

$c\bar{c}$ MESONS

 $\eta_c(1S)$

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

 Mass $m = 2980.4 \pm 1.2$ MeV ($S = 1.5$)

 Full width $\Gamma = 25.5 \pm 3.4$ 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) %		1273
$K^*(892)^0 K^- \pi^+ + \text{c.c.}$	(2.0 \pm 0.7) %		1276
$K^*(892)\bar{K}^*(892)$	(9.2 \pm 3.4) $\times 10^{-3}$		1194
$K^{*0}\bar{K}^{*0}\pi^+\pi^-$	(1.5 \pm 0.8) %		1071
$\phi K^+ K^-$	(2.9 \pm 1.4) $\times 10^{-3}$		1102
$\phi\phi$	(2.7 \pm 0.9) $\times 10^{-3}$		1087
$\phi 2(\pi^+\pi^-)$	< 4.7 $\times 10^{-3}$	90%	1249
$a_0(980)\pi$	< 2 %	90%	1324
$a_2(1320)\pi$	< 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
$f_2(1270)f_2(1270)$	(1.0 $^{+0.4}_{-0.5}$) %		771

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
$K^+ K^- 2(\pi^+\pi^-)$	(10 \pm 4) $\times 10^{-3}$		1252
$2(K^+ K^-)$	(1.5 \pm 0.7) $\times 10^{-3}$		1053
$2(\pi^+\pi^-)$	(1.20 \pm 0.30) %		1457
$3(\pi^+\pi^-)$	(2.0 \pm 0.7) %		1405
$p\bar{p}$	(1.3 \pm 0.4) $\times 10^{-3}$		1158
$K\bar{K}\eta$	< 3.1 %	90%	1263
$\pi^+\pi^- p\bar{p}$	< 1.2 %	90%	1025
$\Lambda\bar{\Lambda}$	< 2 $\times 10^{-3}$	90%	988

Radiative decays

$\gamma\gamma$	(2.8 \pm 0.9) $\times 10^{-4}$		1490
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**Charge conjugation (C), Parity (P),
Lepton family number (LF) violating modes**

$\pi^+ \pi^-$	P, CP	< 8.7	$\times 10^{-4}$	90%	1484
$\pi^0 \pi^0$	P, CP	< 5.6	$\times 10^{-4}$	90%	1484
$K^+ K^-$	P, CP	< 7.6	$\times 10^{-4}$	90%	1406
$K_S^0 K_S^0$	P, CP	< 4.2	$\times 10^{-4}$	90%	1405

$J/\psi(1S)$

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

Mass $m = 3096.916 \pm 0.011$ MeV

Full width $\Gamma = 93.4 \pm 2.1$ keV

$\Gamma_{ee} = 5.55 \pm 0.14 \pm 0.02$ 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) %		—
$e^+ e^-$	(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
$\omega \pi^+ \pi^-$	(7.2 \pm 1.0) $\times 10^{-3}$		1435
$\omega f_2(1270)$	(4.3 \pm 0.6) $\times 10^{-3}$		1142
$K^*(892)^0 \bar{K}_2^*(1430)^0 + \text{c.c.}$	(6.7 \pm 2.6) $\times 10^{-3}$		1012
$\omega K^*(892) \bar{K} + \text{c.c.}$	(5.3 \pm 2.0) $\times 10^{-3}$		1097
$K^+ \bar{K}^*(892)^- + \text{c.c.}$	(5.0 \pm 0.4) $\times 10^{-3}$		1373
$K^0 \bar{K}^*(892)^0 + \text{c.c.}$	(4.2 \pm 0.4) $\times 10^{-3}$		1373
$K_1(1400)^\pm K^\mp$	(3.8 \pm 1.4) $\times 10^{-3}$		1171
$\omega \pi^0 \pi^0$	(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] (2.9 \pm 0.7) $\times 10^{-3}$		1210
$b_1(1235)^0 \pi^0$	(2.3 \pm 0.6) $\times 10^{-3}$		1300
$\phi K^*(892) \bar{K} + \text{c.c.}$	(2.04 \pm 0.28) $\times 10^{-3}$		969
$\omega K \bar{K}$	(1.9 \pm 0.4) $\times 10^{-3}$		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
$p \bar{p} \omega$	(1.30 \pm 0.25) $\times 10^{-3}$	S=1.3	768
$\Delta(1232)^{++} \bar{\Delta}(1232)^{--}$	(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
$p \bar{p} \eta'(958)$	(9 \pm 4) $\times 10^{-4}$	S=1.7	596
$\phi f'_2(1525)$	(8 \pm 4) $\times 10^{-4}$	S=2.7	871
$\phi \pi^+ \pi^-$	(9.4 \pm 1.5) $\times 10^{-4}$	S=1.7	1365
$\phi K^\pm K_S^0 \pi^\mp$	[a] (7.2 \pm 0.9) $\times 10^{-4}$		1114
$\omega f_1(1420)$	(6.8 \pm 2.4) $\times 10^{-4}$		1062
$\phi \eta$	(7.4 \pm 0.8) $\times 10^{-4}$	S=1.5	1320
$\Xi(1530)^- \Xi^+$	(5.9 \pm 1.5) $\times 10^{-4}$		601
$p K^- \bar{\Sigma}(1385)^0$	(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
$\Xi(1530)^0 \Xi^0$	(3.2 \pm 1.4) $\times 10^{-5}$		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
$\rho \eta$	(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
$p \bar{p} \phi$	(4.5 \pm 1.5) $\times 10^{-5}$		527
$a_2(1320)^\pm \pi^\mp$	[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
$K^*(892)^0 \bar{K}^*(892)^0$	< 5 $\times 10^{-4}$	CL=90%	1266
$\phi f_2(1270)$	< 3.7 $\times 10^{-4}$	CL=90%	1036
$p \bar{p} \rho$	< 3.1 $\times 10^{-4}$	CL=90%	774
$\phi \eta(1405) \rightarrow \phi \eta \pi \pi$	< 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

$2(\pi^+\pi^-)\pi^0$	(3.37±0.26) %		1496
$3(\pi^+\pi^-)\pi^0$	(2.9 ±0.6) %		1433
$\pi^+\pi^-\pi^0$	(2.02±0.14) %	S=1.7	1533
$\pi^+\pi^-\pi^0 K^+ K^-$	(1.20±0.30) %		1368
$4(\pi^+\pi^-)\pi^0$	(9.0 ±3.0) × 10 ⁻³		1345
$\pi^+\pi^- K^+ K^-$	(6.2 ±0.7) × 10 ⁻³		1407
$K\bar{K}\pi$	(6.1 ±1.0) × 10 ⁻³		1442
$p\bar{p}\pi^+\pi^-$	(6.0 ±0.5) × 10 ⁻³	S=1.3	1107
$2(\pi^+\pi^-)$	(3.55±0.23) × 10 ⁻³		1517
$3(\pi^+\pi^-)$	(4.3 ±0.4) × 10 ⁻³		1466
$2(\pi^+\pi^-\pi^0)$	(1.62±0.21) %		1468
$2(\pi^+\pi^-)\eta$	(2.26±0.28) × 10 ⁻³		1446
$3(\pi^+\pi^-)\eta$	(7.2 ±1.5) × 10 ⁻⁴		1379
$n\bar{n}\pi^+\pi^-$	(4 ±4) × 10 ⁻³		1106
$\Sigma^0\bar{\Sigma}^0$	(1.31±0.10) × 10 ⁻³		988
$2(\pi^+\pi^-)K^+ K^-$	(4.7 ±0.7) × 10 ⁻³	S=1.3	1320
$p\bar{p}\pi^+\pi^-\pi^0$	[b] (2.3 ±0.9) × 10 ⁻³	S=1.9	1033
$p\bar{p}$	(2.17±0.08) × 10 ⁻³		1232
$p\bar{p}\eta$	(2.09±0.18) × 10 ⁻³		949
$p\bar{n}\pi^-$	(2.00±0.10) × 10 ⁻³		1174
$n\bar{n}$	(2.2 ±0.4) × 10 ⁻³		1231
$\Xi\bar{\Xi}$	(1.8 ±0.4) × 10 ⁻³	S=1.8	818
$\Lambda\bar{\Lambda}$	(1.54±0.19) × 10 ⁻³	S=2.2	1074
$p\bar{p}\pi^0$	(1.09±0.09) × 10 ⁻³		1176
$\Lambda\bar{\Sigma}^-\pi^+$ (or c.c.)	[a] (1.06±0.12) × 10 ⁻³		950
$pK^-\bar{\Lambda}$	(8.9 ±1.6) × 10 ⁻⁴		876
$2(K^+K^-)$	(7.8 ±1.4) × 10 ⁻⁴		1131
$pK^-\bar{\Sigma}^0$	(2.9 ±0.8) × 10 ⁻⁴		819
K^+K^-	(2.37±0.31) × 10 ⁻⁴		1468
$K_S^0 K_L^0$	(1.46±0.26) × 10 ⁻⁴	S=2.7	1466
$\Lambda\bar{\Lambda}\pi^0$	(2.2 ±0.6) × 10 ⁻⁴		998
$\pi^+\pi^-$	(1.47±0.23) × 10 ⁻⁴		1542
$\Lambda\bar{\Sigma} + \text{c.c.}$	< 1.5 × 10 ⁻⁴	CL=90%	1034
$K_S^0 K_S^0$	< 1 × 10 ⁻⁶	CL=95%	1466

Radiative decays

$\gamma\eta_c(1S)$	(1.3 ±0.4) %		114
$\gamma\pi^+\pi^-2\pi^0$	(8.3 ±3.1) × 10 ⁻³		1518
$\gamma\eta\pi\pi$	(6.1 ±1.0) × 10 ⁻³		1488
$\gamma\eta(1405/1475) \rightarrow \gamma K\bar{K}\pi$	[c] (2.8 ±0.6) × 10 ⁻³	S=1.6	1223
$\gamma\eta(1405/1475) \rightarrow \gamma\gamma\rho^0$	(7.8 ±2.0) × 10 ⁻⁶	S=1.8	1223
$\gamma\eta(1405/1475) \rightarrow \gamma\eta\pi^+\pi^-$	(3.0 ±0.5) × 10 ⁻⁴		—
$\gamma\eta(1405/1475) \rightarrow \gamma\gamma\phi$	< 8.2 × 10 ⁻⁵	CL=95%	—

$\gamma \rho \rho$	$(4.5 \pm 0.8) \times 10^{-3}$		1340
$\gamma \eta_2(1870) \rightarrow \gamma \pi^+ \pi^-$	$(6.2 \pm 2.4) \times 10^{-4}$		—
$\gamma \eta'(958)$	$(4.71 \pm 0.27) \times 10^{-3}$	S=1.1	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
$\gamma f_2(1270) f_2(1270) (\text{non resonant})$	$(8.2 \pm 1.9) \times 10^{-4}$		—
$\gamma K^+ K^- \pi^+ \pi^-$	$(2.1 \pm 0.6) \times 10^{-3}$		1407
$\gamma f_4(2050)$	$(2.7 \pm 0.7) \times 10^{-3}$		886
$\gamma \omega \omega$	$(1.59 \pm 0.33) \times 10^{-3}$		1336
$\gamma \eta(1405/1475) \rightarrow \gamma \rho^0 \rho^0$	$(1.7 \pm 0.4) \times 10^{-3}$	S=1.3	1223
$\gamma f_2(1270)$	$(1.38 \pm 0.14) \times 10^{-3}$		1286
$\gamma f_0(1710) \rightarrow \gamma K \bar{K}$	$(8.5 \pm_{-0.9}^{+1.2}) \times 10^{-4}$	S=1.2	1075
$\gamma \eta$	$(9.8 \pm 1.0) \times 10^{-4}$	S=1.7	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
$\gamma f_1(1510) \rightarrow \gamma \eta \pi^+ \pi^-$	$(4.5 \pm 1.2) \times 10^{-4}$		—
$\gamma f'_2(1525)$	$(4.5 \pm_{-0.4}^{+0.7}) \times 10^{-4}$		1173
$\gamma f_2(1950) \rightarrow$	$(7.0 \pm 2.2) \times 10^{-4}$		—
$\gamma K^*(892) \bar{K}^*(892)$			
$\gamma K^*(892) \bar{K}^*(892)$	$(4.0 \pm 1.3) \times 10^{-3}$		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
$\gamma \eta(2225)$	$(2.9 \pm 0.6) \times 10^{-4}$		752
$\gamma \eta(1760) \rightarrow \gamma \rho^0 \rho^0$	$(1.3 \pm 0.9) \times 10^{-4}$		1048
$\gamma X(1835)$	$(2.2 \pm 0.6) \times 10^{-4}$		1006
$\gamma (K \bar{K} \pi)_{JPC=0-+}$	$(7 \pm 4) \times 10^{-4}$	S=2.1	1442
$\gamma \pi^0$	$(3.3 \pm_{-0.4}^{+0.6}) \times 10^{-5}$		1546
$\gamma p \bar{p} \pi^+ \pi^-$	$< 7.9 \times 10^{-4}$	CL=90%	1107
$\gamma \gamma$	$< 5 \times 10^{-4}$	CL=90%	1548
$\gamma \Lambda \bar{\Lambda}$	$< 1.3 \times 10^{-4}$	CL=90%	1074
3γ	$< 5.5 \times 10^{-5}$	CL=90%	1548
$\gamma f_J(2220)$	$> 2.50 \times 10^{-3}$	CL=99.9%	745
$\gamma f_J(2220) \rightarrow \gamma \pi \pi$	$(8 \pm 4) \times 10^{-5}$		—
$\gamma f_J(2220) \rightarrow \gamma K \bar{K}$	$(8.1 \pm 3.0) \times 10^{-5}$		—
$\gamma f_J(2220) \rightarrow \gamma p \bar{p}$	$(1.5 \pm 0.8) \times 10^{-5}$		—
$\gamma f_0(1500)$	$> (5.7 \pm 0.8) \times 10^{-4}$		1182
$\gamma e^+ e^-$	$(8.8 \pm 1.4) \times 10^{-3}$		1548

Lepton Family number (LF) violating modes

$e^\pm \mu^\mp$	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

 $\chi_{c0}(1P)$

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

Mass $m = 3414.76 \pm 0.35$ MeV ($S = 1.2$)Full width $\Gamma = 10.4 \pm 0.7$ MeV

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

$2(\pi^+ \pi^-)$	$(2.41 \pm 0.23) \%$		1679
$f_0(980) f_0(980) \rightarrow 2\pi^+ 2\pi^-$	$(7.1 \pm 2.3) \times 10^{-4}$		—
$\pi^+ \pi^- K^+ K^-$	$(2.0 \pm 0.4) \%$	S=1.6	1580
$f_0(980) f_0(980) \rightarrow \pi^+ \pi^- K^+ K^-$	$(1.7 \pm 1.1) \times 10^{-4}$		—
$f_0(980) f_0(2200) \rightarrow \pi^+ \pi^- K^+ K^-$	$(8.4 \pm 2.2) \times 10^{-4}$		—
$f_0(1370) f_0(1370) \rightarrow \pi^+ \pi^- K^+ K^-$	< 2.9	$\times 10^{-4}$ CL=90%	—
$f_0(1370) f_0(1500) \rightarrow \pi^+ \pi^- K^+ K^-$	< 1.8	$\times 10^{-4}$ CL=90%	—
$f_0(1370) f_0(1710) \rightarrow \pi^+ \pi^- K^+ K^-$	$(7.1 \pm 3.8) \times 10^{-4}$		—
$f_0(1500) f_0(1370) \rightarrow \pi^+ \pi^- K^+ K^-$	< 1.4	$\times 10^{-4}$ CL=90%	—
$f_0(1500) f_0(1500) \rightarrow \pi^+ \pi^- K^+ K^-$	< 6	$\times 10^{-5}$ CL=90%	—
$f_0(1500) f_0(1710) \rightarrow \pi^+ \pi^- K^+ K^-$	< 7	$\times 10^{-5}$ CL=90%	—
$\rho^0 \pi^+ \pi^-$	$(1.6 \pm 0.5) \%$		1607
$3(\pi^+ \pi^-)$	$(1.19 \pm 0.18) \%$		1633
$K^+ \bar{K}^*(892)^0 \pi^- + \text{c.c.}$	$(1.2 \pm 0.4) \%$		1523
$K_1(1270)^+ K^- + \text{c.c.} \rightarrow \pi^+ \pi^- K^+ K^-$	$(6.7 \pm 2.0) \times 10^{-3}$		—
$K_1(1400)^+ K^- + \text{c.c.} \rightarrow \pi^+ \pi^- K^+ K^-$	< 2.9	$\times 10^{-3}$ CL=90%	—
$K^*(892)^0 \bar{K}^*(892)^0$	$(1.8 \pm 0.6) \times 10^{-3}$		1456
$K_0^*(1430)^0 \bar{K}_0^*(1430)^0 \rightarrow \pi^+ \pi^- K^+ K^-$	$(1.05 \pm 0.39) \times 10^{-3}$		—
$K_0^*(1430)^0 \bar{K}_2^*(1430)^0 + \text{c.c.} \rightarrow \pi^+ \pi^- K^+ K^-$	$(8.5 \pm 2.1) \times 10^{-4}$		—

$K^+ K^-$	$(5.4 \pm 0.6) \times 10^{-3}$		1634
$\pi\pi$	$(7.2 \pm 0.6) \times 10^{-3}$		1702
$\eta\eta$	$(1.9 \pm 0.5) \times 10^{-3}$		1617
$\omega\omega$	$(2.3 \pm 0.7) \times 10^{-3}$		1517
$K^+ K^- K_S^0 K_S^0$	$(1.5 \pm 0.5) \times 10^{-3}$		1331
$K^+ K^- K^+ K^-$	$(2.1 \pm 0.4) \times 10^{-3}$		1333
$K_S^0 K_S^0$	$(2.8 \pm 0.7) \times 10^{-3}$	S=1.9	1633
$K_S^0 K_S^0 \pi^+ \pi^-$	$(6.1 \pm 1.1) \times 10^{-3}$		1579
$K_S^0 K_S^0 p \bar{p}$	$< 8.8 \times 10^{-4}$	CL=90%	884
$\pi^+ \pi^- p \bar{p}$	$(2.1 \pm 0.7) \times 10^{-3}$	S=1.4	1320
$\phi\phi$	$(9 \pm 5) \times 10^{-4}$		1370
$p \bar{p}$	$(2.24 \pm 0.27) \times 10^{-4}$		1426
$\Lambda \bar{\Lambda}$	$(4.4 \pm 1.5) \times 10^{-4}$		1292
$\Lambda \bar{\Lambda} \pi^+ \pi^-$	$< 4.0 \times 10^{-3}$	CL=90%	1153
$\Xi^- \Xi^+$	$< 1.03 \times 10^{-3}$	CL=90%	1081
$K_S^0 K^+ \pi^- + \text{c.c.}$	$< 7 \times 10^{-4}$	CL=90%	1610

Radiative decays

$\gamma J/\psi(1S)$	$(1.30 \pm 0.11) \%$	303
$\gamma\gamma$	$(2.76 \pm 0.33) \times 10^{-4}$	1707

 $\chi_{c1}(1P)$

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

Mass $m = 3510.66 \pm 0.07$ MeV (S = 1.5)Full width $\Gamma = 0.89 \pm 0.05$ MeV

$\chi_{c1}(1P)$ DECAY MODES	Fraction (Γ_i/Γ)	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
$\pi^+ \pi^- K^+ K^-$	$(4.5 \pm 1.0) \times 10^{-3}$		1632
$\rho^0 \pi^+ \pi^-$	$(3.9 \pm 3.5) \times 10^{-3}$		1657
$K^+ \bar{K}^*(892)^0 \pi^- + \text{c.c.}$	$(3.2 \pm 2.1) \times 10^{-3}$		1577
$K^*(892)^0 \bar{K}^*(892)^0$	$(1.6 \pm 0.4) \times 10^{-3}$		1512
$K_S^0 K^+ \pi^- + \text{c.c.}$	$(2.3 \pm 0.7) \times 10^{-3}$		1661
$\pi^+ \pi^- K_S^0 K_S^0$	$(7.7 \pm 3.3) \times 10^{-4}$		1630
$\pi^+ \pi^- p \bar{p}$	$(4.9 \pm 1.9) \times 10^{-4}$		1381
$K^+ K^- K^+ K^-$	$(3.9 \pm 1.7) \times 10^{-4}$		1393
$p \bar{p}$	$(6.7 \pm 0.5) \times 10^{-5}$		1484
$\Lambda \bar{\Lambda}$	$(2.4 \pm 1.0) \times 10^{-4}$		1355
$\Lambda \bar{\Lambda} \pi^+ \pi^-$	$< 1.5 \times 10^{-3}$	CL=90%	1223

$K_S^0 K_S^0 p \bar{p}$	< 4.5	$\times 10^{-4}$	CL=90%	968
$\Xi^- \Xi^+$	< 3.4	$\times 10^{-4}$	CL=90%	1156
$\pi^+ \pi^- + K^+ K^-$	< 2.1	$\times 10^{-3}$		—
$K_S^0 K_S^0$	< 7	$\times 10^{-5}$	CL=90%	1683

Radiative decays

$\gamma J/\psi(1S)$	$(35.6 \pm 1.9) \%$	389
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 $\chi_{c2}(1P)$

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

Mass $m = 3556.20 \pm 0.09$ MeVFull width $\Gamma = 2.06 \pm 0.12$ MeV

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

$2(\pi^+ \pi^-)$	$(1.23 \pm 0.15) \%$		1751
$\pi^+ \pi^- K^+ K^-$	$(9.9 \pm 2.5) \times 10^{-3}$	S=1.6	1656
$3(\pi^+ \pi^-)$	$(8.6 \pm 1.8) \times 10^{-3}$		1707
$\rho^0 \pi^+ \pi^-$	$(7 \pm 4) \times 10^{-3}$		1681
$K^+ \bar{K}^*(892)^0 \pi^- + \text{c.c.}$	$(4.8 \pm 2.8) \times 10^{-3}$		1602
$K^*(892)^0 \bar{K}^*(892)^0$	$(3.8 \pm 0.8) \times 10^{-3}$		1538
$\phi \phi$	$(1.9 \pm 0.7) \times 10^{-3}$		1457
$\omega \omega$	$(2.0 \pm 0.7) \times 10^{-3}$		1597
$\pi \pi$	$(2.14 \pm 0.25) \times 10^{-3}$		1773
$\eta \eta$	$< 1.2 \times 10^{-3}$	CL=90%	1692
$\pi^+ \pi^- K_S^0 K_S^0$	$(2.6 \pm 0.6) \times 10^{-3}$		1655
$K^+ K^- K^+ K^-$	$(1.41 \pm 0.35) \times 10^{-3}$		1421
$\pi^+ \pi^- p \bar{p}$	$(1.32 \pm 0.34) \times 10^{-3}$		1410
$K^+ K^-$	$(7.7 \pm 1.4) \times 10^{-4}$		1708
$K_S^0 K_S^0$	$(6.7 \pm 1.1) \times 10^{-4}$		1707
$K_S^0 K_S^0 p \bar{p}$	$< 7.9 \times 10^{-4}$	CL=90%	1007
$p \bar{p}$	$(6.6 \pm 0.5) \times 10^{-5}$		1510
$\Lambda \bar{\Lambda}$	$(2.7 \pm 1.3) \times 10^{-4}$		1385
$\Lambda \bar{\Lambda} \pi^+ \pi^-$	$< 3.5 \times 10^{-3}$	CL=90%	1255
$J/\psi(1S) \pi^+ \pi^- \pi^0$	$< 1.5 \%$	CL=90%	185
$K_S^0 K^+ \pi^- + \text{c.c.}$	$< 1.0 \times 10^{-3}$	CL=90%	1685
$\Xi^- \Xi^+$	$< 3.7 \times 10^{-4}$	CL=90%	1190

Radiative decays

$\gamma J/\psi(1S)$	$(20.2 \pm 1.0) \%$	430
$\gamma\gamma$	$(2.59 \pm 0.19) \times 10^{-4}$	1778

 $\eta_c(2S)$

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

Quantum numbers are quark model predictions.

Mass $m = 3638 \pm 4$ MeV ($S = 1.8$)Full width $\Gamma = 14 \pm 7$ MeV

$\eta_c(2S)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\bar{K}\pi$	seen	1729
$\gamma\gamma$	seen	1819

 $\psi(2S)$

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

Mass $m = 3686.093 \pm 0.034$ MeV ($S = 1.4$)Full width $\Gamma = 337 \pm 13$ keV $\Gamma_{ee} = 2.48 \pm 0.06$ 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	—
e^+e^-	$(7.35 \pm 0.18) \times 10^{-3}$		1843
$\mu^+\mu^-$	$(7.3 \pm 0.8) \times 10^{-3}$		1840
$\tau^+\tau^-$	$(2.8 \pm 0.7) \times 10^{-3}$		489

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

$J/\psi(1S)$ anything	$(56.1 \pm 0.9) \%$		—
$J/\psi(1S)$ neutrals	$(23.0 \pm 0.4) \%$		—
$J/\psi(1S)\pi^+\pi^-$	$(31.8 \pm 0.6) \%$		477
$J/\psi(1S)\pi^0\pi^0$	$(16.46 \pm 0.35) \%$		481
$J/\psi(1S)\eta$	$(3.09 \pm 0.08) \%$		200
$J/\psi(1S)\pi^0$	$(1.26 \pm 0.13) \times 10^{-3}$	S=1.3	528

Hadronic decays

$3(\pi^+\pi^-)\pi^0$	$(3.5 \pm 1.6) \times 10^{-3}$		1746
$2(\pi^+\pi^-)\pi^0$	$(2.66 \pm 0.29) \times 10^{-3}$		1799
$\rho a_2(1320)$	$(2.6 \pm 0.9) \times 10^{-4}$		1500
$p\bar{p}$	$(2.65 \pm 0.22) \times 10^{-4}$	S=1.4	1586
$\Delta^{++}\bar{\Delta}^{--}$	$(1.28 \pm 0.35) \times 10^{-4}$		1371
$\Lambda\bar{\Lambda}$	$(2.5 \pm 0.7) \times 10^{-4}$	S=3.1	1467

$\Sigma^+ \bar{\Sigma}^-$	$(2.6 \pm 0.8) \times 10^{-4}$		1408
$\Sigma^0 \bar{\Sigma}^0$	$(2.1 \pm 0.7) \times 10^{-4}$	S=2.0	1405
$\Sigma(1385)^+ \bar{\Sigma}(1385)^-$	$(1.1 \pm 0.4) \times 10^{-4}$		1218
$\Xi^- \bar{\Xi}^+$	$(1.5 \pm 0.7) \times 10^{-4}$	S=3.0	1285
$\Xi^0 \bar{\Xi}^0$	$(2.8 \pm 0.9) \times 10^{-4}$		1292
$\Xi(1530)^0 \bar{\Xi}(1530)^0$	$< 8.1 \times 10^{-5}$	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
$2(\pi^+ \pi^- \pi^0)$	$(4.5 \pm 1.4) \times 10^{-3}$		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
$\eta' \pi^+ \pi^- \pi^0$	$(4.5 \pm 2.1) \times 10^{-4}$		—
$\omega \pi^+ \pi^-$	$(6.6 \pm 1.7) \times 10^{-4}$	S=2.7	1748
$b_1^\pm \pi^\mp$	$(3.6 \pm 0.6) \times 10^{-4}$		1635
$b_1^0 \pi^0$	$(2.4 \pm 0.6) \times 10^{-4}$		—
$\omega f_2(1270)$	$(2.0 \pm 0.6) \times 10^{-4}$		1515
$\pi^+ \pi^- K^+ K^-$	$(7.2 \pm 0.5) \times 10^{-4}$		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
$K^+ K^- 2(\pi^+ \pi^-)$	$(1.8 \pm 0.9) \times 10^{-3}$		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
$K^+ K^- \pi^+ \pi^- \pi^0$	$(1.24 \pm 0.10) \times 10^{-3}$		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
$K^+ K^-$	$(1.0 \pm 0.7) \times 10^{-4}$		1776
$K_S^0 K_L^0$	$(5.2 \pm 0.7) \times 10^{-5}$		1775
$\pi^+ \pi^- \pi^0$	$(1.68 \pm 0.26) \times 10^{-4}$	S=1.4	1830

$\rho(2150)\pi \rightarrow \pi^+\pi^-\pi^0$	$(1.9^{+1.2}_{-0.4}) \times 10^{-4}$	—	
$\rho(770)\pi \rightarrow \pi^+\pi^-\pi^0$	$(3.2 \pm 1.2) \times 10^{-5}$	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
$\phi\pi^+\pi^-$	$(1.13 \pm 0.29) \times 10^{-4}$	S=1.7	1690
$\phi f_0(980) \rightarrow \pi^+\pi^-$	$(6.0 \pm 2.2) \times 10^{-5}$		—
$2(K^+K^-)$	$(6.0 \pm 1.4) \times 10^{-5}$		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
$p\bar{p}K^+K^-$	$(2.7 \pm 0.7) \times 10^{-5}$		1118
$\Lambda\bar{\Lambda}\pi^+\pi^-$	$(2.8 \pm 0.6) \times 10^{-4}$		1346
$\Lambda\bar{p}K^+$	$(1.00 \pm 0.14) \times 10^{-4}$		1327
$\Lambda\bar{p}K^+\pi^+\pi^-$	$(1.8 \pm 0.4) \times 10^{-4}$		1167
$\phi f'_2(1525)$	$(4.4 \pm 1.6) \times 10^{-5}$		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

$\gamma\chi_{c0}(1P)$	$(9.2 \pm 0.4) \%$		261
$\gamma\chi_{c1}(1P)$	$(8.7 \pm 0.4) \%$		171
$\gamma\chi_{c2}(1P)$	$(8.1 \pm 0.4) \%$		128
$\gamma\eta_c(1S)$	$(2.6 \pm 0.4) \times 10^{-3}$		638
$\gamma\eta_c(2S)$	$< 2.0 \times 10^{-3}$	CL=90%	47
$\gamma\eta'(958)$	$(1.5 \pm 0.4) \times 10^{-4}$		1719

$\gamma f_2(1270)$	$(2.1 \pm 0.4) \times 10^{-4}$	1622
$\gamma f_0(1710) \rightarrow \gamma \pi \pi$	$(3.0 \pm 1.3) \times 10^{-5}$	—
$\gamma f_0(1710) \rightarrow \gamma K \bar{K}$	$(6.0 \pm 1.6) \times 10^{-5}$	—
$\gamma \gamma$	$< 1.3 \times 10^{-4}$	CL=90% 1843
$\gamma \eta$	$< 9 \times 10^{-5}$	CL=90% 1802
$\gamma \eta(1405) \rightarrow \gamma K \bar{K} \pi$	$< 1.2 \times 10^{-4}$	CL=90% 1569

 $\psi(3770)$

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

Mass $m = 3771.1 \pm 2.4$ MeV

Full width $\Gamma = 23.0 \pm 2.7$ MeV (S = 1.1)

$\Gamma_{ee} = 0.242^{+0.027}_{-0.024}$ keV (S = 1.1)

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)
$D\bar{D}$	dominant		281
$D^0\bar{D}^0$	seen		281
D^+D^-	seen		247
$J/\psi \pi^+\pi^-$	$(1.93 \pm 0.28) \times 10^{-3}$		558
$J/\psi \pi^0\pi^0$	$(8.0 \pm 3.0) \times 10^{-4}$		562
$J/\psi \eta$	$(9 \pm 4) \times 10^{-4}$		357
$J/\psi \pi^0$	$< 2.8 \times 10^{-4}$	CL=90%	601
e^+e^-	$(1.05 \pm 0.14) \times 10^{-5}$	S=1.1	1886
$K_S^0 K_L^0$	$< 2.1 \times 10^{-4}$	CL=90%	1819
$2(\pi^+\pi^-)$	$< 1.12 \times 10^{-3}$	CL=90%	1860
$2(\pi^+\pi^-)\pi^0$	$< 1.06 \times 10^{-3}$	CL=90%	1842
$\eta \pi^+\pi^-$	$< 1.24 \times 10^{-3}$	CL=90%	1835
$\omega \pi^+\pi^-$	$< 6.0 \times 10^{-4}$	CL=90%	1793
$\eta 3\pi$	$< 1.34 \times 10^{-3}$	CL=90%	1823
$\eta' 3\pi$	$< 2.44 \times 10^{-3}$	CL=90%	1739
$K^+K^-\pi^+\pi^-$	$< 9.0 \times 10^{-4}$	CL=90%	1771
$\phi \pi^+\pi^-$	$< 4.1 \times 10^{-4}$	CL=90%	1736
$\phi f_0(980)$	$< 4.5 \times 10^{-4}$	CL=90%	1599
$K^+K^-\pi^+\pi^-\pi^0$	$< 2.36 \times 10^{-3}$	CL=90%	1740
ηK^+K^-	$< 4.1 \times 10^{-4}$	CL=90%	1711
ωK^+K^-	$< 3.4 \times 10^{-4}$	CL=90%	1663
$2(K^+K^-)$	$< 6.0 \times 10^{-4}$	CL=90%	1550
ϕK^+K^-	$< 7.5 \times 10^{-4}$	CL=90%	1596
$2(K^+K^-)\pi^0$	$< 2.9 \times 10^{-4}$	CL=90%	1492

$p\bar{p}\pi^+\pi^-$	< 5.8	$\times 10^{-4}$	CL=90%	1543
$p\bar{p}\pi^+\pi^-\pi^0$	< 1.85	$\times 10^{-3}$	CL=90%	1489
$\eta p\bar{p}$	< 5.4	$\times 10^{-4}$	CL=90%	1429
$\omega p\bar{p}$	< 2.9	$\times 10^{-4}$	CL=90%	1308
$p\bar{p}K^+K^-$	< 3.2	$\times 10^{-4}$	CL=90%	1184
$\phi p\bar{p}$	< 1.3	$\times 10^{-4}$	CL=90%	1176
$\Lambda\bar{\Lambda}$	< 1.2	$\times 10^{-4}$	CL=90%	1520
$\Lambda\bar{\Lambda}\pi^+\pi^-$	< 2.5	$\times 10^{-4}$	CL=90%	1403
$\Lambda\bar{p}K^+$	< 2.8	$\times 10^{-4}$	CL=90%	1385
$\Lambda\bar{p}K^+\pi^+\pi^-$	< 6.3	$\times 10^{-4}$	CL=90%	1232
$\phi\eta$	$(3.1 \pm 0.7) \times 10^{-4}$			1702
$\pi^+\pi^-\pi^0$	not seen			1873
$\rho\pi$	not seen			1803
$\omega\pi^0$	not seen			1802
$\phi\pi^0$	not seen			1745
$\rho\eta$	not seen			1762
$\omega\eta$	not seen			1761
$\rho\eta'$	not seen			1673
$\omega\eta'$	not seen			1671
$\phi\eta'$	not seen			1605
$K^{*0}\bar{K}^0$	not seen			1743
$K^{*+}K^-$	not seen			1744
$b_1\pi$	not seen			1682

X(3872)

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

Quantum numbers not established.

$$\text{Mass } m = 3871.2 \pm 0.5 \text{ MeV} \quad (S = 1.4)$$

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

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

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

X(3872) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi^+\pi^- J/\psi(1S)$	seen	649
$D^0\bar{D}^0$	not seen	520
D^+D^-	not seen	502
$D^0\bar{D}^0\pi^0$	not seen	117

 $\chi_{c2}(2P)$

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

$$\text{Mass } m = 3929 \pm 5 \text{ MeV}$$

$$\text{Full width } \Gamma = 29 \pm 10 \text{ MeV}$$

$\psi(4040)$ ^[d]

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

Mass $m = 4039 \pm 1$ MeVFull width $\Gamma = 80 \pm 10$ MeV $\Gamma_{ee} = 0.86 \pm 0.07$ 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
$D^0\bar{D}^0$	seen			776
$D^{*}(2007)^0\bar{D}^0 + \text{c.c.}$	seen			576
$D^{*}(2007)^0\bar{D}^{*}(2007)^0$	seen			227
$J/\psi\pi^+\pi^-$	< 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	P (MeV/c)
e^+e^-	$(8.1 \pm 0.9) \times 10^{-6}$			2076
$J/\psi\pi^+\pi^-$	< 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

 $\psi(4415)$ ^[d]

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

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)	p (MeV/c)
hadrons	dominant	—
$e^+ e^-$	$(9.4 \pm 3.2) \times 10^{-6}$	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.