

LIGHT UNFLAVORED MESONS ($S = C = B = 0$)

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

π^\pm

$$I^G(J^P) = 1^-(0^-)$$

Mass $m = 139.57039 \pm 0.00018$ MeV ($S = 1.8$)

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 $a = 0.10 \pm 0.06$

$$R = 0.059^{+0.009}_{-0.008}$$

π^- 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.

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



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

Mass $m = 134.9768 \pm 0.0005$ MeV (S = 1.1)

$m_{\pi^\pm} - m_{\pi^0} = 4.5936 \pm 0.0005$ MeV

Mean life $\tau = (8.43 \pm 0.13) \times 10^{-17}$ s (S = 1.2)

$c\tau = 25.3$ 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.).

π^0 DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)	
2γ	$(98.823 \pm 0.034) \%$	S=1.5	67	
$e^+ e^- \gamma$	$(1.174 \pm 0.035) \%$	S=1.5	67	
γ 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	
4γ	< 2	$\times 10^{-8}$ CL=90%	67	
invisible	< 4.4	$\times 10^{-9}$ CL=90%	—	
$\nu_e \bar{\nu}_e$	< 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	
$\gamma \nu \bar{\nu}$	< 1.9	$\times 10^{-7}$ CL=90%	67	
Charge conjugation (C) or Lepton Family number (LF) violating modes				
3γ	C	< 3.1	$\times 10^{-8}$ CL=90%	67
$\mu^+ e^-$	LF	< 3.8	$\times 10^{-10}$ CL=90%	26
$\mu^- e^+$	LF	< 3.2	$\times 10^{-10}$ CL=90%	26
$\mu^+ e^- + \mu^- e^+$	LF	< 3.6	$\times 10^{-10}$ CL=90%	26



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

Mass $m = 547.862 \pm 0.017$ MeV

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

C-nonconserving decay parameters

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

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

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

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

$\pi^+ \pi^- \gamma$ β (D-wave) = -0.02 ± 0.07 (S = 1.3)

CP-nonconserving decay parameters

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

Other decay parameters

$$\pi^0 \pi^0 \pi^0 \quad \text{Dalitz plot } \alpha = -0.0296 \pm 0.0016 \quad (S = 1.7)$$

$$\text{Parameter } \Lambda \text{ in } \eta \rightarrow \ell^+ \ell^- \gamma \text{ decay} = 0.716 \pm 0.011 \text{ GeV}/c^2$$

η DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
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Neutral modes

neutral modes	(71.96±0.30) %	S=1.3	—
2 γ	(39.36±0.18) %	S=1.1	274
3 π^0	(32.57±0.21) %	S=1.2	179
$\pi^0 2\gamma$	(2.55±0.22) $\times 10^{-4}$		257
2 $\pi^0 2\gamma$	< 1.2 $\times 10^{-3}$	CL=90%	238
4 γ	< 2.8 $\times 10^{-4}$	CL=90%	274
invisible	< 1.0 $\times 10^{-4}$	CL=90%	—

Charged modes

charged modes	(28.04±0.30) %	S=1.3	—
$\pi^+ \pi^- \pi^0$	(23.02±0.25) %	S=1.2	174
$\pi^+ \pi^- \gamma$	(4.28±0.07) %	S=1.1	236
$e^+ e^- \gamma$	(6.9 ±0.4) $\times 10^{-3}$	S=1.2	274
$\mu^+ \mu^- \gamma$	(3.1 ±0.4) $\times 10^{-4}$		253
$e^+ e^-$	< 7 $\times 10^{-7}$	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 $\mu^+ 2\mu^-$	(5.0 ±1.3) $\times 10^{-9}$		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
$\pi^+ \pi^- \pi^0 \gamma$	< 6 $\times 10^{-4}$	CL=90%	174
$\pi^0 \mu^+ \mu^- \gamma$	< 3 $\times 10^{-6}$	CL=90%	210

Charge conjugation (C), Parity (P), Charge conjugation \times Parity (CP), or Lepton Family number (LF) violating modes

$\pi^0 \gamma$	C	[e] < 9 $\times 10^{-5}$	CL=90%	257
$\pi^+ \pi^-$	P,CP	< 4.4 $\times 10^{-6}$	CL=90%	236
2 π^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 γ	C	< 1.6 $\times 10^{-5}$	CL=90%	274
4 π^0	P,CP	< 6.9 $\times 10^{-7}$	CL=90%	40
$\pi^0 e^+ e^-$	C	[f] < 8 $\times 10^{-6}$	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

$f_0(500)$

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

also known as σ ; was $f_0(600)$, $f_0(400-1200)$

See the review on "Scalar Mesons below 1 GeV."

Mass (T-Matrix Pole \sqrt{s}) = (400-550) - i (200-350) MeV

Mass (Breit-Wigner) = 400 to 800 MeV

Full width (Breit-Wigner) = 100 to 800 MeV

$f_0(500)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
$\pi\pi$	seen	-
$\gamma\gamma$	seen	-

$\rho(770)$

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

See the review on "Spectroscopy of Light Meson Resonances."

T-Matrix Pole \sqrt{s} = (761-765) - i (71-74) MeV

ρ^0 mass (Breit-Wigner) = 775.26 ± 0.23 MeV [g]

ρ^0 full width (Breit-Wigner) = 147.4 ± 0.8 MeV [g] (S = 2.0)

$\rho(770)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	ρ (MeV/c)
$\pi\pi$	~ 100	%	363
$\rho(770)^\pm$ decays			
$\pi^\pm \gamma$	(4.5 ± 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 ± 1.6)	$\times 10^{-3}$	362
$\pi^0 \gamma$	(4.7 ± 0.8)	$\times 10^{-4}$ S=1.7	376
$\eta \gamma$	(3.00 ± 0.21)	$\times 10^{-4}$	194
$\pi^0 \pi^0 \gamma$	(4.5 ± 0.8)	$\times 10^{-5}$	363
$\mu^+ \mu^-$	[h] (4.55 ± 0.28)	$\times 10^{-5}$	373
$e^+ e^-$	[h] (4.72 ± 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 ± 0.9)	$\times 10^{-5}$	251
$\pi^+ \pi^- \pi^0 \pi^0$	(1.6 ± 0.8)	$\times 10^{-5}$	257
$\pi^0 e^+ e^-$	< 1.2	$\times 10^{-5}$ CL=90%	376

$\omega(782)$

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

Mass $m = 782.66 \pm 0.13$ MeV ($S = 2.0$)

Full width $\Gamma = 8.68 \pm 0.13$ MeV

$\omega(782)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\pi^+\pi^-\pi^0$	(89.2 ± 0.7) %		327
$\pi^0\gamma$	(8.35±0.27) %	S=2.2	380
$\pi^+\pi^-$	(1.53±0.12) %	S=1.2	366
neutrals (excluding $\pi^0\gamma$)	(7 ⁺⁸ / ₋₄) × 10 ⁻³	S=1.1	–
$\eta\gamma$	(4.5 ± 0.4) × 10 ⁻⁴	S=1.1	200
$\pi^0e^+e^-$	(7.7 ± 0.6) × 10 ⁻⁴		380
$\pi^0\mu^+\mu^-$	(1.34±0.18) × 10 ⁻⁴	S=1.5	349
e^+e^-	(7.38±0.22) × 10 ⁻⁵	S=1.9	391
$\pi^+\pi^-\pi^0\pi^0$	< 2 × 10 ⁻⁴	CL=90%	262
$\pi^+\pi^-\gamma$	< 3.6 × 10 ⁻³	CL=95%	366
$\pi^+\pi^-\pi^+\pi^-$	< 1 × 10 ⁻³	CL=90%	256
$\pi^0\pi^0\gamma$	(6.7 ± 1.1) × 10 ⁻⁵		367
$\eta\pi^0\gamma$	< 3.3 × 10 ⁻⁵	CL=90%	162
$\mu^+\mu^-$	(7.4 ± 1.8) × 10 ⁻⁵		377
3γ	< 1.9 × 10 ⁻⁴	CL=95%	391

Charge conjugation (C) violating modes

$\eta\pi^0$	C	< 2.1 × 10 ⁻⁴	CL=90%	162
$2\pi^0$	C	< 2.2 × 10 ⁻⁴	CL=90%	367
$3\pi^0$	C	< 2.3 × 10 ⁻⁴	CL=90%	330
invisible		< 7 × 10 ⁻⁵	CL=90%	–

$\eta'(958)$

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

Mass $m = 957.78 \pm 0.06$ MeV

Full width $\Gamma = 0.188 \pm 0.006$ MeV

$\eta'(958)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\pi^+\pi^-\eta$	(42.5 ± 0.5) %		232
$\rho^0\gamma$ (including non-resonant $\pi^+\pi^-\gamma$)	(29.5 ± 0.4) %		165
$\pi^0\pi^0\eta$	(22.4 ± 0.5) %		239
$\omega\gamma$	(2.52 ± 0.07) %		159
ωe^+e^-	(2.0 ± 0.4) × 10 ⁻⁴		159
$\gamma\gamma$	(2.307±0.033) %		479
$3\pi^0$	(2.50 ± 0.17) × 10 ⁻³		430

$\mu^+ \mu^- \gamma$	$(1.13 \pm 0.28) \times 10^{-4}$			467
$\pi^+ \pi^- \mu^+ \mu^-$	$(1.9 \pm 0.4) \times 10^{-5}$			401
$\pi^+ \pi^- \pi^0$	$(3.61 \pm 0.17) \times 10^{-3}$			428
$(\pi^+ \pi^- \pi^0)$ S-wave	$(3.8 \pm 0.5) \times 10^{-3}$			428
$\pi^\mp \rho^\pm$	$(7.4 \pm 2.3) \times 10^{-4}$			106
$2(\pi^+ \pi^-)$	$(8.3 \pm 0.9) \times 10^{-5}$			372
$\pi^+ \pi^- 2\pi^0$	$(1.8 \pm 0.4) \times 10^{-4}$			376
$2(\pi^+ \pi^-)$ neutrals	< 1	%	95%	–
$2(\pi^+ \pi^-)\pi^0$	< 1.8	$\times 10^{-3}$	90%	298
$2(\pi^+ \pi^-)2\pi^0$	< 1	%	95%	197
$3(\pi^+ \pi^-)$	< 3.1	$\times 10^{-5}$	90%	189
$K^\pm \pi^\mp$	< 4	$\times 10^{-5}$	90%	334
$\pi^+ \pi^- e^+ e^-$	$(2.42 \pm 0.10) \times 10^{-3}$			458
$\pi^+ e^- \nu_e + \text{c.c.}$	< 2.1	$\times 10^{-4}$	90%	469
$\gamma e^+ e^-$	$(4.91 \pm 0.27) \times 10^{-4}$			479
$\pi^0 \gamma \gamma$	$(3.20 \pm 0.24) \times 10^{-3}$			469
$\pi^0 \gamma \gamma$ (non resonant)	$(6.2 \pm 0.9) \times 10^{-4}$			–
$\eta \gamma \gamma$	< 1.33	$\times 10^{-4}$	90%	322
$4\pi^0$	< 4.94	$\times 10^{-5}$	90%	380
$e^+ e^-$	< 5.6	$\times 10^{-9}$	90%	479
$e^+ e^- e^+ e^-$	$(4.5 \pm 1.1) \times 10^{-6}$			479
invisible	< 6	$\times 10^{-4}$	90%	–

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

$\pi^+ \pi^-$	P, CP	< 1.8	$\times 10^{-5}$	90%	458
$\pi^0 \pi^0$	P, CP	< 4	$\times 10^{-4}$	90%	459
$\pi^0 e^+ e^-$	C [f]	< 1.4	$\times 10^{-3}$	90%	469
$\pi^0 \rho^0$	C	< 4	%	90%	111
$\eta e^+ e^-$	C [f]	< 2.4	$\times 10^{-3}$	90%	322
3γ	C	< 1.0	$\times 10^{-4}$	90%	479
$\mu^+ \mu^- \pi^0$	C [f]	< 6.0	$\times 10^{-5}$	90%	445
$\mu^+ \mu^- \eta$	C [f]	< 1.5	$\times 10^{-5}$	90%	273
$e\mu$	LF	< 4.7	$\times 10^{-4}$	90%	473

$f_0(980)$

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

See the review on "Scalar Mesons below 1 GeV."

T-matrix pole $\sqrt{s} = (980-1010) - i(20-35)$ MeV [i]

Mass (Breit-Wigner) = 990 ± 20 MeV [i]

Full width (Breit-Wigner) = 10 to 100 MeV [i]

$f_0(980)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\pi$	seen	476
$K\bar{K}$	seen	36
$\gamma\gamma$	seen	495

$a_0(980)$

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

See the review on "Scalar Mesons below 1 GeV."

T-matrix pole $\sqrt{s} = (970-1020) - i(30-70)$ MeV [i]

Mass $m = 980 \pm 20$ MeV [i]

Full width $\Gamma = 50$ to 100 MeV [i]

$a_0(980)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta\pi$	seen	319
$K\bar{K}$	seen	†
$\eta'\pi$	seen	†
$\rho\pi$	not seen	137
$\gamma\gamma$	seen	490

$\phi(1020)$

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

Mass $m = 1019.461 \pm 0.016$ MeV

Full width $\Gamma = 4.249 \pm 0.013$ MeV (S = 1.1)

$\phi(1020)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
K^+K^-	(49.1 ± 0.5) %	S=1.3	127
$K_L^0 K_S^0$	(33.9 ± 0.4) %	S=1.2	110
$\rho\pi + \pi^+\pi^-\pi^0$	(15.4 ± 0.4) %	S=1.2	—
$\eta\gamma$	(1.301±0.024) %	S=1.2	363
$\pi^0\gamma$	(1.32 ± 0.05) × 10 ⁻³		501
$\ell^+\ell^-$	—		510
e^+e^-	(2.979±0.033) × 10 ⁻⁴	S=1.2	510
$\mu^+\mu^-$	(2.85 ± 0.22) × 10 ⁻⁴	S=1.2	499
ηe^+e^-	(1.08 ± 0.04) × 10 ⁻⁴		363
$\pi^+\pi^-$	(7.3 ± 1.3) × 10 ⁻⁵		490
$\omega\pi^0$	(4.7 ± 0.5) × 10 ⁻⁵		171
$\omega\gamma$	< 5 %	CL=84%	209
$\rho\gamma$	< 1.2 × 10 ⁻⁵	CL=90%	215
$\pi^+\pi^-\gamma$	(4.1 ± 1.3) × 10 ⁻⁵		490
$f_0(980)\gamma$	(3.22 ± 0.19) × 10 ⁻⁴	S=1.1	29

$\pi^0 \pi^0 \gamma$	$(1.12 \pm 0.06) \times 10^{-4}$	492
$\pi^+ \pi^- \pi^+ \pi^-$	$(3.9 \begin{smallmatrix} +2.8 \\ -2.2 \end{smallmatrix}) \times 10^{-6}$	410
$\pi^+ \pi^+ \pi^- \pi^- \pi^0$	$< 4.6 \times 10^{-6}$ CL=90%	342
$\pi^0 e^+ e^-$	$(1.33 \begin{smallmatrix} +0.07 \\ -0.10 \end{smallmatrix}) \times 10^{-5}$	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
$\eta'(958) \gamma$	$(6.21 \pm 0.20) \times 10^{-5}$	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%	–
invisible	$< 1.7 \times 10^{-4}$ CL=90%	–

Lepton Family number (LF) violating modes

$e^\pm \mu^\mp$	LF	$< 2 \times 10^{-6}$ CL=90%	504
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$h_1(1170)$

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

Mass $m = 1166 \pm 6$ MeV

Full width $\Gamma = 375 \pm 35$ MeV

$h_1(1170)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\rho \pi$	seen	305

$b_1(1235)$

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

Mass $m = 1229.5 \pm 3.2$ MeV (S = 1.6)

Full width $\Gamma = 142 \pm 9$ MeV (S = 1.2)

$b_1(1235)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\omega \pi$	seen		348
[D/S amplitude ratio = 0.277 ± 0.027]			
$\pi^\pm \gamma$	$(1.6 \pm 0.4) \times 10^{-3}$		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

$a_1(1260)$ [j]

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

T-Matrix Pole $\sqrt{s} = (1209^{+13}_{-10}) - i(288^{+45}_{-12})$ MeV

Mass (Breit-Wigner) = 1230 ± 40 MeV [i]

Full width (Breit-Wigner) = 250 to 600 MeV [i]

$a_1(1260)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
3π	seen	577
$(\rho\pi)_{S\text{-wave}}, \rho \rightarrow \pi\pi$	seen	353
$(\rho\pi)_{D\text{-wave}}, \rho \rightarrow \pi\pi$	seen	353
$(\rho(1450)\pi)_{S\text{-wave}}, \rho \rightarrow \pi\pi$	seen	†
$(\rho(1450)\pi)_{D\text{-wave}}, \rho \rightarrow \pi\pi$	seen	†
$f_0(500)\pi, f_0 \rightarrow \pi\pi$	seen	—
$f_0(980)\pi, f_0 \rightarrow \pi\pi$	seen	179
$f_0(1370)\pi, f_0 \rightarrow \pi\pi$	seen	†
$f_2(1270)\pi, f_2 \rightarrow \pi\pi$	seen	†
$\pi^+\pi^-\pi^0$	seen	576
$\pi^0\pi^0\pi^0$	not seen	577
$KK\pi$	seen	250
$K^*(892)K$	seen	†
$\pi\gamma$	seen	608

$f_2(1270)$

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

T-Matrix Pole $\sqrt{s} = (1260-1283) - i(90-110)$ MeV

Mass (Breit-Wigner) = 1275.4 ± 0.8 MeV (S = 1.1)

Full width (Breit-Wigner) = $186.6^{+2.8}_{-2.2}$ MeV (S = 1.5)

$f_2(1270)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	ρ (MeV/c)
$\pi\pi$	$(84.3^{+2.8}_{-1.0})\%$	S=1.2	623
$\pi^+\pi^-\pi^0$	$(7.7^{+1.2}_{-3.1})\%$	S=1.2	563
$K\bar{K}$	$(4.6 \pm 0.4)\%$	S=2.7	404
$2\pi^+2\pi^-$	$(2.8 \pm 0.4)\%$	S=1.2	559
$\eta\eta$	$(4.0 \pm 0.8) \times 10^{-3}$	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
$K^0 K^- \pi^+ + \text{c.c.}$	< 3.4	$\times 10^{-3}$	CL=95%	293
$e^+ e^-$	< 6	$\times 10^{-10}$	CL=90%	638

$f_1(1285)$

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

Mass $m = 1281.8 \pm 0.5$ MeV (S = 1.7)

Full width $\Gamma = 23.0 \pm 1.1$ MeV (S = 1.6)

$f_1(1285)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
4π	$(32.7 \pm 1.8) \%$	S=1.2	568
$\pi^0 \pi^0 \pi^+ \pi^-$	$(21.8 \pm 1.2) \%$	S=1.2	566
$2\pi^+ 2\pi^-$	$(10.9 \pm 0.6) \%$	S=1.2	563
$\rho^0 \pi^+ \pi^-$	$(10.9 \pm 0.6) \%$	S=1.2	336
$\rho^0 \rho^0$	seen		†
$4\pi^0$	$< 7 \times 10^{-4}$	CL=90%	568
$\eta\pi^+ \pi^-$	$(35 \pm 15) \%$		479
$\eta\pi\pi$	$(52.2 \pm 1.9) \%$	S=1.2	482
$a_0(980)\pi$ [ignoring $a_0(980) \rightarrow K\bar{K}$]	$(38 \pm 4) \%$		238
$\eta\pi\pi$ [excluding $a_0(980)\pi$]	$(14 \pm 4) \%$		482
$K\bar{K}\pi$	$(9.0 \pm 0.4) \%$	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
$\gamma\rho^0$	$(6.1 \pm 1.0) \%$	S=1.7	406
$\phi\gamma$	$(7.4 \pm 2.6) \times 10^{-4}$		235
$e^+ e^-$	$< 9.4 \times 10^{-9}$	CL=90%	641

$\eta(1295)$

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

See the review on "Spectroscopy of Light Meson Resonances."

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

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

$\eta(1295)$ DECAY MODES	Fraction (Γ_i/Γ)	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-wave	seen	—
$\sigma\eta$	seen	—

$K \bar{K} \pi$

seen

320

$\pi(1300)$

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

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

Full width $\Gamma = 200$ to 600 MeV [i]

$\pi(1300)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\rho\pi$	seen	404
$\pi(\pi\pi)_{S\text{-wave}}$	seen	–

$a_2(1320)$

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

T-Matrix Pole $\sqrt{s} = (1305-1321) - i(52-58)$ MeV

Mass (Breit-Wigner) = 1318.2 ± 0.6 MeV ($S = 1.2$)

Full width $\Gamma = 107 \pm 5$ MeV

$a_2(1320)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
3π	(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

$f_0(1370)$

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

See the review on "Spectroscopy of Light Meson Resonances."

T-Matrix Pole $\sqrt{s} = (1250-1440) - i(60-300)$ MeV

Mass (Breit-Wigner) = 1200 to 1500 MeV

Full width (Breit-Wigner) = 200 to 500 MeV

$f_0(1370)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\pi$	seen	672
4π	seen	617
$4\pi^0$	seen	617
$2\pi^+2\pi^-$	seen	612
$\pi^+\pi^-2\pi^0$	seen	615
$\rho\rho$	seen	†

$2(\pi\pi)_{S\text{-wave}}$	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	†
6π	not seen	508
$\omega\omega$	not seen	†
$\gamma\gamma$	seen	685
e^+e^-	not seen	685

$\eta(1405)$

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

See the review on "Spectroscopy of Light Meson Resonances." See also $\eta(1475)$.

$$\text{Mass } m = 1408.7^{+2.0}_{-1.2} \text{ MeV} \quad (S = 2.2)$$

$$\text{Full width } \Gamma = 50.3 \pm 2.5 \text{ MeV} \quad (S = 1.6)$$

$\eta(1405)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	$\frac{P}{\text{MeV}/c}$
$K\bar{K}\pi$	seen		424
$\eta\pi\pi$	seen		562
$a_0(980)\pi$	seen		344
$\eta(\pi\pi)_{S\text{-wave}}$	seen		—
$f_0(980)\pi^0 \rightarrow \pi^+\pi^-\pi^0$	not seen		—
$f_0(980)\eta$	seen		†
4π	seen		638
$\rho\rho$	<58 %	99.85%	†
$\rho^0\gamma$	seen		491
$K^*(892)K$	seen		122

$h_1(1415)$

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

$$\text{Mass } m = 1409^{+9}_{-8} \text{ MeV} \quad (S = 1.9)$$

$$\text{Full width } \Gamma = 78 \pm 11 \text{ MeV}$$

$f_1(1420)$

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

See the review on "Spectroscopy of Light Meson Resonances."

$$\text{Mass } m = 1428.4^{+1.5}_{-1.3} \text{ MeV} \quad (S = 1.8)$$

$$\text{Full width } \Gamma = 56.7 \pm 3.3 \text{ MeV} \quad (S = 1.3)$$

f₁(1420) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K \bar{K} \pi$	seen	440
$K \bar{K}^*(892) + \text{c.c.}$	seen	167
$\eta \pi \pi$	possibly seen	574
$\phi \gamma$	seen	350

$\omega(1420)$ [k]	$I^G(J^{PC}) = 0^-(1^- -)$
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Mass $m = 1410 \pm 60$ MeV [i]
 Full width $\Gamma = 290 \pm 190$ MeV [i]

$\omega(1420)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\rho \pi$	seen	480
$\omega \pi \pi$	seen	437
$b_1(1235) \pi$	seen	112
$e^+ e^-$	seen	705

$a_0(1450)$	$I^G(J^{PC}) = 1^-(0^{++})$
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See the review on "Spectroscopy of Light Meson Resonances."
 T-Matrix Pole $\sqrt{s} = (1290-1500) - i(30-140)$ MeV
 Mass (Breit-Wigner) = 1439 ± 34 MeV ($S = 1.8$)
 Full width (Breit-Wigner) = 258 ± 14 MeV

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

$a_0(1450)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi \eta$	0.093 ± 0.020	607
$\pi \eta'(958)$	0.033 ± 0.017	384
$K \bar{K}$	0.082 ± 0.028	523
$\omega \pi \pi$	DEFINED AS 1	458
$a_0(980) \pi \pi$	seen	310
$\gamma \gamma$	seen	719

$\rho(1450)$	$I^G(J^{PC}) = 1^+(1^- -)$
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See the review on "Spectroscopy of Light Meson Resonances."
 Mass $m = 1465 \pm 25$ MeV [i]
 Full width $\Gamma = 400 \pm 60$ MeV [i]

$\rho(1450)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\pi$	seen	720
$\pi^+\pi^-$	seen	719
4π	seen	669
e^+e^-	seen	732
$\eta\rho$	seen	311
$a_2(1320)\pi$	not seen	55
$K\bar{K}$	seen	541
K^+K^-	seen	541
$K\bar{K}^*(892)+\text{c.c.}$	possibly seen	229
$\pi^0\gamma$	seen	726
$\eta\gamma$	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

$\eta(1475)$

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

See the review on "Spectroscopy of Light Meson Resonances." See also $\eta(1405)$.

$$\text{Mass } m = 1476 \pm 4 \text{ MeV} \quad (S = 1.4)$$

$$\text{Full width } \Gamma = 96 \pm 9 \text{ MeV} \quad (S = 1.7)$$

$\eta(1475)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\bar{K}\pi$	seen	477
$K\bar{K}^*(892)+\text{c.c.}$	seen	245
$a_0(980)\pi$	seen	396
$\gamma\gamma$	seen	738
$K_S^0 K_S^0 \eta$	possibly seen	†
$\gamma\phi(1020)$	possibly seen	386

$f_0(1500)$

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

See the review on "Spectroscopy of Light Meson Resonances."

$$\text{T-Matrix Pole } \sqrt{s} = (1430-1530) - i(40-90) \text{ MeV}$$

$$\text{Mass (Breit-Wigner)} = 1522 \pm 25 \text{ MeV}$$

$$\text{Full width (Breit-Wigner)} = 108 \pm 33 \text{ MeV}$$

$f_0(1500)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	p (MeV/c)
$\pi\pi$	(34.5±2.2) %	1.2	749
$\pi^+\pi^-$	seen		748
$2\pi^0$	seen		749
4π	(48.9±3.3) %	1.2	700
$4\pi^0$	seen		700
$2\pi^+2\pi^-$	seen		696
$2(\pi\pi)_{S\text{-wave}}$	seen		—
$\rho\rho$	seen		†
$\pi(1300)\pi$	seen		163
$a_1(1260)\pi$	seen		234
$\eta\eta$	(6.0±0.9) %	1.1	528
$\eta\eta'(958)$	(2.2±0.8) %	1.4	107
$K\bar{K}$	(8.5±1.0) %	1.1	579
$\gamma\gamma$	not seen		761

$f'_2(1525)$

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

Mass $m = 1517.3 \pm 2.4$ MeV (S = 2.8)

Full width $\Gamma = 72^{+7}_{-6}$ MeV

$f'_2(1525)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\bar{K}$	(88.8 ±2.2) %	576
$\eta\eta$	(10.3 ±2.2) %	525
$\pi\pi$	(8.2 ±1.5) × 10 ⁻³	747
$\gamma\gamma$	(1.12±0.15) × 10 ⁻⁶	759

$f_2(1565)$

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

See the review on "Spectroscopy of Light Meson Resonances."

T-Matrix Pole $\sqrt{s} = (1495-1560) - i(40-110)$ MeV

Mass (Breit-Wigner) = 1571 ± 13 MeV

Full width (Breit-Wigner) = 132 ± 23 MeV (S = 1.1)

$f_2(1565)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\pi$	seen	774
$\pi^+\pi^-$	seen	773
$\pi^0\pi^0$	seen	774
$\rho^0\rho^0$	seen	125

$2\pi^+ 2\pi^-$	seen	722
$\eta\eta$	seen	563
$\omega\omega$	seen	64
$K\bar{K}$	seen	611
$\gamma\gamma$	seen	785

$\pi_1(1600)$

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

See the review on "Spectroscopy of Light Meson Resonances."

Mass (T-Matrix Pole \sqrt{s}) = (1480–1680) – i (150–300) MeV

Mass (Breit-Wigner, $\eta\pi$ mode) = 1354 ± 25 MeV (S = 1.8)

Mass (Breit-Wigner, non- $\eta\pi$ mode) = 1645^{+40}_{-17} MeV (S = 1.3)

Full width (Breit-Wigner, $\eta\pi$ mode) = 330 ± 35 MeV

Full width (Breit-Wigner, non- $\eta\pi$ mode) = 370^{+50}_{-60} MeV

$\pi_1(1600)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
$\pi\pi\pi$	seen	795
$\rho^0\pi^-$	seen	631
$f_2(1270)\pi^-$	not seen	304
$b_1(1235)\pi$	seen	343
$\eta'(958)\pi^-$	seen	532
$\eta\pi$	seen	725
$f_1(1285)\pi$	seen	300

$a_1(1640)$

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

Mass $m = 1655 \pm 16$ MeV (S = 1.2)

Full width $\Gamma = 250 \pm 40$ MeV (S = 1.8)

$a_1(1640)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
$\pi\pi\pi$	seen	800
$f_2(1270)\pi$	seen	314
$\sigma\pi$	seen	–
$\rho\pi$ S-wave	seen	638
$\rho\pi$ D-wave	seen	638
$\omega\pi\pi$	seen	607
$f_1(1285)\pi$	seen	309
$a_1(1260)\eta$	not seen	†

$\eta_2(1645)$

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

Mass $m = 1617 \pm 5$ MeV

Full width $\Gamma = 181 \pm 11$ MeV

$\eta_2(1645)$ DECAY MODES	Fraction (Γ_i/Γ)	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	†

$\omega(1650)$ [i]

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

Mass $m = 1670 \pm 30$ MeV [i]

Full width $\Gamma = 315 \pm 35$ MeV [i]

$\omega(1650)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\rho\pi$	seen	647
$\rho(1450)\pi$	seen	145
$\omega\pi\pi$	seen	617
$\omega\eta$	seen	500
e^+e^-	seen	835
$\pi^0\gamma$	not seen	830

$\omega_3(1670)$

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

Mass $m = 1667 \pm 4$ MeV

Full width $\Gamma = 168 \pm 10$ MeV

$\omega_3(1670)$ DECAY MODES	Fraction (Γ_i/Γ)	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 $m = 1670.6^{+2.9}_{-1.2}$ MeV ($S = 1.3$)

Full width $\Gamma = 258^{+8}_{-9}$ MeV ($S = 1.2$)

$\pi_2(1670)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
3π	(95.8±1.4) %		808
$f_2(1270)\pi$	(56.3±3.2) %		327
$\rho\pi$	(31 ±4) %		647
$\sigma\pi$	(10 ±4) %		—
$\pi(\pi\pi)_{S\text{-wave}}$	(8.7±3.4) %		—
$\pi^\pm\pi^+\pi^-$	(53 ±4) %		806
$K\bar{K}^*(892) + \text{c.c.}$	(4.2±1.4) %		453
$\omega\rho$	(2.7±1.1) %		302
$\pi^\pm\gamma$	(7.0±1.2) × 10 ⁻⁴		829
$\gamma\gamma$	< 2.8 × 10 ⁻⁷	90%	835
$\eta\pi$	< 5 %		739
$\pi^\pm 2\pi^+ 2\pi^-$	< 5 %		735
$\rho(1450)\pi$	< 3.6 × 10 ⁻³	97.7%	145
$b_1(1235)\pi$	< 1.9 × 10 ⁻³	97.7%	364
$f_1(1285)\pi$	possibly seen		322
$a_2(1320)\pi$	not seen		291

$\phi(1680)$

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

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

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

$\phi(1680)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\bar{K}^*(892) + \text{c.c.}$	seen	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
$f_2'(1525)\gamma$	not seen	155

$\rho_3(1690)$

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

Mass $m = 1688.8 \pm 2.1$ MeV

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

$\rho_3(1690)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	ρ (MeV/c)
4π	(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
$a_2(1320)\pi$	seen		307
$\rho \rho$	seen		335

$\rho(1700)$

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

See the review on "Spectroscopy of Light Meson Resonances."

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

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

$\rho(1700)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
$2(\pi^+ \pi^-)$	seen	803
$\rho \pi \pi$	seen	653
$\rho^0 \pi^+ \pi^-$	seen	651
$\rho^\pm \pi^\mp \pi^0$	seen	652
$a_1(1260)\pi$	seen	404
$h_1(1170)\pi$	seen	450
$\pi(1300)\pi$	seen	349
$\rho \rho$	seen	372
$\pi^+ \pi^-$	seen	849
$\pi \pi$	seen	849
$K \bar{K}^*(892) + c.c.$	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
$\pi^0 \gamma$	not seen	855
$f_0(1500)\gamma$	not seen	187

$a_2(1700)$

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

T-Matrix Pole $\sqrt{s} = (1630-1780) - i(60-250)$ MeV

Mass $m = 1706 \pm 14$ MeV (S = 1.2)

Full width $\Gamma = 380^{+60}_{-50}$ MeV (S = 3.9)

$a_2(1700)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta\pi$	(2.5±0.6) %	758
$\eta'\pi$	seen	574
$\gamma\gamma$	(7.9±1.7) × 10 ⁻⁷	853
$\rho\pi$	seen	669
$f_2(1270)\pi$	seen	357
$K\bar{K}$	(1.3±0.8) %	695
$\omega\pi^-\pi^0$	seen	639
$\omega\rho$	seen	347

$f_0(1710)$

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

See the review on "Spectroscopy of Light Meson Resonances."

T-matrix pole $\sqrt{s} = (1680-1820) - i(50-180)$ MeV

Mass (Breit-Wigner) = 1733⁺⁸₋₇ MeV (S = 1.5)

Full width (Breit-Wigner) = 150⁺¹²₋₁₀ MeV (S = 1.3)

$f_0(1710)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\bar{K}$	seen	712
$\eta\eta$	seen	671
$\eta\eta'$	not seen	417
$\pi\pi$	seen	856
$\gamma\gamma$	seen	866
$\omega\omega$	seen	372

$\pi(1800)$

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

See the review on "Spectroscopy of Light Meson Resonances."

Mass $m = 1810^{+9}_{-11}$ MeV (S = 2.2)

Full width $\Gamma = 215^{+7}_{-8}$ MeV

$\pi(1800)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi^+ \pi^- \pi^-$	seen	878
$f_0(500)\pi^-$	seen	—
$f_0(980)\pi^-$	seen	624
$f_0(1370)\pi^-$	seen	366
$f_0(1500)\pi^-$	not seen	232
$\rho\pi^-$	not seen	731
$\eta\eta\pi^-$	seen	660
$a_0(980)\eta$	seen	471
$a_2(1320)\eta$	not seen	†
$f_2(1270)\pi$	not seen	441
$f_0(1370)\pi^-$	not seen	366
$f_0(1500)\pi^-$	seen	232
$\eta\eta'(958)\pi^-$	seen	373
$K_0^*(1430)K^-$	seen	†
$K^*(892)K^-$	not seen	568

$\phi_3(1850)$

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

Mass $m = 1854 \pm 7$ MeV

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

$\phi_3(1850)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\bar{K}$	seen	785
$K\bar{K}^*(892) + \text{c.c.}$	seen	602

$\eta_2(1870)$

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

Mass $m = 1842 \pm 8$ MeV

Full width $\Gamma = 225 \pm 14$ MeV

$\eta_2(1870)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta\pi\pi$	seen	816
$a_2(1320)\pi$	seen	434
$f_2(1270)\eta$	seen	119
$a_0(980)\pi$	seen	651
$\gamma\gamma$	seen	921

$\pi_2(1880)$

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

$$\text{Mass } m = 1874^{+26}_{-5} \text{ MeV} \quad (S = 1.6)$$

$$\text{Full width } \Gamma = 237^{+33}_{-30} \text{ MeV} \quad (S = 1.2)$$

$\pi_2(1880)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta\eta\pi^-$	seen	702
$a_0(980)\eta$	seen	528
$a_2(1320)\eta$	seen	76
$f_0(1500)\pi$	seen	294
$f_1(1285)\pi$	seen	485
$\omega\pi^-\pi^0$	seen	744

 $f_2(1950)$

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

$$\text{T-Matrix Pole } \sqrt{s} = (1830-2020) - i(110-220) \text{ MeV}$$

$$\text{Mass (Breit-Wigner)} = 1936 \pm 12 \text{ MeV} \quad (S = 1.3)$$

$$\text{Full width (Breit-Wigner)} = 464 \pm 24 \text{ MeV}$$

$f_2(1950)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K^*(892)\bar{K}^*(892)$	seen	377
$\pi^+\pi^-$	seen	958
$\pi^0\pi^0$	seen	959
4π	seen	921
$\eta\eta$	seen	798
$K\bar{K}$	seen	833
$\gamma\gamma$	seen	968
$p\bar{p}$	seen	238

 $a_4(1970)$

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

$$\text{Mass } m = 1967 \pm 16 \text{ MeV} \quad (S = 2.1)$$

$$\text{Full width } \Gamma = 324^{+15}_{-18} \text{ MeV}$$

$a_4(1970)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\bar{K}$	seen	851
$\pi^+\pi^-\pi^0$	seen	959
$\rho\pi$	seen	825
$f_2(1270)\pi$	seen	559

$\omega \pi^- \pi^0$	seen	801
$\omega \rho$	seen	601
$\eta \pi$	seen	902
$\eta'(958) \pi$	seen	743

$f_2(2010)$

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

Mass $m = 2010_{-80}^{+60}$ MeV

Full width $\Gamma = 200 \pm 60$ MeV

$f_2(2010)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\phi \phi$	seen	†
$K \bar{K}$	seen	876

$f_0(2020)$

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

T-Matrix Pole $\sqrt{s} = (1870-2080) - i(120-240)$ MeV

Mass (Breit-Wigner) = $1982_{-3.0}^{+54.1}$ MeV

Full width (Breit-Wigner) = 440 ± 50 MeV

$f_0(2020)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\rho \pi \pi$	seen	814
$\pi^0 \pi^0$	seen	982
$\rho \rho$	seen	617
$\omega \omega$	seen	608
$\eta \eta$	seen	826
$\eta' \eta'$	seen	254

$f_4(2050)$

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

Mass $m = 2018 \pm 11$ MeV ($S = 2.1$)

Full width $\Gamma = 237 \pm 18$ MeV ($S = 1.9$)

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

$\gamma\gamma$	seen	1009
$a_2(1320)\pi$	seen	567

$\phi(2170)$

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

Mass $m = 2164 \pm 6$ MeV
 Full width $\Gamma = 106^{+24}_{-18}$ MeV ($S = 2.0$)

$\phi(2170)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
e^+e^-	seen	1082
$\phi\eta$	seen	728
$\omega\eta$	seen	848
$\phi\eta'$	seen	440
$\phi\pi\pi$	seen	815
$\phi f_0(980)$	seen	402
$K^+K^-f_0(980) \rightarrow$	seen	—
$K^+K^-\pi^+\pi^-$		
$K^+K^-f_0(980) \rightarrow K^+K^-\pi^0\pi^0$	seen	—
$K^{*0}K^\pm\pi^\mp$	not seen	762
$K^*(892)^0\bar{K}^*(892)^0$	not seen	613

$f_2(2300)$

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

Mass $m = 2297 \pm 28$ MeV
 Full width $\Gamma = 150 \pm 40$ MeV

$f_2(2300)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\phi\phi$	seen	529
$K\bar{K}$	seen	1037
$\gamma\gamma$	seen	1149
$\Lambda\bar{\Lambda}$	seen	273

$f_2(2340)$

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

Mass $m = 2346^{+21}_{-10}$ MeV
 Full width $\Gamma = 331^{+27}_{-18}$ MeV

$f_2(2340)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\phi\phi$	seen	580
$\eta\eta$	seen	1037
$\eta'\eta'$	seen	677

NOTES

- [a] See the review on “Form Factors for Radiative Pion and Kaon Decays” for definitions and details.
- [b] Measurements of $\Gamma(e^+ \nu_e)/\Gamma(\mu^+ \nu_\mu)$ always include decays with γ 's, and measurements of $\Gamma(e^+ \nu_e \gamma)$ and $\Gamma(\mu^+ \nu_\mu \gamma)$ never include low-energy γ 's. Therefore, since no clean separation is possible, we consider the modes with γ '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 π^\pm Particle Listings for the energy limits used in this measurement; low-energy γ 's are not included.
- [d] Derived from an analysis of neutrino-oscillation experiments.
- [e] Forbidden by angular momentum conservation.
- [f] C parity forbids this to occur as a single-photon process.
- [g] As measured in $e^+ e^- \rightarrow \rho^0$.
- [h] The $\omega\rho$ interference is then due to $\omega\rho$ mixing only, and is expected to be small. If $e\mu$ universality holds, $\Gamma(\rho^0 \rightarrow \mu^+ \mu^-) = \Gamma(\rho^0 \rightarrow e^+ e^-) \times 0.99785$.
- [i] Our estimate. See the Particle Listings for details.
- [j] See the “Note on $a_1(1260)$ ” in the $a_1(1260)$ Particle Listings in PDG 06, Journal of Physics **G33** 1 (2006).
- [k] See also the $\omega(1650)$.
- [l] See also the $\omega(1420)$.