^+D^- + \text{c.c.}$	not seen		1059
$D^*\bar{D}^*$	not seen		919
$D^*(2007)^0\bar{D}^*(2007)^0 + \text{c.c.}$	not seen		927
$D^*(2010)^+D^*(2010)^- + \text{c.c.}$	not seen		919
$(D^0D^-\pi^+)_{\text{non-res}}$	$< 2.3 \quad \%$	90%	—
$D\bar{D}_2^*(2460) \rightarrow D^0D^-\pi^+$	$(10 \pm 4) \quad \%$		—
$D^0D^{*-}\pi^+$	$< 11 \quad \%$	90%	926
e^+e^-	$(9.4 \pm 3.2) \times 10^{-6}$		2210

NOTES

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

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

[c] See the “Note on the $\eta(1405)$ ” in the $\eta(1405)$ Particle Listings.

[d] 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.

[e] See COAN 06 for details.