

# LIGHT UNFLAVORED MESONS

## ( $S = C = B = 0$ )

For  $I = 1$  ( $\pi, \rho, \omega$ ):  $u\bar{d}, (u\bar{u}-d\bar{d})/\sqrt{2}, d\bar{u}$ ;  
 for  $I = 0$  ( $\eta, \eta', h, h', \omega, \phi, f, f'$ ):  $c_1(u\bar{u} + d\bar{d}) + c_2(s\bar{s})$

$\pi^\pm$

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

Mass  $m = 139.57018 \pm 0.00035$  MeV ( $S = 1.2$ )  
 Mean life  $\tau = (2.6033 \pm 0.0005) \times 10^{-8}$  s ( $S = 1.2$ )  
 $c\tau = 7.8045$  m

$\pi^\pm \rightarrow \ell^\pm \nu \gamma$  form factors [a]

$F_V = 0.0254 \pm 0.0017$   
 $F_A = 0.0119 \pm 0.0001$   
 $F_V$  slope parameter  $a = 0.10 \pm 0.06$   
 $R = 0.059^{+0.009}_{-0.008}$

$\pi^-$  modes are charge conjugates of the modes below.

For decay limits to particles which are not established, see the section on Searches for Axions and Other Very Light Bosons.

$\pi^+$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$\frac{p}{\text{MeV}/c}$
$\mu^+ \nu_\mu$	[b] (99.98770 ± 0.00004) %		30
$\mu^+ \nu_\mu \gamma$	[c] ( 2.00 ± 0.25 ) × 10 <sup>-4</sup>		30
$e^+ \nu_e$	[b] ( 1.230 ± 0.004 ) × 10 <sup>-4</sup>		70
$e^+ \nu_e \gamma$	[c] ( 7.39 ± 0.05 ) × 10 <sup>-7</sup>		70
$e^+ \nu_e \pi^0$	( 1.036 ± 0.006 ) × 10 <sup>-8</sup>		4
$e^+ \nu_e e^+ e^-$	( 3.2 ± 0.5 ) × 10 <sup>-9</sup>		70
$e^+ \nu_e \nu \bar{\nu}$	< 5 × 10 <sup>-6</sup>	90%	70
<b>Lepton Family number (LF) or Lepton number (L) violating modes</b>			
$\mu^+ \bar{\nu}_e$	L [d] < 1.5	× 10 <sup>-3</sup> 90%	30
$\mu^+ \nu_e$	LF [d] < 8.0	× 10 <sup>-3</sup> 90%	30
$\mu^- e^+ e^+ \nu$	LF < 1.6	× 10 <sup>-6</sup> 90%	30

$\pi^0$

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

Mass  $m = 134.9766 \pm 0.0006$  MeV ( $S = 1.1$ )  
 $m_{\pi^\pm} - m_{\pi^0} = 4.5936 \pm 0.0005$  MeV  
 Mean life  $\tau = (8.52 \pm 0.18) \times 10^{-17}$  s ( $S = 1.2$ )  
 $c\tau = 25.5$  nm

For decay limits to particles which are not established, see the appropriate Search sections ( $A^0$  (axion) and Other Light Boson ( $X^0$ ) Searches, etc.).

$\pi^0$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$2\gamma$	$(98.823 \pm 0.034) \%$	S=1.5	67
$e^+ e^- \gamma$	$(1.174 \pm 0.035) \%$	S=1.5	67
$\gamma$ positronium	$(1.82 \pm 0.29) \times 10^{-9}$		67
$e^+ e^+ e^- e^-$	$(3.34 \pm 0.16) \times 10^{-5}$		67
$e^+ e^-$	$(6.46 \pm 0.33) \times 10^{-8}$		67
$4\gamma$	$< 2$	$\times 10^{-8}$ CL=90%	67
$\nu \bar{\nu}$	[e] $< 2.7$	$\times 10^{-7}$ CL=90%	67
$\nu_e \bar{\nu}_e$	$< 1.7$	$\times 10^{-6}$ CL=90%	67
$\nu_\mu \bar{\nu}_\mu$	$< 1.6$	$\times 10^{-6}$ CL=90%	67
$\nu_\tau \bar{\nu}_\tau$	$< 2.1$	$\times 10^{-6}$ CL=90%	67
$\gamma \nu \bar{\nu}$	$< 6$	$\times 10^{-4}$ CL=90%	67
<b>Charge conjugation (C) or Lepton Family number (LF) violating modes</b>			
$3\gamma$	C $< 3.1$	$\times 10^{-8}$ CL=90%	67
$\mu^+ e^-$	LF $< 3.8$	$\times 10^{-10}$ CL=90%	26
$\mu^- e^+$	LF $< 3.4$	$\times 10^{-9}$ CL=90%	26
$\mu^+ e^- + \mu^- e^+$	LF $< 3.6$	$\times 10^{-10}$ CL=90%	26

**$\eta$**

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

Mass  $m = 547.862 \pm 0.017$  MeV

Full width  $\Gamma = 1.31 \pm 0.05$  keV

**C-nonconserving decay parameters**

$$\pi^+ \pi^- \pi^0 \text{ left-right asymmetry} = (0.09^{+0.11}_{-0.12}) \times 10^{-2}$$

$$\pi^+ \pi^- \pi^0 \text{ sextant asymmetry} = (0.12^{+0.10}_{-0.11}) \times 10^{-2}$$

$$\pi^+ \pi^- \pi^0 \text{ quadrant asymmetry} = (-0.09 \pm 0.09) \times 10^{-2}$$

$$\pi^+ \pi^- \gamma \text{ left-right asymmetry} = (0.9 \pm 0.4) \times 10^{-2}$$

$$\pi^+ \pi^- \gamma \beta \text{ (D-wave)} = -0.02 \pm 0.07 \quad (S = 1.3)$$

**CP-nonconserving decay parameters**

$$\pi^+ \pi^- e^+ e^- \text{ decay-plane asymmetry } A_\phi = (-0.6 \pm 3.1) \times 10^{-2}$$

**Dalitz plot parameter**

$$\pi^0 \pi^0 \pi^0 \quad \alpha = -0.0315 \pm 0.0015$$

$\eta$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
<b>Neutral modes</b>			
neutral modes	(72.12±0.34) %	S=1.2	–
2 $\gamma$	(39.41±0.20) %	S=1.1	274
3 $\pi^0$	(32.68±0.23) %	S=1.1	179
$\pi^0 2\gamma$	( 2.56±0.22) $\times 10^{-4}$		257
2 $\pi^0 2\gamma$	< 1.2 $\times 10^{-3}$	CL=90%	238
4 $\gamma$	< 2.8 $\times 10^{-4}$	CL=90%	274
invisible	< 1.0 $\times 10^{-4}$	CL=90%	–
<b>Charged modes</b>			
charged modes	(28.10±0.34) %	S=1.2	–
$\pi^+ \pi^- \pi^0$	(22.92±0.28) %	S=1.2	174
$\pi^+ \pi^- \gamma$	( 4.22±0.08) %	S=1.1	236
$e^+ e^- \gamma$	( 6.9 ±0.4 ) $\times 10^{-3}$	S=1.3	274
$\mu^+ \mu^- \gamma$	( 3.1 ±0.4 ) $\times 10^{-4}$		253
$e^+ e^-$	< 2.3 $\times 10^{-6}$	CL=90%	274
$\mu^+ \mu^-$	( 5.8 ±0.8 ) $\times 10^{-6}$		253
2 $e^+ 2e^-$	( 2.40±0.22) $\times 10^{-5}$		274
$\pi^+ \pi^- e^+ e^- (\gamma)$	( 2.68±0.11) $\times 10^{-4}$		235
$e^+ e^- \mu^+ \mu^-$	< 1.6 $\times 10^{-4}$	CL=90%	253
2 $\mu^+ 2\mu^-$	< 3.6 $\times 10^{-4}$	CL=90%	161
$\mu^+ \mu^- \pi^+ \pi^-$	< 3.6 $\times 10^{-4}$	CL=90%	113
$\pi^+ e^- \bar{\nu}_e + \text{c.c.}$	< 1.7 $\times 10^{-4}$	CL=90%	256
$\pi^+ \pi^- 2\gamma$	< 2.1 $\times 10^{-3}$		236
$\pi^+ \pi^- \pi^0 \gamma$	< 5 $\times 10^{-4}$	CL=90%	174
$\pi^0 \mu^+ \mu^- \gamma$	< 3 $\times 10^{-6}$	CL=90%	210
<b>Charge conjugation (C), Parity (P), Charge conjugation <math>\times</math> Parity (CP), or Lepton Family number (LF) violating modes</b>			
$\pi^0 \gamma$	C	< 9 $\times 10^{-5}$	CL=90% 257
$\pi^+ \pi^-$	P,CP	< 1.3 $\times 10^{-5}$	CL=90% 236
2 $\pi^0$	P,CP	< 3.5 $\times 10^{-4}$	CL=90% 238
2 $\pi^0 \gamma$	C	< 5 $\times 10^{-4}$	CL=90% 238
3 $\pi^0 \gamma$	C	< 6 $\times 10^{-5}$	CL=90% 179
3 $\gamma$	C	< 1.6 $\times 10^{-5}$	CL=90% 274
4 $\pi^0$	P,CP	< 6.9 $\times 10^{-7}$	CL=90% 40
$\pi^0 e^+ e^-$	C	[f] < 4 $\times 10^{-5}$	CL=90% 257
$\pi^0 \mu^+ \mu^-$	C	[f] < 5 $\times 10^{-6}$	CL=90% 210
$\mu^+ e^- + \mu^- e^+$	LF	< 6 $\times 10^{-6}$	CL=90% 264

**$f_0(500)$  or  $\sigma$  [ $g$ ]  
was  $f_0(600)$**

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

Mass  $m = (400\text{--}550)$  MeV

Full width  $\Gamma = (400\text{--}700)$  MeV

$f_0(500)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\pi$	dominant	—
$\gamma\gamma$	seen	—

**$\rho(770)$  [ $h$ ]**

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

Mass  $m = 775.26 \pm 0.25$  MeV

Full width  $\Gamma = 149.1 \pm 0.8$  MeV

$\Gamma_{ee} = 7.04 \pm 0.06$  keV

$\rho(770)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$\pi\pi$	$\sim 100$	%	363

**$\rho(770)^\pm$  decays**

$\pi^\pm\gamma$	( $4.5 \pm 0.5$ ) $\times 10^{-4}$	S=2.2	375
$\pi^\pm\eta$	< 6 $\times 10^{-3}$	CL=84%	152
$\pi^\pm\pi^+\pi^-\pi^0$	< 2.0 $\times 10^{-3}$	CL=84%	254

**$\rho(770)^0$  decays**

$\pi^+\pi^-\gamma$	( $9.9 \pm 1.6$ ) $\times 10^{-3}$		362
$\pi^0\gamma$	( $6.0 \pm 0.8$ ) $\times 10^{-4}$		376
$\eta\gamma$	( $3.00 \pm 0.20$ ) $\times 10^{-4}$		194
$\pi^0\pi^0\gamma$	( $4.5 \pm 0.8$ ) $\times 10^{-5}$		363
$\mu^+\mu^-$	[i] ( $4.55 \pm 0.28$ ) $\times 10^{-5}$		373
$e^+e^-$	[i] ( $4.72 \pm 0.05$ ) $\times 10^{-5}$		388
$\pi^+\pi^-\pi^0$	( $1.01^{+0.54}_{-0.36} \pm 0.34$ ) $\times 10^{-4}$		323
$\pi^+\pi^-\pi^+\pi^-$	( $1.8 \pm 0.9$ ) $\times 10^{-5}$		251
$\pi^+\pi^-\pi^0\pi^0$	( $1.6 \pm 0.8$ ) $\times 10^{-5}$		257
$\pi^0e^+e^-$	< 1.2 $\times 10^{-5}$	CL=90%	376

**$\omega(782)$**

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

Mass  $m = 782.65 \pm 0.12$  MeV (S = 1.9)

Full width  $\Gamma = 8.49 \pm 0.08$  MeV

$\Gamma_{ee} = 0.60 \pm 0.02$  keV

$\omega(782)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$\pi^+ \pi^- \pi^0$	(89.2 $\pm$ 0.7 ) %		327
$\pi^0 \gamma$	( 8.28 $\pm$ 0.28) %	S=2.1	380
$\pi^+ \pi^-$	( 1.53 $^{+0.11}_{-0.13}$ ) %	S=1.2	366
neutrals (excluding $\pi^0 \gamma$ )	( 8 $^{+8}_{-5}$ ) $\times 10^{-3}$	S=1.1	–
$\eta \gamma$	( 4.6 $\pm$ 0.4 ) $\times 10^{-4}$	S=1.1	200
$\pi^0 e^+ e^-$	( 7.7 $\pm$ 0.6 ) $\times 10^{-4}$		380
$\pi^0 \mu^+ \mu^-$	( 1.3 $\pm$ 0.4 ) $\times 10^{-4}$	S=2.1	349
$e^+ e^-$	( 7.28 $\pm$ 0.14) $\times 10^{-5}$	S=1.3	391
$\pi^+ \pi^- \pi^0 \pi^0$	< 2 $\times 10^{-4}$	CL=90%	262
$\pi^+ \pi^- \gamma$	< 3.6 $\times 10^{-3}$	CL=95%	366
$\pi^+ \pi^- \pi^+ \pi^-$	< 1 $\times 10^{-3}$	CL=90%	256
$\pi^0 \pi^0 \gamma$	( 6.6 $\pm$ 1.1 ) $\times 10^{-5}$		367
$\eta \pi^0 \gamma$	< 3.3 $\times 10^{-5}$	CL=90%	162
$\mu^+ \mu^-$	( 9.0 $\pm$ 3.1 ) $\times 10^{-5}$		377
$3\gamma$	< 1.9 $\times 10^{-4}$	CL=95%	391

**Charge conjugation (C) violating modes**

$\eta \pi^0$	C	< 2.1 $\times 10^{-4}$	CL=90%	162
$2\pi^0$	C	< 2.1 $\times 10^{-4}$	CL=90%	367
$3\pi^0$	C	< 2.3 $\times 10^{-4}$	CL=90%	330

**$\eta'(958)$**

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

Mass  $m = 957.78 \pm 0.06$  MeV

Full width  $\Gamma = 0.198 \pm 0.009$  MeV

$\eta'(958)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\pi^+ \pi^- \eta$	(42.9 $\pm$ 0.7 ) %		232
$\rho^0 \gamma$ (including non-resonant $\pi^+ \pi^- \gamma$ )	(29.1 $\pm$ 0.5 ) %		165
$\pi^0 \pi^0 \eta$	(22.2 $\pm$ 0.8 ) %		239
$\omega \gamma$	( 2.75 $\pm$ 0.23) %		159
$\gamma \gamma$	( 2.20 $\pm$ 0.08) %		479
$3\pi^0$	( 2.14 $\pm$ 0.20) $\times 10^{-3}$		430
$\mu^+ \mu^- \gamma$	( 1.08 $\pm$ 0.27) $\times 10^{-4}$		467
$\pi^+ \pi^- \mu^+ \mu^-$	< 2.9 $\times 10^{-5}$	90%	401
$\pi^+ \pi^- \pi^0$	( 3.8 $\pm$ 0.4 ) $\times 10^{-3}$		428
$\pi^0 \rho^0$	< 4 %	90%	111
$2(\pi^+ \pi^-)$	( 8.5 $\pm$ 0.9 ) $\times 10^{-5}$		372
$\pi^+ \pi^- 2\pi^0$	( 1.8 $\pm$ 0.4 ) $\times 10^{-4}$		376

$2(\pi^+\pi^-)$ neutrals	< 1	%	95%	—
$2(\pi^+\pi^-)\pi^0$	< 1.9	$\times 10^{-3}$	90%	298
$2(\pi^+\pi^-)2\pi^0$	< 1	%	95%	197
$3(\pi^+\pi^-)$	< 3.1	$\times 10^{-5}$	90%	189
$\pi^+\pi^-e^+e^-$	$(2.4^{+1.3}_{-1.0}) \times 10^{-3}$			458
$\pi^+e^-\nu_e + \text{c.c.}$	< 2.1	$\times 10^{-4}$	90%	469
$\gamma e^+e^-$	< 9	$\times 10^{-4}$	90%	479
$\pi^0\gamma\gamma$	< 8	$\times 10^{-4}$	90%	469
$4\pi^0$	< 3.2	$\times 10^{-4}$	90%	380
$e^+e^-$	< 1.2	$\times 10^{-8}$	90%	479
invisible	< 5	$\times 10^{-4}$	90%	—

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

$\pi^+\pi^-$	<i>P,CP</i>	< 6	$\times 10^{-5}$	90%	458
$\pi^0\pi^0$	<i>P,CP</i>	< 4	$\times 10^{-4}$	90%	459
$\pi^0e^+e^-$	<i>C</i>	[ <i>f</i> ] < 1.4	$\times 10^{-3}$	90%	469
$\eta e^+e^-$	<i>C</i>	[ <i>f</i> ] < 2.4	$\times 10^{-3}$	90%	322
$3\gamma$	<i>C</i>	< 1.0	$\times 10^{-4}$	90%	479
$\mu^+\mu^-\pi^0$	<i>C</i>	[ <i>f</i> ] < 6.0	$\times 10^{-5}$	90%	445
$\mu^+\mu^-\eta$	<i>C</i>	[ <i>f</i> ] < 1.5	$\times 10^{-5}$	90%	273
$e\mu$	<i>LF</i>	< 4.7	$\times 10^{-4}$	90%	473

**$f_0(980)$  [*j*]**

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

Mass  $m = 990 \pm 20$  MeV  
Full width  $\Gamma = 40$  to 100 MeV

<b><math>f_0(980)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\pi$	dominant	476
$K\bar{K}$	seen	36
$\gamma\gamma$	seen	495

**$a_0(980)$  [*j*]**

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

Mass  $m = 980 \pm 20$  MeV  
Full width  $\Gamma = 50$  to 100 MeV

<b><math>a_0(980)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\eta\pi$	dominant	319
$K\bar{K}$	seen	†
$\gamma\gamma$	seen	490

**$\phi(1020)$**

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

Mass  $m = 1019.461 \pm 0.019$  MeV (S = 1.1)

Full width  $\Gamma = 4.266 \pm 0.031$  MeV (S = 1.2)

<b><math>\phi(1020)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$K^+ K^-$	(48.9 $\pm$ 0.5 ) %	S=1.1	127
$K_L^0 K_S^0$	(34.2 $\pm$ 0.4 ) %	S=1.1	110
$\rho\pi + \pi^+\pi^-\pi^0$	(15.32 $\pm$ 0.32 ) %	S=1.1	—
$\eta\gamma$	( 1.309 $\pm$ 0.024 ) %	S=1.2	363
$\pi^0\gamma$	( 1.27 $\pm$ 0.06 ) $\times 10^{-3}$		501
$\ell^+\ell^-$	—		510
$e^+e^-$	( 2.954 $\pm$ 0.030 ) $\times 10^{-4}$	S=1.1	510
$\mu^+\mu^-$	( 2.87 $\pm$ 0.19 ) $\times 10^{-4}$		499
$\eta e^+e^-$	( 1.15 $\pm$ 0.10 ) $\times 10^{-4}$		363
$\pi^+\pi^-$	( 7.4 $\pm$ 1.3 ) $\times 10^{-5}$		490
$\omega\pi^0$	( 4.7 $\pm$ 0.5 ) $\times 10^{-5}$		172
$\omega\gamma$	< 5 %	CL=84%	209
$\rho\gamma$	< 1.2 $\times 10^{-5}$	CL=90%	215
$\pi^+\pi^-\gamma$	( 4.1 $\pm$ 1.3 ) $\times 10^{-5}$		490
$f_0(980)\gamma$	( 3.22 $\pm$ 0.19 ) $\times 10^{-4}$	S=1.1	29
$\pi^0\pi^0\gamma$	( 1.13 $\pm$ 0.06 ) $\times 10^{-4}$		492
$\pi^+\pi^-\pi^+\pi^-$	( 4.0 $^{+2.8}_{-2.2}$ ) $\times 10^{-6}$		410
$\pi^+\pi^+\pi^-\pi^-\pi^0$	< 4.6 $\times 10^{-6}$	CL=90%	342
$\pi^0 e^+ e^-$	( 1.12 $\pm$ 0.28 ) $\times 10^{-5}$		501
$\pi^0\eta\gamma$	( 7.27 $\pm$ 0.30 ) $\times 10^{-5}$	S=1.5	346
$a_0(980)\gamma$	( 7.6 $\pm$ 0.6 ) $\times 10^{-5}$		39
$K^0\bar{K}^0\gamma$	< 1.9 $\times 10^{-8}$	CL=90%	110
$\eta'(958)\gamma$	( 6.25 $\pm$ 0.21 ) $\times 10^{-5}$		60
$\eta\pi^0\pi^0\gamma$	< 2 $\times 10^{-5}$	CL=90%	293
$\mu^+\mu^-\gamma$	( 1.4 $\pm$ 0.5 ) $\times 10^{-5}$		499
$\rho\gamma\gamma$	< 1.2 $\times 10^{-4}$	CL=90%	215
$\eta\pi^+\pi^-$	< 1.8 $\times 10^{-5}$	CL=90%	288
$\eta\mu^+\mu^-$	< 9.4 $\times 10^{-6}$	CL=90%	321
$\eta U \rightarrow \eta e^+ e^-$	< 1 $\times 10^{-6}$	CL=90%	—
<b>Lepton Family number (LF) violating modes</b>			
$e^\pm\mu^\mp$	LF < 2 $\times 10^{-6}$	CL=90%	504

**$h_1(1170)$**

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

Mass  $m = 1170 \pm 20$  MeV  
 Full width  $\Gamma = 360 \pm 40$  MeV

<b><math>h_1(1170)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho\pi$	seen	308

**$b_1(1235)$**

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

Mass  $m = 1229.5 \pm 3.2$  MeV ( $S = 1.6$ )  
 Full width  $\Gamma = 142 \pm 9$  MeV ( $S = 1.2$ )

<b><math>b_1(1235)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$\omega\pi$	dominant		348
$\pi^\pm\gamma$	$[D/S \text{ amplitude ratio} = 0.277 \pm 0.027]$ $(1.6 \pm 0.4) \times 10^{-3}$		607
$\eta\rho$	seen		†
$\pi^+\pi^+\pi^-\pi^0$	< 50 %	84%	535
$K^*(892)^\pm K^\mp$	seen		†
$(K\bar{K})^\pm\pi^0$	< 8 %	90%	248
$K_S^0 K_L^0 \pi^\pm$	< 6 %	90%	235
$K_S^0 K_S^0 \pi^\pm$	< 2 %	90%	235
$\phi\pi$	< 1.5 %	84%	147

**$a_1(1260)$  <sup>[k]</sup>**

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

Mass  $m = 1230 \pm 40$  MeV <sup>[l]</sup>  
 Full width  $\Gamma = 250$  to  $600$  MeV

<b><math>a_1(1260)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$(\rho\pi)_{S\text{-wave}}$	seen	353
$(\rho\pi)_{D\text{-wave}}$	seen	353
$(\rho(1450)\pi)_{S\text{-wave}}$	seen	†
$(\rho(1450)\pi)_{D\text{-wave}}$	seen	†
$\sigma\pi$	seen	–
$f_0(980)\pi$	not seen	179
$f_0(1370)\pi$	seen	†
$f_2(1270)\pi$	seen	†
$K K^*(892) + \text{c.c.}$	seen	†
$\pi\gamma$	seen	608



**$f_2(1270)$**

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

Mass  $m = 1275.5 \pm 0.8$  MeV

Full width  $\Gamma = 186.7^{+2.2}_{-2.5}$  MeV (S = 1.4)

<b><math>f_2(1270)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$\rho$ (MeV/c)
$\pi\pi$	(84.2 $^{+2.9}_{-0.9}$ ) %	S=1.1	623
$\pi^+\pi^-2\pi^0$	( 7.7 $^{+1.1}_{-3.2}$ ) %	S=1.2	563
$K\bar{K}$	( 4.6 $^{+0.5}_{-0.4}$ ) %	S=2.7	404
$2\pi^+2\pi^-$	( 2.8 $\pm 0.4$ ) %	S=1.2	560
$\eta\eta$	( 4.0 $\pm 0.8$ ) $\times 10^{-3}$	S=2.1	326
$4\pi^0$	( 3.0 $\pm 1.0$ ) $\times 10^{-3}$		565
$\gamma\gamma$	( 1.42 $\pm 0.24$ ) $\times 10^{-5}$	S=1.4	638
$\eta\pi\pi$	< 8 $\times 10^{-3}$	CL=95%	478
$K^0K^-\pi^+$ + c.c.	< 3.4 $\times 10^{-3}$	CL=95%	293
$e^+e^-$	< 6 $\times 10^{-10}$	CL=90%	638

**$f_1(1285)$**

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

Mass  $m = 1281.9 \pm 0.5$  MeV (S = 1.8)

Full width  $\Gamma = 24.2 \pm 1.1$  MeV (S = 1.3)

<b><math>f_1(1285)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$\rho$ (MeV/c)
$4\pi$	(33.1 $^{+2.1}_{-1.8}$ ) %	S=1.3	568
$\pi^0\pi^0\pi^+\pi^-$	(22.0 $^{+1.4}_{-1.2}$ ) %	S=1.3	566
$2\pi^+2\pi^-$	(11.0 $^{+0.7}_{-0.6}$ ) %	S=1.3	563
$\rho^0\pi^+\pi^-$	(11.0 $^{+0.7}_{-0.6}$ ) %	S=1.3	336
$4\pi^0$	seen		†
$\eta\pi^+\pi^-$	< 7 $\times 10^{-4}$	CL=90%	568
$\eta\pi\pi$	(35 $\pm 15$ ) %		479
$a_0(980)\pi$ [ignoring $a_0(980) \rightarrow K\bar{K}$ ]	(52.4 $^{+1.9}_{-2.2}$ ) %	S=1.2	482
$\eta\pi\pi$ [excluding $a_0(980)\pi$ ]	(36 $\pm 7$ ) %		238
$K\bar{K}\pi$	(16 $\pm 7$ ) %		482
	( 9.0 $\pm 0.4$ ) %	S=1.1	308

$K \bar{K}^*(892)$	not seen		†
$\pi^+ \pi^- \pi^0$	$(3.0 \pm 0.9) \times 10^{-3}$		603
$\rho^\pm \pi^\mp$	$< 3.1 \times 10^{-3}$	CL=95%	390
$\gamma \rho^0$	$(5.5 \pm 1.3) \%$	S=2.8	407
$\phi \gamma$	$(7.4 \pm 2.6) \times 10^{-4}$		236

### $\eta(1295)$

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

Mass  $m = 1294 \pm 4$  MeV (S = 1.6)

Full width  $\Gamma = 55 \pm 5$  MeV

$\eta(1295)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\eta \pi^+ \pi^-$	seen	487
$a_0(980) \pi$	seen	248
$\eta \pi^0 \pi^0$	seen	490
$\eta(\pi\pi)_{S\text{-wave}}$	seen	—

### $\pi(1300)$

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

Mass  $m = 1300 \pm 100$  MeV [1]

Full width  $\Gamma = 200$  to 600 MeV

$\pi(1300)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho \pi$	seen	404
$\pi(\pi\pi)_{S\text{-wave}}$	seen	—

### $a_2(1320)$

$$I^G(J^{PC}) = 1^-(2^{++})$$

Mass  $m = 1318.3^{+0.5}_{-0.6}$  MeV (S = 1.2)

Full width  $\Gamma = 107 \pm 5$  MeV [1]

$a_2(1320)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor/ Confidence level	$p$ (MeV/c)
$3\pi$	$(70.1 \pm 2.7) \%$	S=1.2	624
$\eta \pi$	$(14.5 \pm 1.2) \%$		535
$\omega \pi \pi$	$(10.6 \pm 3.2) \%$	S=1.3	366
$K \bar{K}$	$(4.9 \pm 0.8) \%$		437
$\eta'(958) \pi$	$(5.5 \pm 0.9) \times 10^{-3}$		288
$\pi^\pm \gamma$	$(2.91 \pm 0.27) \times 10^{-3}$		652
$\gamma \gamma$	$(9.4 \pm 0.7) \times 10^{-6}$		659
$e^+ e^-$	$< 5 \times 10^{-9}$	CL=90%	659

**$f_0(1370)$**  [*J*]

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

Mass  $m = 1200$  to  $1500$  MeV  
 Full width  $\Gamma = 200$  to  $500$  MeV

<b><math>f_0(1370)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\pi$	seen	672
$4\pi$	seen	617
$4\pi^0$	seen	617
$2\pi^+2\pi^-$	seen	612
$\pi^+\pi^-2\pi^0$	seen	615
$\rho\rho$	dominant	†
$2(\pi\pi)_{S\text{-wave}}$	seen	—
$\pi(1300)\pi$	seen	†
$a_1(1260)\pi$	seen	35
$\eta\eta$	seen	411
$K\bar{K}$	seen	475
$K\bar{K}n\pi$	not seen	†
$6\pi$	not seen	508
$\omega\omega$	not seen	†
$\gamma\gamma$	seen	685
$e^+e^-$	not seen	685

**$\pi_1(1400)$**  [*n*]

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

Mass  $m = 1354 \pm 25$  MeV ( $S = 1.8$ )  
 Full width  $\Gamma = 330 \pm 35$  MeV

<b><math>\pi_1(1400)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\eta\pi^0$	seen	557
$\eta\pi^-$	seen	556

**$\eta(1405)$  [o]**

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

Mass  $m = 1408.8 \pm 1.8$  MeV [1] (S = 2.1)

Full width  $\Gamma = 51.0 \pm 2.9$  MeV [1] (S = 1.8)

$\eta(1405)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$K\bar{K}\pi$	seen		424
$\eta\pi\pi$	seen		562
$a_0(980)\pi$	seen		345
$\eta(\pi\pi)_{S\text{-wave}}$	seen		—
$f_0(980)\eta$	seen		†
$4\pi$	seen		639
$\rho\rho$	<58 %	99.85%	†
$\rho^0\gamma$	seen		491
$K^*(892)K$	seen		123

**$f_1(1420)$  [p]**

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

Mass  $m = 1426.4 \pm 0.9$  MeV (S = 1.1)

Full width  $\Gamma = 54.9 \pm 2.6$  MeV

$f_1(1420)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}\pi$	dominant	438
$K\bar{K}^*(892) + \text{c.c.}$	dominant	163
$\eta\pi\pi$	possibly seen	573
$\phi\gamma$	seen	349

**$\omega(1420)$  [q]**

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

Mass  $m$  (1400–1450) MeV

Full width  $\Gamma$  (180–250) MeV

$\omega(1420)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho\pi$	dominant	486
$\omega\pi\pi$	seen	444
$b_1(1235)\pi$	seen	125
$e^+e^-$	seen	710

**$a_0(1450)$**  [l]

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

Mass  $m = 1474 \pm 19$  MeV

Full width  $\Gamma = 265 \pm 13$  MeV

<b><math>a_0(1450)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\eta$	seen	627
$\pi\eta'(958)$	seen	410
$K\bar{K}$	seen	547
$\omega\pi\pi$	seen	484
$a_0(980)\pi\pi$	seen	342
$\gamma\gamma$	seen	737

**$\rho(1450)$**  [r]

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

Mass  $m = 1465 \pm 25$  MeV [l]

Full width  $\Gamma = 400 \pm 60$  MeV [l]

<b><math>\rho(1450)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\pi$	seen	720
$4\pi$	seen	669
$e^+e^-$	seen	732
$\eta\rho$	seen	311
$a_2(1320)\pi$	not seen	54
$K\bar{K}$	not seen	541
$K\bar{K}^*(892) + \text{c.c.}$	possibly seen	229
$\eta\gamma$	seen	630
$f_0(500)\gamma$	not seen	—
$f_0(980)\gamma$	not seen	398
$f_0(1370)\gamma$	not seen	92
$f_2(1270)\gamma$	not seen	177

**$\eta(1475)$**  [ $0^-$ ]

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

Mass  $m = 1476 \pm 4$  MeV ( $S = 1.3$ )

Full width  $\Gamma = 85 \pm 9$  MeV ( $S = 1.5$ )

<b><math>\eta(1475)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}\pi$	dominant	477
$K\bar{K}^*(892)+$ c.c.	seen	245
$a_0(980)\pi$	seen	396
$\gamma\gamma$	seen	738

**$f_0(1500)$**  [ $0^+$ ]

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

Mass  $m = 1504 \pm 6$  MeV ( $S = 1.3$ )

Full width  $\Gamma = 109 \pm 7$  MeV

<b><math>f_0(1500)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor	$p$ (MeV/c)
$\pi\pi$	(34.9±2.3) %	1.2	740
$\pi^+\pi^-$	seen		739
$2\pi^0$	seen		740
$4\pi$	(49.5±3.3) %	1.2	691
$4\pi^0$	seen		691
$2\pi^+2\pi^-$	seen		686
$2(\pi\pi)_S$ -wave	seen		—
$\rho\rho$	seen		†
$\pi(1300)\pi$	seen		143
$a_1(1260)\pi$	seen		217
$\eta\eta$	( 5.1±0.9) %	1.4	515
$\eta\eta'(958)$	( 1.9±0.8) %	1.7	†
$K\bar{K}$	( 8.6±1.0) %	1.1	568
$\gamma\gamma$	not seen		752

**$f_2'(1525)$** 

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

Mass  $m = 1525 \pm 5$  MeV [1]Full width  $\Gamma = 73_{-5}^{+6}$  MeV [1]

<b><math>f_2'(1525)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}$	(88.7 $\pm$ 2.2 ) %	581
$\eta\eta$	(10.4 $\pm$ 2.2 ) %	530
$\pi\pi$	( 8.2 $\pm$ 1.5 ) $\times 10^{-3}$	750
$\gamma\gamma$	( 1.10 $\pm$ 0.14) $\times 10^{-6}$	763

 **$\pi_1(1600)$  [n]**

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

Mass  $m = 1662_{-9}^{+8}$  MeVFull width  $\Gamma = 241 \pm 40$  MeV (S = 1.4)

<b><math>\pi_1(1600)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi\pi\pi$	not seen	803
$\rho^0\pi^-$	not seen	641
$f_2(1270)\pi^-$	not seen	318
$b_1(1235)\pi$	seen	357
$\eta'(958)\pi^-$	seen	543
$f_1(1285)\pi$	seen	314

 **$\eta_2(1645)$** 

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

Mass  $m = 1617 \pm 5$  MeVFull width  $\Gamma = 181 \pm 11$  MeV

<b><math>\eta_2(1645)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$a_2(1320)\pi$	seen	242
$K\bar{K}\pi$	seen	580
$K^*\bar{K}$	seen	404
$\eta\pi^+\pi^-$	seen	685
$a_0(980)\pi$	seen	499
$f_2(1270)\eta$	not seen	†

**$\omega(1650)$  [s]**

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

Mass  $m = 1670 \pm 30$  MeV

Full width  $\Gamma = 315 \pm 35$  MeV

$\omega(1650)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho\pi$	seen	647
$\omega\pi\pi$	seen	617
$\omega\eta$	seen	500
$e^+e^-$	seen	835

**$\omega_3(1670)$**

$$I^G(J^{PC}) = 0^-(3^--)$$

Mass  $m = 1667 \pm 4$  MeV

Full width  $\Gamma = 168 \pm 10$  MeV [1]

$\omega_3(1670)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\rho\pi$	seen	645
$\omega\pi\pi$	seen	615
$b_1(1235)\pi$	possibly seen	361

**$\pi_2(1670)$**

$$I^G(J^{PC}) = 1^-(2^-+)$$

Mass  $m = 1672.2 \pm 3.0$  MeV [1] ( $S = 1.4$ )

Full width  $\Gamma = 260 \pm 9$  MeV [1] ( $S = 1.2$ )

$\pi_2(1670)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level	$p$ (MeV/c)
$3\pi$	(95.8±1.4) %		809
$f_2(1270)\pi$	(56.3±3.2) %		328
$\rho\pi$	(31 ±4 ) %		648
$\sigma\pi$	(10.9±3.4) %		—
$\pi(\pi\pi)S$ -wave	( 8.7±3.4) %		—
$K\bar{K}^*(892) + c.c.$	( 4.2±1.4) %		455
$\omega\rho$	( 2.7±1.1) %		304
$\pi^\pm\gamma$	( 7.0±1.1) × 10 <sup>-4</sup>		830
$\gamma\gamma$	< 2.8 × 10 <sup>-7</sup>	90%	836
$\rho(1450)\pi$	< 3.6 × 10 <sup>-3</sup>	97.7%	147
$b_1(1235)\pi$	< 1.9 × 10 <sup>-3</sup>	97.7%	365
$f_1(1285)\pi$	possibly seen		323
$a_2(1320)\pi$	not seen		292



**$\phi(1680)$**

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

Mass  $m = 1680 \pm 20$  MeV [1]

Full width  $\Gamma = 150 \pm 50$  MeV [1]

<b><math>\phi(1680)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}^*(892) + \text{c.c.}$	dominant	462
$K_S^0 K \pi$	seen	621
$K\bar{K}$	seen	680
$e^+ e^-$	seen	840
$\omega \pi \pi$	not seen	623
$K^+ K^- \pi^+ \pi^-$	seen	544
$\eta \phi$	seen	290
$\eta \gamma$	seen	751

**$\rho_3(1690)$**

$$J^{PC} = 1^+(3^--)$$

Mass  $m = 1688.8 \pm 2.1$  MeV [1]

Full width  $\Gamma = 161 \pm 10$  MeV [1] (S = 1.5)

<b><math>\rho_3(1690)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	Scale factor	$p$ (MeV/c)
$4\pi$	(71.1 $\pm$ 1.9 ) %		790
$\pi^\pm \pi^+ \pi^- \pi^0$	(67 $\pm$ 22 ) %		787
$\omega \pi$	(16 $\pm$ 6 ) %		655
$\pi \pi$	(23.6 $\pm$ 1.3 ) %		834
$K\bar{K} \pi$	( 3.8 $\pm$ 1.2 ) %		629
$K\bar{K}$	( 1.58 $\pm$ 0.26 ) %	1.2	685
$\eta \pi^+ \pi^-$	seen		727
$\rho(770)\eta$	seen		520
$\pi \pi \rho$	seen		633
Excluding $2\rho$ and $a_2(1320)\pi$ .			
$a_2(1320)\pi$	seen		307
$\rho \rho$	seen		335

**$\rho(1700)$**  [r]

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

Mass  $m = 1720 \pm 20$  MeV [1] ( $\eta\rho^0$  and  $\pi^+\pi^-$  modes)

Full width  $\Gamma = 250 \pm 100$  MeV [1] ( $\eta\rho^0$  and  $\pi^+\pi^-$  modes)

<b><math>\rho(1700)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$2(\pi^+\pi^-)$	large	803
$\rho\pi\pi$	dominant	653
$\rho^0\pi^+\pi^-$	large	651
$\rho^\pm\pi^\mp\pi^0$	large	652
$a_1(1260)\pi$	seen	404
$h_1(1170)\pi$	seen	447
$\pi(1300)\pi$	seen	349
$\rho\rho$	seen	372
$\pi^+\pi^-$	seen	849
$\pi\pi$	seen	849
$K\bar{K}^*(892) + \text{c.c.}$	seen	496
$\eta\rho$	seen	545
$a_2(1320)\pi$	not seen	334
$K\bar{K}$	seen	704
$e^+e^-$	seen	860
$\pi^0\omega$	seen	674

**$f_0(1710)$**  [t]

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

Mass  $m = 1723^{+6}_{-5}$  MeV ( $S = 1.6$ )

Full width  $\Gamma = 139 \pm 8$  MeV ( $S = 1.1$ )

<b><math>f_0(1710)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}$	seen	706
$\eta\eta$	seen	665
$\pi\pi$	seen	851
$\omega\omega$	seen	360

**$\pi(1800)$**

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

Mass  $m = 1812 \pm 12$  MeV (S = 2.3)

Full width  $\Gamma = 208 \pm 12$  MeV

<b><math>\pi(1800)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\pi^+\pi^-\pi^-$	seen	879
$f_0(500)\pi^-$	seen	—
$f_0(980)\pi^-$	seen	625
$f_0(1370)\pi^-$	seen	368
$f_0(1500)\pi^-$	not seen	250
$\rho\pi^-$	not seen	732
$\eta\eta\pi^-$	seen	661
$a_0(980)\eta$	seen	473
$a_2(1320)\eta$	not seen	†
$f_2(1270)\pi$	not seen	442
$f_0(1370)\pi^-$	not seen	368
$f_0(1500)\pi^-$	seen	250
$\eta\eta'(958)\pi^-$	seen	375
$K_0^*(1430)K^-$	seen	†
$K^*(892)K^-$	not seen	570

**$\phi_3(1850)$**

$$I^G(J^{PC}) = 0^-(3^{--})$$

Mass  $m = 1854 \pm 7$  MeV

Full width  $\Gamma = 87^{+28}_{-23}$  MeV (S = 1.2)

<b><math>\phi_3(1850)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}$	seen	785
$K\bar{K}^*(892) + \text{c.c.}$	seen	602

**$\pi_2(1880)$**

$$I^G(J^{PC}) = 1^-(2^-+)$$

Mass  $m = 1895 \pm 16$  MeV

Full width  $\Gamma = 235 \pm 34$  MeV

**$f_2(1950)$** 

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

Mass  $m = 1944 \pm 12$  MeV (S = 1.5)Full width  $\Gamma = 472 \pm 18$  MeV

<b><math>f_2(1950)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K^*(892)\bar{K}^*(892)$	seen	387
$\pi^+\pi^-$	seen	962
$\pi^0\pi^0$	seen	963
$4\pi$	seen	925
$\eta\eta$	seen	803
$K\bar{K}$	seen	837
$\gamma\gamma$	seen	972
$p\bar{p}$	seen	254

 **$f_2(2010)$** 

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

Mass  $m = 2011^{+60}_{-80}$  MeVFull width  $\Gamma = 202 \pm 60$  MeV

<b><math>f_2(2010)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\phi\phi$	seen	†
$K\bar{K}$	seen	876

 **$a_4(2040)$** 

$$I^G(J^{PC}) = 1^-(4^{++})$$

Mass  $m = 1995^{+10}_{-8}$  MeV (S = 1.1)Full width  $\Gamma = 257^{+25}_{-23}$  MeV (S = 1.3)

<b><math>a_4(2040)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$K\bar{K}$	seen	867
$\pi^+\pi^-\pi^0$	seen	973
$\rho\pi$	seen	841
$f_2(1270)\pi$	seen	579
$\omega\pi^-\pi^0$	seen	818
$\omega\rho$	seen	623
$\eta\pi$	seen	917
$\eta'(958)\pi$	seen	760

**$f_4(2050)$** 

$$I^G(J^{PC}) = 0^+(4^{++})$$

Mass  $m = 2018 \pm 11$  MeV (S = 2.1)Full width  $\Gamma = 237 \pm 18$  MeV (S = 1.9)

<b><math>f_4(2050)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\omega\omega$	seen	637
$\pi\pi$	$(17.0 \pm 1.5) \%$	1000
$K\bar{K}$	$(6.8^{+3.4}_{-1.8}) \times 10^{-3}$	880
$\eta\eta$	$(2.1 \pm 0.8) \times 10^{-3}$	848
$4\pi^0$	$< 1.2 \%$	964
$a_2(1320)\pi$	seen	567

 **$\phi(2170)$** 

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

Mass  $m = 2175 \pm 15$  MeV (S = 1.6)Full width  $\Gamma = 61 \pm 18$  MeV

<b><math>\phi(2170)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$e^+e^-$	seen	1087
$\phi f_0(980)$	seen	416
$K^+K^- f_0(980) \rightarrow$ $K^+K^-\pi^+\pi^-$	seen	—
$K^+K^- f_0(980) \rightarrow K^+K^-\pi^0\pi^0$	seen	—
$K^{*0}K^\pm\pi^\mp$	not seen	770
$K^*(892)^0\bar{K}^*(892)^0$	not seen	622

 **$f_2(2300)$** 

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

Mass  $m = 2297 \pm 28$  MeVFull width  $\Gamma = 149 \pm 40$  MeV

<b><math>f_2(2300)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$\phi\phi$	seen	529
$K\bar{K}$	seen	1037
$\gamma\gamma$	seen	1149

**$f_2(2340)$** 

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

$$\text{Mass } m = 2345_{-40}^{+50} \text{ MeV}$$

$$\text{Full width } \Gamma = 322_{-60}^{+70} \text{ MeV}$$

<b><math>f_2(2340)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$\rho$ (MeV/c)
$\phi\phi$	seen	580
$\eta\eta$	seen	1037

## NOTES

- [a] See the “Note on  $\pi^\pm \rightarrow \ell^\pm \nu \gamma$  and  $K^\pm \rightarrow \ell^\pm \nu \gamma$  Form Factors” in the  $\pi^\pm$  Particle Listings for definitions and details.
- [b] Measurements of  $\Gamma(e^+ \nu_e)/\Gamma(\mu^+ \nu_\mu)$  always include decays with  $\gamma$ 's, and measurements of  $\Gamma(e^+ \nu_e \gamma)$  and  $\Gamma(\mu^+ \nu_\mu \gamma)$  never include low-energy  $\gamma$ 's. Therefore, since no clean separation is possible, we consider the modes with  $\gamma$ 's to be subreactions of the modes without them, and let  $[\Gamma(e^+ \nu_e) + \Gamma(\mu^+ \nu_\mu)]/\Gamma_{\text{total}} = 100\%$ .
- [c] See the  $\pi^\pm$  Particle Listings for the energy limits used in this measurement; low-energy  $\gamma$ 's are not included.
- [d] Derived from an analysis of neutrino-oscillation experiments.
- [e] Astrophysical and cosmological arguments give limits of order  $10^{-13}$ ; see the  $\pi^0$  Particle Listings.
- [f]  $C$  parity forbids this to occur as a single-photon process.
- [g] See the “Note on scalar mesons” in the  $f_0(500)$  Particle Listings . The interpretation of this entry as a particle is controversial.
- [h] See the “Note on  $\rho(770)$ ” in the  $\rho(770)$  Particle Listings .
- [i] The  $\omega\rho$  interference is then due to  $\omega\rho$  mixing only, and is expected to be small. If  $e\mu$  universality holds,  $\Gamma(\rho^0 \rightarrow \mu^+ \mu^-) = \Gamma(\rho^0 \rightarrow e^+ e^-) \times 0.99785$ .
- [j] See the “Note on scalar mesons” in the  $f_0(500)$  Particle Listings .
- [k] See the “Note on  $a_1(1260)$ ” in the  $a_1(1260)$  Particle Listings in PDG 06, Journal of Physics **G33** 1 (2006).
- [l] This is only an educated guess; the error given is larger than the error on the average of the published values. See the Particle Listings for details.
- [n] See the “Note on non- $q\bar{q}$  mesons” in the Particle Listings in PDG 06, Journal of Physics **G33** 1 (2006).
- [o] See the “Note on the  $\eta(1405)$ ” in the  $\eta(1405)$  Particle Listings.
- [p] See the “Note on the  $f_1(1420)$ ” in the  $\eta(1405)$  Particle Listings.

[q] See also the  $\omega(1650)$  Particle Listings.

[r] See the “Note on the  $\rho(1450)$  and the  $\rho(1700)$ ” in the  $\rho(1700)$  Particle Listings.

[s] See also the  $\omega(1420)$  Particle Listings.

[t] See the “Note on  $f_0(1710)$ ” in the  $f_0(1710)$  Particle Listings in 2004 edition of *Review of Particle Physics*.