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

For $I = 1$ (π, b, ρ, a): $u\overline{d}$, $(u\overline{u}-d\overline{d})/\sqrt{2}$, $d\overline{u}$;
for $I = 0$ (η, η', h, h', ω, ϕ, f, f'): $c_1(u\overline{u} + d\overline{d}) + c_2(s\overline{s})$

$\pi^{\pm}$

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

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

$\pi^{\pm} \to \ell^{\pm}\nu\gamma$ form factors [a]

$F_V = 0.017 \pm 0.008$
$F_A = 0.0115 \pm 0.0005$ (S = 1.2)
$R = 0.059^{+0.009}_{-0.008}$

π^- modes are charge conjugates of the modes below.

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

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]	(1.61 ±0.23) × 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
$e^+\nu_e\nu\overline{\nu}$		< 5 × 10^{-6}	90%	70
Lepton Family number (LF) or Lepton number (L) violating modes				
$\mu^+\overline{\nu}_e$	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

π^0

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

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 $\tau = (8.4 \pm 0.6) \times 10^{-17}$ s (S = 3.0)
$c\tau = 25.1$ 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		(98.798±0.032) %	S=1.1	67
$e^+e^-\gamma$		(1.198±0.032) %	S=1.1	67
γ positronium		(1.82 ±0.29) × 10^{-9}		67
$e^+e^+e^-e^-$		(3.14 ±0.30) × 10^{-5}		67
e^+e^-		(6.46 ±0.33) × 10^{-8}		67
4γ		< 2 × 10^{-8}	CL=90%	67
$\nu\overline{\nu}$	[e]	< 2.7 × 10^{-7}	CL=90%	67
$\nu_e\overline{\nu}_e$		< 1.7 × 10^{-6}	CL=90%	67
$\nu_\mu\overline{\nu}_\mu$		< 1.6 × 10^{-6}	CL=90%	67
$\nu_\tau\overline{\nu}_\tau$		< 2.1 × 10^{-6}	CL=90%	67
$\gamma\nu\overline{\nu}$		< 6 × 10^{-4}	CL=90%	67
Charge conjugation (C) or Lepton Family number (LF) violating modes				
3γ	C	< 3.1 × 10^{-8}	CL=90%	67
μ^+e^-	LF	< 3.8 × 10^{-10}	CL=90%	26
μ^-e^+	LF	< 3.4 × 10^{-9}	CL=90%	26
$\mu^+e^- + \mu^-e^+$	LF	< 1.72 × 10^{-8}	CL=90%	26

η

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

Mass $m = 547.853 \pm 0.024$ MeV [f]
Full width $\Gamma = 1.30 \pm 0.07$ keV [g]

C-nonconserving decay parameters

$\pi^+\pi^-\pi^0$	Left-right asymmetry	$= (0.09 \pm 0.17) \times 10^{-2}$
$\pi^+\pi^-\pi^0$	Sextant asymmetry	$= (0.18 \pm 0.16) \times 10^{-2}$
$\pi^+\pi^-\pi^0$	Quadrant asymmetry	$= (-0.17 \pm 0.17) \times 10^{-2}$
$\pi^+\pi^-\gamma$	Left-right asymmetry	$= (0.9 \pm 0.4) \times 10^{-2}$
$\pi^+\pi^-\gamma$	β (D-wave)	$= -0.02 \pm 0.07$ (S = 1.3)

Dalitz plot parameter

$\pi^0\pi^0\pi^0$	$\alpha = -0.031 \pm 0.004$

η DECAY MODES		Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
Neutral modes				
neutral modes		(71.91±0.34) %	S=1.2	–
2γ	[g]	(39.31±0.20) %	S=1.1	274
$3\pi^0$		(32.56±0.23) %	S=1.1	179
$\pi^0 2\gamma$		(4.4 ±1.5) $\times 10^{-4}$	S=2.0	257
$\pi^0\pi^0\gamma\gamma$		$< 1.2 \times 10^{-3}$	CL=90%	238
4γ		$< 2.8 \times 10^{-4}$	CL=90%	274
invisible		$< 6 \times 10^{-4}$	CL=90%	–
Charged modes				
charged modes		(28.06±0.34) %	S=1.2	–
$\pi^+\pi^-\pi^0$		(22.73±0.28) %	S=1.2	174
$\pi^+\pi^-\gamma$		(4.60±0.16) %	S=2.1	236
$e^+e^-\gamma$		(6.8 ±0.8) $\times 10^{-3}$	S=1.7	274
$\mu^+\mu^-\gamma$		(3.1 ±0.4) $\times 10^{-4}$		253
e^+e^-		$< 7.7 \times 10^{-5}$	CL=90%	274
$\mu^+\mu^-$		(5.8 ±0.8) $\times 10^{-6}$		253
$e^+e^-e^+e^-$		$< 6.9 \times 10^{-5}$	CL=90%	274
$\pi^+\pi^-e^+e^-$		(4.2 ±1.2) $\times 10^{-4}$		235
$\pi^+\pi^-2\gamma$		$< 2.0 \times 10^{-3}$		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
Charge conjugation (C), Parity (P), Charge conjugation × Parity (CP), or Lepton Family number (LF) violating modes				
$\pi^0\gamma$	C	$< 9 \times 10^{-5}$	CL=90%	257
$\pi^+\pi^-$	P,CP	$< 1.3 \times 10^{-5}$	CL=90%	236
$\pi^0\pi^0$	P,CP	$< 3.5 \times 10^{-4}$	CL=90%	238
$\pi^0\pi^0\gamma$	C	$< 5 \times 10^{-4}$	CL=90%	238
$\pi^0\pi^0\pi^0\gamma$	C	$< 6 \times 10^{-5}$	CL=90%	179
3γ	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 [h]	$< 4 \times 10^{-5}$	CL=90%	257
$\pi^0\mu^+\mu^-$	C [h]	$< 5 \times 10^{-6}$	CL=90%	210
$\mu^+e^- + \mu^-e^+$	LF	$< 6 \times 10^{-6}$	CL=90%	264

$f_0(600)$ [i] or σ

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

Mass m = (400–1200) MeV
Full width Γ = (600–1000) MeV

$f_0(600)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\pi$	dominant	–
$\gamma\gamma$	seen	–

$\rho(770)$ [j]

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

Mass $m = 775.49 \pm 0.34$ MeV
Full width $\Gamma = 149.4 \pm 1.0$ MeV
$\Gamma_{ee} = 7.04 \pm 0.06$ keV

$\rho(770)$ DECAY MODES		Fraction (Γ_i/Γ)		Scale factor/ Confidence level	p (MeV/c)
$\pi\pi$		$\sim$ 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%	153
$\pi^\pm\pi^+\pi^-\pi^0$		$<$ 2.0	$\times 10^{-3}$	CL=84%	254
$\rho(770)^0$ decays					
$\pi^+\pi^-\gamma$		(9.9 ±1.6)	$\times 10^{-3}$		362
$\pi^0\gamma$		(6.0 ±0.8)	$\times 10^{-4}$		376
$\eta\gamma$		(3.00±0.21)	$\times 10^{-4}$		194
$\pi^0\pi^0\gamma$		(4.5 ±0.8)	$\times 10^{-5}$		363
$\mu^+\mu^-$	[k]	(4.55±0.28)	$\times 10^{-5}$		373
e^+e^-	[k]	(4.71±0.05)	$\times 10^{-5}$		388
$\pi^+\pi^-\pi^0$		($1.01^{+0.54}_{-0.36}\pm0.34$)	$\times 10^{-4}$		323
$\pi^+\pi^-\pi^+\pi^-$		(1.8 ±0.9)	$\times 10^{-5}$		251
$\pi^+\pi^-\pi^0\pi^0$		$<$ 4	$\times 10^{-5}$	CL=90%	257

$\omega(782)$

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

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

ω(782) DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\pi^+\pi^-\pi^0$	(89.2 ±0.7) %		327
$\pi^0\gamma$	(8.92±0.24) %	S=1.1	380
$\pi^+\pi^-$	($1.53^{+0.11}_{-0.13}$) %	S=1.2	366
neutrals (excluding $\pi^0\gamma$)	($1.5\ ^{+7.4}_{-1.0}$) × 10^{-3}		–
$\eta\gamma$	(4.6 ±0.4) × 10^{-4}	S=1.1	200
$\pi^0 e^+ e^-$	(7.7 ±0.9) × 10^{-4}	S=1.1	380
$\pi^0\mu^+\mu^-$	(9.6 ±2.3) × 10^{-5}		349
e^+e^-	(7.16±0.12) × 10^{-5}	S=1.1	391
$\pi^+\pi^-\pi^0\pi^0$	< 2 %	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
$\mu^+\mu^-$	(9.0 ±3.1) × 10^{-5}		377
3γ	< 1.9 × 10^{-4}	CL=95%	391
Charge conjugation (C) violating modes			
$\eta\pi^0$ C	< 1 × 10^{-3}	CL=90%	162
$3\pi^0$ C	< 3 × 10^{-4}	CL=90%	330

$\eta'(958)$

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

Mass $m = 957.66 \pm 0.24$ MeV
Full width $\Gamma = 0.205 \pm 0.015$ MeV (S = 1.2)
c C-violating decay parameter $= 0.015 \pm 0.018$

$\eta'(958)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\pi^+\pi^-\eta$	(44.6 ±1.4) %	S=1.2	232
$\rho^0\gamma$(including non-resonant $\pi^+\ \pi^-\ \gamma$)	(29.4 ±0.9) %	S=1.1	165
$\pi^0\pi^0\eta$	(20.7 ±1.2) %	S=1.2	238
$\omega\gamma$	(3.02±0.31) %		159
$\gamma\gamma$	(2.10±0.12) %	S=1.2	479
$3\pi^0$	(1.54±0.26) $\times 10^{-3}$		430
$\mu^+\mu^-\gamma$	(1.03±0.26) $\times 10^{-4}$		467
$\pi^+\pi^-\pi^0$	$<$ 5 %	CL=90%	427
$\pi^0\rho^0$	$<$ 4 %	CL=90%	110
$\pi^+\pi^+\pi^-\pi^-$	$<$ 1 %	CL=90%	372
$\pi^+\pi^+\pi^-\pi^-$ neutrals	$<$ 1 %	CL=95%	–
$\pi^+\pi^+\pi^-\pi^-\pi^0$	$<$ 1 %	CL=90%	298
6π	$<$ 1 %	CL=90%	211
$\pi^+\pi^-e^+e^-$	$<$ 6 $\times 10^{-3}$	CL=90%	458
γe^+e^-	$<$ 9 $\times 10^{-4}$	CL=90%	479
$\pi^0\gamma\gamma$	$<$ 8 $\times 10^{-4}$	CL=90%	469
$4\pi^0$	$<$ 5 $\times 10^{-4}$	CL=90%	379
e^+e^-	$<$ 2.1 $\times 10^{-7}$	CL=90%	479
invisible	$<$ 1.4 $\times 10^{-3}$	CL=90%	–

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

$\pi^+\pi^-$	P,CP	$<$ 2.9	$\times 10^{-3}$	CL=90%	458
$\pi^0\pi^0$	P,CP	$<$ 9	$\times 10^{-4}$	CL=90%	459
$\pi^0e^+e^-$	C	[h] $<$ 1.4	$\times 10^{-3}$	CL=90%	469
ηe^+e^-	C	[h] $<$ 2.4	$\times 10^{-3}$	CL=90%	322
3γ	C	$<$ 1.0	$\times 10^{-4}$	CL=90%	479
$\mu^+\mu^-\pi^0$	C	[h] $<$ 6.0	$\times 10^{-5}$	CL=90%	445
$\mu^+\mu^-\eta$	C	[h] $<$ 1.5	$\times 10^{-5}$	CL=90%	273
$e\mu$	LF	$<$ 4.7	$\times 10^{-4}$	CL=90%	473

$f_0(980)$ [l]

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

Mass $m = 980 \pm 10$ MeV
Full width $\Gamma = 40$ to 100 MeV

$f_0(980)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\pi$	dominant	471
$K\overline{K}$	seen	†
$\gamma\gamma$	seen	490

$a_0(980)$ [*l*]

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

Mass $m = 984.7 \pm 1.2$ MeV (S = 1.5)
Full width $\Gamma = 50$ to 100 MeV

$a_0(980)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta\pi$	dominant	322
$K\overline{K}$	seen	†
$\gamma\gamma$	seen	492

$\phi(1020)$

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

Mass $m = 1019.455 \pm 0.020$ MeV (S = 1.1)
Full width $\Gamma = 4.26 \pm 0.04$ MeV (S = 1.4)

$\phi(1020)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
K^+K^-	(49.2 ±0.6) %	S=1.2	127
$K^0_L K^0_S$	(34.0 ±0.5) %	S=1.1	110
$\rho\pi + \pi^+\pi^-\pi^0$	(15.25 ±0.35) %	S=1.1	–
$\eta\gamma$	(1.304±0.025) %	S=1.1	363
$\pi^0\gamma$	(1.26 ±0.06) $\times 10^{-3}$		501
e^+e^-	(2.97 ±0.04) $\times 10^{-4}$	S=1.1	510
$\mu^+\mu^-$	(2.86 ±0.19) $\times 10^{-4}$		499
ηe^+e^-	(1.15 ±0.10) $\times 10^{-4}$		363
$\pi^+\pi^-$	(7.3 ±1.3) $\times 10^{-5}$		490
$\omega\pi^0$	(5.2 $^{+1.3}_{-1.1}$) $\times 10^{-5}$		171
$\omega\gamma$	< 5 %	CL=84%	209
$\rho\gamma$	< 1.2 $\times 10^{-5}$	CL=90%	215
$\pi^+\pi^-\gamma$	(4.1 ±1.3) $\times 10^{-5}$		490
$f_0(980)\gamma$	(3.22 ±0.19) $\times 10^{-4}$	S=1.1	39
$\pi^0\pi^0\gamma$	(1.07 ±0.06) $\times 10^{-4}$		492
$\pi^+\pi^-\pi^+\pi^-$	(3.9 $^{+2.8}_{-2.2}$) $\times 10^{-6}$		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
$\pi^0 \eta \gamma$	$(\ 8.3\ \pm 0.5\ ) \times 10^{-5}$		346
$a_0(980)\gamma$	$(\ 7.6\ \pm 0.6\ ) \times 10^{-5}$		34
$\eta'(958)\gamma$	$(\ 6.23\ \pm 0.21\ ) \times 10^{-5}$		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
$\rho \gamma \gamma$	$< 5 \times 10^{-4}$	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

$h_1(1170)$

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

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

$h_1(1170)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\rho \pi$	seen	307

$b_1(1235)$

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

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

$b_1(1235)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\omega \pi$	dominant		348
[D/S amplitude ratio $= 0.277 \pm 0.027$]			
$\pi^\pm \gamma$	$(\ 1.6 \pm 0.4) \times 10^{-3}$		607
$\eta \rho$	seen		†
$\pi^+ \pi^+ \pi^- \pi^0$	< 50 %	84%	535
$(K\overline{K})^\pm \pi^0$	< 8 %	90%	248
$K^0_S K^0_L \pi^\pm$	< 6 %	90%	235
$K^0_S K^0_S \pi^\pm$	< 2 %	90%	235
$\phi \pi$	< 1.5 %	84%	147

$a_1(1260)$ [m]

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

Mass $m = 1230 \pm 40$ MeV [n]
Full width $\Gamma = 250$ to 600 MeV

$a_1(1260)$ DECAY MODES	Fraction (Γ_i/Γ)	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	189
$f_0(1370)\pi$	seen	†
$f_2(1270)\pi$	seen	†
$K\overline{K}^*(892)+$ c.c.	seen	†
$\pi\gamma$	seen	608

$f_2(1270)$

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

Mass $m = 1275.1 \pm 1.2$ MeV (S = 1.1)
Full width $\Gamma = 185.0^{+2.9}_{-2.4}$ MeV (S = 1.5)

$f_2(1270)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\pi\pi$	$(84.8\ ^{+2.4}_{-1.2})$ %	S=1.2	623
$\pi^+\pi^-2\pi^0$	$(7.1\ ^{+1.4}_{-2.7})$ %	S=1.3	562
$K\overline{K}$	(4.6 ± 0.4) %	S=2.7	403
$2\pi^+2\pi^-$	(2.8 ± 0.4) %	S=1.2	559
$\eta\eta$	$(4.0 \pm 0.8) \times 10^{-3}$	S=2.1	326
$4\pi^0$	$(3.0 \pm 1.0) \times 10^{-3}$		564
$\gamma\gamma$	$(1.41 \pm 0.13) \times 10^{-5}$		638
$\eta\pi\pi$	$< 8 \times 10^{-3}$	CL=95%	477
$K^0K^-\pi^+ +$ 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 $m = 1281.8 \pm 0.6$ MeV (S = 1.6)
Full width $\Gamma = 24.3 \pm 1.1$ MeV (S = 1.4)

$f_1(1285)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
4π	$(33.1^{+\ 2.1}_{-\ 1.8})$ %	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
$\rho^0\rho^0$	seen		†
$4\pi^0$	$< 7 \times 10^{-4}$	CL=90%	568
$\eta\pi\pi$	(52 ± 16) %		482
$a_0(980)\pi$ [ignoring $a_0(980) \to K\overline{K}$]	(36 ± 7) %		234
$\eta\pi\pi$ [excluding $a_0(980)\pi$]	(16 ± 7) %		482
$K\overline{K}\pi$	(9.0 ± 0.4) %	S=1.1	308
$K\overline{K}^*(892)$	not seen		†
$\gamma\rho^0$	(5.5 ± 1.3) %	S=2.8	406
$\phi\gamma$	$(7.4 \pm 2.6) \times 10^{-4}$		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 (Γ_i/Γ)	p (MeV/c)
$\eta\pi^+\pi^-$	seen	487
$a_0(980)\pi$	seen	244
$\eta\pi^0\pi^0$	seen	490
$\eta(\pi\pi)_{S\text{-wave}}$	seen	–

$\pi(1300)$

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

Mass $m = 1300 \pm 100$ MeV [n]
Full width $\Gamma = 200$ to 600 MeV

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

$a_2(1320)$

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

Mass $m = 1318.3 \pm 0.6$ MeV (S = 1.2)
Full width $\Gamma = 107 \pm 5$ MeV [n]

$a_2(1320)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
3π	(70.1 ±2.7) %	S=1.2	624
$\eta\pi$	(14.5 ±1.2) %		535
$\omega\pi\pi$	(10.6 ±3.2) %	S=1.3	366
$K\overline{K}$	(4.9 ±0.8) %		437
$\eta'(958)\pi$	(5.3 ±0.9) $\times 10^{-3}$		288
$\pi^\pm\gamma$	(2.68±0.31) $\times 10^{-3}$		652
$\gamma\gamma$	(9.4 ±0.7) $\times 10^{-6}$		659
e^+e^-	< 6 $\times 10^{-9}$	CL=90%	659

$f_0(1370)$ [l]

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

Mass $m = 1200$ to 1500 MeV
Full width $\Gamma = 200$ 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
$\rho\rho$	dominant	†
$2(\pi\pi)_{S\text{-wave}}$	seen	–
$\pi(1300)\pi$	seen	†
$a_1(1260)\pi$	seen	35
$\eta\eta$	seen	411
$K\overline{K}$	seen	475
$K\overline{K}n\pi$	not seen	†
6π	not seen	508

$\omega\omega$	not seen	†
$\gamma\gamma$	seen	685
e^+e^-	not seen	685

$\pi_1(1400)$ [o]

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

Mass $m = 1351 \pm 30$ MeV (S = 2.0)
Full width $\Gamma = 313 \pm 40$ MeV

$\pi_1(1400)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta\pi^0$	seen	555
$\eta\pi^-$	seen	554

$\eta(1405)$ [p]

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

Mass $m = 1409.8 \pm 2.5$ MeV [n] (S = 2.2)
Full width $\Gamma = 51.1 \pm 3.4$ MeV [n] (S = 2.0)

$\eta(1405)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$K\overline{K}\pi$	seen		425
$\eta\pi\pi$	seen		563
$a_0(980)\pi$	seen		342
$\eta(\pi\pi)_{S\text{-wave}}$	seen		–
$f_0(980)\eta$	seen		†
4π	seen		639
$\rho\rho$	<58 %	99.85%	†
$K^*(892)K$	seen		125

$f_1(1420)$ [q]

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

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 (Γ_i/Γ)	p (MeV/c)
$K\overline{K}\pi$	dominant	438
$K\overline{K}^*(892)+$ c.c.	dominant	163
$\eta\pi\pi$	possibly seen	573
$\phi\gamma$	seen	349

$\omega(1420)$ [r]

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

Mass m (1400–1450) MeV
Full width Γ (180–250) MeV

$\omega(1420)$ DECAY MODES	Fraction (Γ_i/Γ)	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

$a_0(1450)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\eta$	seen	627
$\pi\eta'(958)$	seen	411
$K\overline{K}$	seen	547
$\omega\pi\pi$	seen	484

$\rho(1450)$ [s]

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

Mass $m = 1465 \pm 25$ MeV [n]
Full width $\Gamma = 400 \pm 60$ MeV [n]

$\rho(1450)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\pi$	seen	720
4π	seen	669
e^+e^-	seen	732
$\eta\rho$	possibly seen	310
$a_2(1320)\pi$	not seen	55
$K\overline{K}$	not seen	541
$K\overline{K}^*(892)+$ c.c.	possibly seen	229
$\eta\gamma$	possibly seen	630

$\eta(1475)$ [p]

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

Mass $m = 1476 \pm 4$ MeV (S = 1.3)
Full width $\Gamma = 85 \pm 9$ MeV (S = 1.5)

$\eta(1475)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\overline{K}\pi$	dominant	477
$K\overline{K}^*(892)+$ c.c.	seen	245
$a_0(980)\pi$	seen	393
$\gamma\gamma$	seen	738

$f_0(1500)$ [o]

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

Mass $m = 1505 \pm 6$ MeV (S = 1.3)
Full width $\Gamma = 109 \pm 7$ MeV

$f_0(1500)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	p (MeV/c)
$\pi\pi$	(34.9±2.3) %	1.2	741
$\pi^+\pi^-$	seen		740
$2\pi^0$	seen		741
4π	(49.5±3.3) %	1.2	691
$4\pi^0$	seen		691
$2\pi^+2\pi^-$	seen		687
$\eta\eta$	(5.1±0.9) %	1.4	516
$\eta\eta'(958)$	(1.9±0.8) %	1.7	†
$K\overline{K}$	(8.6±1.0) %	1.1	568
$\gamma\gamma$	not seen		753

$f_2'(1525)$

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

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

$f_2'(1525)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\overline{K}$	(88.7 ±2.2) %	581
$\eta\eta$	(10.4 ±2.2) %	530
$\pi\pi$	(8.2 ±1.5) × 10^{-3}	750
$\gamma\gamma$	(1.11±0.14) × 10^{-6}	763

$\pi_1(1600)$ [o]

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

Mass $m = 1662^{+15}_{-11}$ MeV (S = 1.2)
Full width $\Gamma = 234 \pm 50$ MeV (S = 1.7)

$\pi_1(1600)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\pi\pi$	not seen	803
$\rho^0\pi^-$	not seen	641
$f_2(1270)\pi^-$	not seen	319
$b_1(1235)\pi$	seen	357
$\eta'(958)\pi^-$	seen	544
$f_1(1285)\pi$	seen	315

$\eta_2(1645)$

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

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
$K\overline{K}\pi$	seen	580
$K^*\overline{K}$	seen	404
$\eta\pi^+\pi^-$	seen	685
$a_0(980)\pi$	seen	496
$f_2(1270)\eta$	not seen	†

$\omega(1650)$ [t]

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

Mass $m = 1670 \pm 30$ MeV
Full width $\Gamma = 315 \pm 35$ MeV

$\omega(1650)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\rho\pi$	seen	646
$\omega\pi\pi$	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 [n]

$\omega_3(1670)$ 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 $m = 1672.4 \pm 3.2$ MeV [n] (S = 1.4)
Full width $\Gamma = 259 \pm 9$ MeV [n] (S = 1.3)

$\pi_2(1670)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
3π	(95.8±1.4) %		809
$f_2(1270)\pi$	(56.3±3.2) %		329
$\rho\pi$	(31 ±4) %		648
$\sigma\pi$	(10.9±3.4) %		–
$(\pi\pi)_{S\text{-wave}}$	(8.7±3.4) %		–
$K\overline{K}^*(892)+$ c.c.	(4.2±1.4) %		455
$\omega\rho$	(2.7±1.1) %		304
$\gamma\gamma$	$< 2.8 \times 10^{-7}$	90%	836
$\rho(1450)\pi$	$< 3.6 \times 10^{-3}$	97.7%	148
$b_1(1235)\pi$	$< 1.9 \times 10^{-3}$	97.7%	366
$f_1(1285)\pi$	possibly seen		323
$a_2(1320)\pi$	not seen		292

$\phi(1680)$

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

Mass $m = 1680 \pm 20$ MeV [n]
Full width $\Gamma = 150 \pm 50$ MeV [n]

$\phi(1680)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\overline{K}^*(892)+$ c.c.	dominant	462
$K^0_S K\pi$	seen	621
$K\overline{K}$	seen	680
e^+e^-	seen	840
$\omega\pi\pi$	not seen	623

$\rho_3(1690)$

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

Mass $m = 1688.8 \pm 2.1$ MeV [n]
Full width $\Gamma = 161 \pm 10$ MeV [n] (S = 1.5)

$\rho_3(1690)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	p (MeV/c)
4π	(71.1 ± 1.9) %		790
$\pi^\pm\pi^+\pi^-\pi^0$	(67 ±22) %		787
$\omega\pi$	(16 ± 6) %		655
$\pi\pi$	(23.6 ± 1.3) %		834
$K\overline{K}\pi$	(3.8 ± 1.2) %		629
$K\overline{K}$	(1.58± 0.26) %	1.2	685
$\eta\pi^+\pi^-$	seen		727
$\rho(770)\eta$	seen		520
$\pi\pi\rho$	seen		633
Excluding 2ρ and $a_2(1320)\pi$.			
$a_2(1320)\pi$	seen		307
$\rho\rho$	seen		334

$\rho(1700)$ [s]

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

Mass $m = 1720 \pm 20$ MeV [n] ($\eta\rho^0$ and $\pi^+\pi^-$ modes)
Full width $\Gamma = 250 \pm 100$ MeV [n] ($\eta\rho^0$ and $\pi^+\pi^-$ modes)

$\rho(1700)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$2(\pi^+\pi^-)$	large	803
$\rho\pi\pi$	dominant	653
$\rho^0\pi^+\pi^-$	large	650
$\rho^\pm\pi^\mp\pi^0$	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
$K\overline{K}^*(892)+$ c.c.	seen	496
$\eta\rho$	seen	545
$a_2(1320)\pi$	not seen	334
$K\overline{K}$	seen	704
e^+e^-	seen	860
$\pi^0\omega$	seen	674

$f_0(1710)$ [u]

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

Mass $m = 1724 \pm 7$ MeV (S = 1.5)
Full width $\Gamma = 137 \pm 8$ MeV (S = 1.1)

$f_0(1710)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\overline{K}$	seen	707
$\eta\eta$	seen	666
$\pi\pi$	seen	852
$\omega\omega$	seen	362

$\pi(1800)$

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

Mass $m = 1816 \pm 14$ MeV (S = 2.3)
Full width $\Gamma = 208 \pm 12$ MeV

$\pi(1800)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi^+\pi^-\pi^-$	seen	881
$f_0(600)\pi^-$	seen	–
$f_0(980)\pi^-$	seen	634
$f_0(1370)\pi^-$	seen	371
$f_0(1500)\pi^-$	not seen	254
$\rho\pi^-$	not seen	735
$\eta\eta\pi^-$	seen	664
$a_0(980)\eta$	seen	473
$a_2(1320)\eta$	not seen	†
$f_2(1270)\pi$	not seen	445
$f_0(1300)\pi$	not seen	–
$f_0(1500)\pi^-$	seen	254
$\eta\eta'(958)\pi^-$	seen	380
$K_0^*(1430)K^-$	seen	†
$K^*(892)K^-$	not seen	573

$\phi_3(1850)$

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

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)
$K\overline{K}$	seen	785
$K\overline{K}^*(892)+$ 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

$f_2(1950)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K^*(892)\overline{K}^*(892)$	seen	387
$\pi^+\pi^-$	seen	962
4π	seen	925
$\eta\eta$	seen	803
$K\overline{K}$	seen	837
$\gamma\gamma$	seen	972

$f_2(2010)$

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

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

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

$a_4(2040)$

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

Mass $m = 2001 \pm 10$ MeV
Full width $\Gamma = 313 \pm 31$ MeV

$a_4(2040)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\overline{K}$	seen	870
$\pi^+\pi^-\pi^0$	seen	977
$\rho\pi$	seen	844
$f_2(1270)\pi$	seen	583
$\omega\pi^-\pi^0$	seen	822
$\omega\rho$	seen	628
$\eta\pi^0$	seen	920
$\eta'(958)\pi$	seen	764

$f_4(2050)$

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

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±1.5) %	1000
$K\overline{K}$	$(6.8^{+3.4}_{-1.8}) \times 10^{-3}$	880
$\eta\eta$	(2.1±0.8) $\times 10^{-3}$	848
$4\pi^0$	< 1.2 %	964
$a_2(1320)\pi$	seen	567

$f_2(2300)$

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

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

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

$f_2(2340)$

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

Mass $m = 2339 \pm 60$ MeV
Full width $\Gamma = 319^{+80}_{-70}$ MeV

$f_2(2340)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\phi\phi$	seen	573
$\eta\eta$	seen	1033

NOTES

[*a*] See the "Note on $\pi^\pm \to \ell^\pm \nu\gamma$ and $K^\pm \to \ell^\pm \nu\gamma$ 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 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 $\pi^\pm$ 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*] Astrophysical and cosmological arguments give limits of order 10^{-13}; see the π^0 Particle Listings.

[*f*] Due to a new measurement in the average, this is 0.45 MeV larger than the mass we gave in our 2002 edition, 547.30 ± 0.12 MeV.

[*g*] Due to removing an old measurement from the average, this is 0.11 keV larger than the width we gave in our 2002 edition, 1.18 ± 0.11 keV. See the $\Gamma(2\gamma)$ data block in the Data Listings.

[*h*] *C* parity forbids this to occur as a single-photon process.

[*i*] See the "Note on scalar mesons" in the $f_0(1370)$ Particle Listings . The interpretation of this entry as a particle is controversial.

[*j*] See the "Note on $\rho(770)$" in the $\rho(770)$ Particle Listings .

[*k*] The $\omega\rho$ interference is then due to $\omega\rho$ mixing only, and is expected to be small. If $e\mu$ universality holds, $\Gamma(\rho^0 \to \mu^+\mu^-) = \Gamma(\rho^0 \to e^+e^-) \times 0.99785$.

[*l*] See the "Note on scalar mesons" in the $f_0(1370)$ Particle Listings .

[*m*] See the "Note on $a_1(1260)$" in the $a_1(1260)$ Particle Listings in PDG 06, Journal of Physics, G **33** 1 (2006).

[*n*] 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.

[*o*] See the "Note on non-$q\overline{q}$ mesons" in the Particle Listings in PDG 06, Journal of Physics, G **33** 1 (2006).

[*p*] See the "Note on the $\eta(1405)$" in the $\eta(1405)$ Particle Listings.

[*q*] See the "Note on the $f_1(1420)$" in the $\eta(1405)$ Particle Listings.

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

[*s*] See the "Note on the $\rho(1450)$ and the $\rho(1700)$" in the $\rho(1700)$ Particle Listings.

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

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