

LIGHT UNFLAVORED MESONS

($S = C = B = 0$)

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

$\pi^\pm$

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

Mass $m = 139.57018 \pm 0.00035$ MeV ($S = 1.2$)

Mean life $\tau = (2.6033 \pm 0.0005) \times 10^{-8}$ s ($S = 1.2$)

$$c\tau = 7.8045 \text{ m}$$

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

$$F_V = 0.0254 \pm 0.0017$$

$$F_A = 0.0119 \pm 0.0001$$

$$F_V \text{ slope parameter } a = 0.10 \pm 0.06$$

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

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 $\pm$ 0.00004) %		30
$\mu^+ \nu_\mu \gamma$	[c] (2.00 $\pm$ 0.25) $\times 10^{-4}$		30
$e^+ \nu_e$	[b] (1.230 $\pm$ 0.004) $\times 10^{-4}$		70
$e^+ \nu_e \gamma$	[c] (7.39 $\pm$ 0.05) $\times 10^{-7}$		70
$e^+ \nu_e \pi^0$	(1.036 $\pm$ 0.006) $\times 10^{-8}$		4
$e^+ \nu_e e^+ e^-$	(3.2 $\pm$ 0.5) $\times 10^{-9}$		70
$e^+ \nu_e \nu \bar{\nu}$	< 5 $\times 10^{-6}$	90%	70

Lepton Family number (LF) or Lepton number (L) violating modes

$\mu^+ \bar{\nu}_e$	L	[d] < 1.5	$\times 10^{-3}$ 90%	30
$\mu^+ \nu_e$	LF	[d] < 8.0	$\times 10^{-3}$ 90%	30
$\mu^- e^+ e^+ \nu$	LF	< 1.6	$\times 10^{-6}$ 90%	30



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

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 ($S = 1.2$)

$$c\tau = 25.5 \text{ nm}$$

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
$\nu \bar{\nu}$	$[e] < 2.7$	$\times 10^{-7}$ 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

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	< 3.4	$\times 10^{-9}$ CL=90%	26
$\mu^+ e^- + \mu^- e^+$	LF	< 3.6	$\times 10^{-10}$ CL=90%	26



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

Mass $m = 547.862 \pm 0.018$ MeV

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

C-nonconserving decay parameters

$$\begin{aligned} \pi^+ \pi^- \pi^0 & \text{ left-right asymmetry} = (0.09^{+0.11}_{-0.12}) \times 10^{-2} \\ \pi^+ \pi^- \pi^0 & \text{ sextant asymmetry} = (0.12^{+0.10}_{-0.11}) \times 10^{-2} \\ \pi^+ \pi^- \pi^0 & \text{ quadrant asymmetry} = (-0.09 \pm 0.09) \times 10^{-2} \\ \pi^+ \pi^- \gamma & \text{ left-right asymmetry} = (0.9 \pm 0.4) \times 10^{-2} \\ \pi^+ \pi^- \gamma & \beta \text{ (D-wave)} = -0.02 \pm 0.07 \quad (S = 1.3) \end{aligned}$$

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

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

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

neutral modes	(72.12 $\pm$ 0.34) %	S=1.2	—
$\rightarrow 2\gamma$	(39.41 $\pm$ 0.20) %	S=1.1	274
$\rightarrow 3\pi^0$	(32.68 $\pm$ 0.23) %	S=1.1	179
$\pi^0 2\gamma$	(2.7 $\pm$ 0.5) $\times 10^{-4}$	S=1.1	257
$2\pi^0 2\gamma$	< 1.2 $\times 10^{-3}$	CL=90%	238
4γ	< 2.8 $\times 10^{-4}$	CL=90%	274
invisible	< 1.0 $\times 10^{-4}$	CL=90%	—

Charged modes

charged modes	(28.10 $\pm$ 0.34) %	S=1.2	—
$\rightarrow \pi^+ \pi^- \pi^0$	(22.92 $\pm$ 0.28) %	S=1.2	174
$\rightarrow \pi^+ \pi^- \gamma$	(4.22 $\pm$ 0.08) %	S=1.1	236
$\rightarrow e^+ e^- \gamma$	(6.9 $\pm$ 0.4) $\times 10^{-3}$	S=1.3	274
$\rightarrow \mu^+ \mu^- \gamma$	(3.1 $\pm$ 0.4) $\times 10^{-4}$		253
$e^+ e^-$	< 5.6 $\times 10^{-6}$	CL=90%	274
$\mu^+ \mu^-$	(5.8 $\pm$ 0.8) $\times 10^{-6}$		253
$2e^+ 2e^-$	(2.40 $\pm$ 0.22) $\times 10^{-5}$		274
$\pi^+ \pi^- e^+ e^- (\gamma)$	(2.68 $\pm$ 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

**Charge conjugation (C), Parity (P),
Charge conjugation $\times$ 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
$2\pi^0$	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
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	$[f] < 4$	$\times 10^{-5}$	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 σ ^[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 (Γ_i/Γ)	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 (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\pi\pi$	~ 100	%	363

later useful for
alpha

$\rho(770)^\pm$ 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
$\pi^0 \gamma$	(6.0 ± 0.8)	$\times 10^{-4}$		376
$\eta \gamma$	(3.00 ± 0.20)	$\times 10^{-4}$		194
$\pi^0 \pi^0 \gamma$	(4.5 ± 0.8)	$\times 10^{-5}$		363
$\mu^+ \mu^-$	[i] (4.55 ± 0.28)	$\times 10^{-5}$		373
$e^+ e^-$	[i] (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 $m = 782.65 \pm 0.12$ 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 (Γ_i/Γ)	Scale factor/ Confidence level	p (MeV/c)
$\pi^+\pi^-\pi^0$	(89.2 ± 0.7) %		327
$\pi^0\gamma$	(8.28±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) × 10 ⁻³	S=1.1	—
$\eta\gamma$	(4.6 ± 0.4) × 10 ⁻⁴	S=1.1	200
$\pi^0e^+e^-$	(7.7 ± 0.6) × 10 ⁻⁴		380
$\pi^0\mu^+\mu^-$	(1.3 ± 0.4) × 10 ⁻⁴	S=2.1	349
e^+e^-	(7.28±0.14) × 10 ⁻⁵	S=1.3	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
$\pi^0\pi^0\gamma$	(6.6 ± 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 < 2.1 × 10 ⁻⁴	CL=90%	162
$2\pi^0$	C < 2.1 × 10 ⁻⁴	CL=90%	367
$3\pi^0$	C < 2.3 × 10 ⁻⁴	CL=90%	330

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

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

Mass $m = 957.78 \pm 0.06$ MeVFull width $\Gamma = 0.198 \pm 0.009$ MeV

$\eta'(958)$ DECAY MODES	Fraction (Γ_i/Γ)	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
$\pi^+\pi^-\mu^+\mu^-$	$< 2.2 \times 10^{-4}$	90%	401
$\pi^+\pi^-\pi^0$	$(3.8 \pm 0.4) \times 10^{-3}$		428
$\pi^0\rho^0$	$< 4 \%$	90%	111
$2(\pi^+\pi^-)$	$< 2.4 \times 10^{-4}$	90%	372
$\pi^+\pi^-2\pi^0$	$< 2.5 \times 10^{-3}$	90%	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
$3(\pi^+\pi^-)$	$< 5 \times 10^{-4}$	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
γe^+e^-	$< 9 \times 10^{-4}$	90%	479
$\pi^0\gamma\gamma$	$< 8 \times 10^{-4}$	90%	469
$4\pi^0$	$< 5 \times 10^{-4}$	90%	380
e^+e^-	$< 2.1 \times 10^{-7}$	90%	479
invisible	$< 5 \times 10^{-4}$	90%	—

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

$\pi^+\pi^-$	P, CP	< 6	$\times 10^{-5}$	90%	458
$\pi^0\pi^0$	P, CP	< 4	$\times 10^{-4}$	90%	459
$\pi^0e^+e^-$	C	$[f] < 1.4$	$\times 10^{-3}$	90%	469
ηe^+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

$f_0(980)$ [j]

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

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

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

$a_0(980)$ [j]

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

useful for alpha

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

$a_0(980)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\eta\pi$	dominant	319
$K\bar{K}$	seen	†
$\gamma\gamma$	seen	490

$\phi(1020)$

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

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^-	(48.9 ± 0.5) %	S=1.1	127
$K_L^0 K_S^0$	(34.2 ± 0.4) %	S=1.1	110
$\rho\pi^+ \pi^-\pi^0$	(15.32 ± 0.32) %	S=1.1	—
$\eta\gamma$	(1.309±0.024) %	S=1.2	363
$\pi^0\gamma$	(1.27 ± 0.06) × 10 ^{−3}		501
$\ell^+\ell^-$	—		510
e^+e^-	(2.954±0.030) × 10 ^{−4}	S=1.1	510
$\mu^+\mu^-$	(2.87 ± 0.19) × 10 ^{−4}		499
ηe^+e^-	(1.15 ± 0.10) × 10 ^{−4}		363
$\pi^+\pi^-$	(7.4 ± 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

$f_0(980)\gamma$	$(3.22 \pm 0.19) \times 10^{-4}$	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
$\pi^0e^+e^-$	$(1.12 \pm 0.28) \times 10^{-5}$		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

Lepton Family number (LF) violating modes

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

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

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

$h_1(1170)$ DECAY MODES	Fraction (Γ_i/Γ)	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)

$b_1(1235)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\omega\pi$	dominant		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

$a_1(1260)$ ^[k]

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

Mass $m = 1230 \pm 40$ MeV ^[l]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	179
$f_0(1370)\pi$	seen	†
$f_2(1270)\pi$	seen	†
$K\bar{K}^*(892) + \text{c.c.}$	seen	†
$\pi\gamma$	seen	608

 $f_2(1270)$

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

Mass $m = 1275.1 \pm 1.2$ MeV ($S = 1.1$)Full width $\Gamma = 185.1^{+2.9}_{-2.4}$ 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
$K\bar{K}$	$(4.6 \pm 0.4)\%$	$S=2.8$	403
$2\pi^+2\pi^-$	$(2.8 \pm 0.4)\%$	$S=1.2$	559
$\eta\eta$	$(4.0 \pm 0.8) \times 10^{-3}$	$S=2.1$	326
$4\pi^0$	$(3.0 \pm 1.0) \times 10^{-3}$		564
$\gamma\gamma$	$(1.64 \pm 0.19) \times 10^{-5}$	$S=1.9$	638
$\eta\pi\pi$	$< 8 \times 10^{-3}$	$CL=95\%$	477
$K^0K^-\pi^+ + \text{c.c.}$	$< 3.4 \times 10^{-3}$	$CL=95\%$	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)

$f_1(1285)$ 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
$\eta\pi^+\pi^-$	$(35 \pm 15)\%$		479
$\eta\pi\pi$	$(52.4^{+1.9}_{-2.2})\%$	S=1.2	482
$a_0(980)\pi$ [ignoring $a_0(980) \rightarrow K\bar{K}$]	$(36 \pm 7)\%$		238
$\eta\pi\pi$ [excluding $a_0(980)\pi$]	$(16 \pm 7)\%$		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
$\gamma\rho^0$	$(5.5 \pm 1.3)\%$	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 (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	—

$\pi(1300)$

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

Mass $m = 1300 \pm 100$ MeV [1]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	—

 $a_2(1320)$

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

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 (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
$\eta'(958)\pi$	(5.3 $\pm$ 0.9) $\times 10^{-3}$		288
$\pi^\pm\gamma$	(2.68 $\pm$ 0.31) $\times 10^{-3}$		652
$\gamma\gamma$	(9.4 $\pm$ 0.7) $\times 10^{-6}$		659
e^+e^-	< 5 $\times 10^{-9}$	CL=90%	659

 $f_0(1370)$ [1]

$$J^{PC} = 0^+(0^{++}) \leftarrow \text{glueball ?}$$

Mass $m = 1200$ to 1500 MeVFull 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
$K\bar{K}$	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

$\pi_1(1400)$ ^[n]

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

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

$\pi_1(1400)$ DECAY MODES	Fraction (Γ_i/Γ)	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 ^[l] (S = 2.1)
Full width $\Gamma = 51.0 \pm 2.9$ MeV ^[l] (S = 1.8)

$\eta(1405)$ DECAY MODES	Fraction (Γ_i/Γ)	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-wave	seen		—
$f_0(980)\eta$	seen		†
4π	seen		639
$\rho\rho$	<58 %	99.85%	†
$\rho^0\gamma$	seen		491
$K^*(892)K$	seen		123

$f_1(1420)$ [ρ]

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

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)
$K \bar{K} \pi$	dominant	438
$K \bar{K}^*(892) + \text{c.c.}$	dominant	163
$\eta \pi \pi$	possibly seen	573
$\phi \gamma$	seen	349

 $\omega(1420)$ [q]

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

Mass m (1400–1450) MeVFull 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

 $a_0(1450)$ [j]

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

Mass $m = 1474 \pm 19$ MeVFull 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	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]

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

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

$\rho(1450)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\pi\pi$	seen	720
4π	seen	669
e^+e^-	seen	732
$\eta\rho$	possibly seen	311
$a_2(1320)\pi$	not seen	54
$K\bar{K}$	not seen	541
$K\bar{K}^*(892)+\text{c.c.}$	possibly seen	229
$\eta\gamma$	possibly 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	178

$\eta(1475)$ [o]

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

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)
$K\bar{K}\pi$	dominant	477
$K\bar{K}^*(892)+\text{c.c.}$	seen	245
$a_0(980)\pi$	seen	396
$\gamma\gamma$	seen	738

$f_0(1500)$ ^[n]

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

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
$2(\pi\pi)_{S\text{-wave}}$	seen		—
$\rho\rho$	seen		†
$\pi(1300)\pi$	seen		144
$a_1(1260)\pi$	seen		218
$\eta\eta$	(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 [l]
Full width $\Gamma = 73^{+6}_{-5}$ MeV [l]

$f'_2(1525)$ 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

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

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

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

$\pi_1(1600)$ 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	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

$\eta_2(1645)$ 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	†

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

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

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

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

$\omega_3(1670)$

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

Mass $m = 1667 \pm 4$ MeVFull width $\Gamma = 168 \pm 10$ MeV [1]

$\omega_3(1670)$ 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

 $\pi_2(1670)$

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

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 (Γ_i/Γ)	Confidence level	p (MeV/c)
3π	$(95.8 \pm 1.4) \%$		809
$f_2(1270)\pi$	$(56.3 \pm 3.2) \%$		329
$\rho\pi$	$(31 \pm 4) \%$		648
$\sigma\pi$	$(10.9 \pm 3.4) \%$		—
$(\pi\pi)_{S\text{-wave}}$	$(8.7 \pm 3.4) \%$		—
$K\bar{K}^*(892) + \text{c.c.}$	$(4.2 \pm 1.4) \%$		455
$\omega\rho$	$(2.7 \pm 1.1) \%$		304
$\gamma\gamma$	$< 2.8 \times 10^{-7}$	90%	836
$\rho(1450)\pi$	$< 3.6 \times 10^{-3}$	97.7%	147
$b_1(1235)\pi$	$< 1.9 \times 10^{-3}$	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]

$\phi(1680)$ DECAY MODES	Fraction (Γ_i/Γ)	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

$\rho_3(1690)$

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

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

$\rho_3(1690)$ DECAY MODES	Fraction (Γ_i/Γ)	Scale factor	p (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
Excluding 2ρ 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 [l] ($\eta \rho^0$ and $\pi^+ \pi^-$ modes)Full width $\Gamma = 250 \pm 100$ MeV [l] ($\eta \rho^0$ 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	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]

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

$$\text{Mass } m = 1720 \pm 6 \text{ MeV} \quad (S = 1.6)$$

$$\text{Full width } \Gamma = 135 \pm 8 \text{ MeV} \quad (S = 1.1)$$

$f_0(1710)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K \bar{K}$	seen	704
$\eta \eta$	seen	663
$\pi \pi$	seen	849
$\omega \omega$	seen	357

 $\pi(1800)$

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

$$\text{Mass } m = 1812 \pm 12 \text{ MeV} \quad (S = 2.3)$$

$$\text{Full width } \Gamma = 208 \pm 12 \text{ MeV}$$

$\pi(1800)$ DECAY MODES	Fraction (Γ_i/Γ)	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 $m = 1854 \pm 7$ MeVFull 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

 $\pi_2(1880)$

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

Mass $m = 1895 \pm 16$ MeVFull 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)
$K^*(892)\bar{K}^*(892)$	seen	387
$\pi^+\pi^-$	seen	962
$\pi^0\pi^0$	seen	963
4π	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

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

$a_4(2040)$

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

$$\text{Mass } m = 1996^{+10}_{-9} \text{ MeV} \quad (S = 1.1)$$

$$\text{Full width } \Gamma = 255^{+28}_{-24} \text{ MeV} \quad (S = 1.3)$$

$a_4(2040)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$K\bar{K}$	seen	868
$\pi^+\pi^-\pi^0$	seen	974
$\rho\pi$	seen	841
$f_2(1270)\pi$	seen	580
$\omega\pi^-\pi^0$	seen	819
$\omega\rho$	seen	624
$\eta\pi^0$	seen	918
$\eta'(958)\pi$	seen	761

 $f_4(2050)$

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

$$\text{Mass } m = 2018 \pm 11 \text{ MeV} \quad (S = 2.1)$$

$$\text{Full width } \Gamma = 237 \pm 18 \text{ MeV} \quad (S = 1.9)$$

$f_4(2050)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\omega\omega$	seen	637
$\pi\pi$	$(17.0 \pm 1.5) \%$	1000
$K\bar{K}$	$(6.8^{+3.4}_{-1.8}) \times 10^{-3}$	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

$\phi(2170)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$e^+ e^-$	seen	1087
$\phi f_0(980)$	seen	416
$K^+ K^- f_0(980) \rightarrow$	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	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

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

 $f_2(2340)$

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

Mass $m = 2339 \pm 60$ MeVFull 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 $\pi^\pm \rightarrow \ell^\pm \nu \gamma$ 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 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] 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, G **33** 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, G **33** 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*.