

SUMMARY CARD on PARTICLES AND RESONANCES

NAME(M, Γ) MeV	$I^G(J^P)C_\eta$	DECAY MODES and REMARKS
<u>LEPTONS</u>		
ν_e (< .2 keV)	$J = 1/2$	stable
ν_μ (< 2.1 MeV)	$J = 1/2$	stable
e^- (.511)	$J = 1/2$	stable; $\mu_e = 1.001\ 159\ 60\ \mu_{Bohr}$
μ^- (105.7)	$J = 1/2$	$\tau = 2.2 \times 10^{-6}$; $e\nu\bar{\nu}$ 100%; $\mu_\mu = 1.001\ 167\ e\hbar/2m_\mu c$
<u>MESONS</u>		
<u>$Y = 0$</u>		
* π^\pm (139.6)	$1^-(0^-)^+$	$\tau = 2.6 \times 10^{-8}$; $\mu\nu$ 100%; $e\nu$ 1.24×10^{-4} ; $\mu\nu\gamma$ 1.2×10^{-4} ; $\pi^0 e\nu$ 1×10^{-8} ; $e\nu\gamma$ 3×10^{-8}
* π^0 (135.0, 7 eV)	$1^-(0^-)^+$	$\gamma\gamma$ 98.8%; $\gamma e e$ 1.2%; $4e$ 3.5×10^{-5} (theo)
* η (549, 2 keV)	$0^+(0^-)^+$	$\gamma\gamma$ (42 \rightarrow 34)%; $\pi\gamma\gamma$ (1 \rightarrow 19)%; $3\pi^0$ (28 \rightarrow 18)%; $\pi^+\pi^-\pi^0$ 23%; $\pi^+\pi^-\gamma$ 6%
* ρ (765, ~125)	$1^+(1^-)^-$	2π 100%; e^+e^- 5×10^{-5} ; $\mu^+\mu^-$ 6×10^{-5}
* ω (783, 12)	$0^-(1^-)^-$	$\pi^+\pi^-\pi^0$ 90%; $\pi^+\pi^-$ \lesssim 15%; $\pi^0\gamma$ 10%; e^+e^- 5×10^{-5}
* η' (958, < 4)	$0^+(0^-)^+$	$\eta\pi\pi \sim 70\%$; $\pi^+\pi^-\gamma + \rho^0\gamma$ 22%; other neutrals \lesssim 20%
? δ (962, < 5)	1, 2()	1 chrgd + neutral(s) \sim 60% \geq 3 chrgd + neutral(s) \sim 40%
? H (~990, \leq 80)	(A?)	$3\pi + \rho\pi$, only mode seen; assumed $I = 0$
π_V (1016, 25)	$1^-(0^+)^+$	$K^\pm K^0$, only mode seen. May be $K\bar{K}$, $I = 1$ scatt. length
* ϕ (1019, 3)	$0^-(1^-)^-$	K^+K^- 47%; $K_L K_S$ 39%; $\pi^+\pi^-\pi^0$ 14%; e^+e^- , $\mu^+\mu^-$ seen
η_V (1070, ~80)	$0^+(0^+)^+$	$K\bar{K} > 30\%$; $\pi\pi < 70\%$. May be $K\bar{K}$, $I = 0$ scatt. length
A1 (1070, ~80)	$1^-(1^+)^+$	$3\pi + \rho\pi$, only mode seen.
B (1220, 130)	$1^+(A?)^-$	$\omega\pi$, only mode seen
* f (1260, 140)	$0^+(2^+)^+$	2π large, $K\bar{K}$?
D (1285, 30)	$0^+(1^+)^+$	$K\bar{K}\pi + \pi_V(1016)\pi$, only mode seen
* A2 (1305, 90)	$1^-(2^+)^+$	$\rho\pi + 3\pi$, 85%; $\eta\pi$ 11%; $K\bar{K}$ 4% (Possibly another resonance exists at nearly same mass)
E (1420, 70)	$0^+(0^-)^+$	$K^*\bar{K} + \bar{K}^*K$ 50%; $\pi_V(1016)\pi$ 50%
* f' (1514, 70)	$0^+(2^+)^+$	$K\bar{K}$ 60-90%; $\eta\pi\pi \sim 20\%$; $K^*\bar{K} + \bar{K}^*K \lesssim 20\%$
π_A (1650, 110)	$1^?(A?)$	3π (mainly $f\pi$?), only mode seen
ρ_V (1660, 170)	$1^+(V)^-$	2π , appears dominant; $4\pi(\rho\pi\pi?)$, $\omega\pi$, $K\bar{K}$, some indications seen
"g"		
? S (1930, \leq 35)	1, 2 (A?)	3 charged + neutral(s), dominant
? T (2200, \leq 13)	1, 2 (A?)	3 charged + neutral(s), dominant
? U (2380, \leq 30)	1, 2 ()	1:3; $>$ 3 chrdg + neutral(s) = 30%; 45%: 25%
<u>$Y = \pm 1$</u>		
* K^\pm (493.8)	$1/2(0^-)$	$\tau = 1.235 \times 10^{-8}$; $\mu\nu$ 63.6%; $\pi\pi^0$ 20.9%; $\pi^+\pi^-$ 5.57%; $\pi\pi^0\pi^0$ 1.7%; $\mu\pi^0\nu$ 3.4%; $e\pi^0\nu$ 4.8%; $\pi\pi^\pm e^\mp\nu$ 4×10^{-5} ; $e\nu$ 1.2×10^{-5} ; $\pi\pi^0\gamma$ 2.2×10^{-4} ; $\pi\pi^+\pi^-\gamma$ 1×10^{-4} ; $\pi e\nu\gamma$ 6×10^{-4}
* K_S^0 (497.8)	$1/2(0^-)$	$\tau_S = .87 \times 10^{-10}$; $M_{KS} - M_{KL} = -.48/\tau_S$; $\pi^+\pi^-$ 68%; $\pi^0\pi^0$ 32%
* K_L^0 (497.8)	$1/2(0^-)$	$\tau_L = .53 \times 10^{-7}$; ΔM see above; $3\pi^0$ 26%; $\pi^+\pi^-\pi^0$ 12%; $\pi\mu\nu$ 27%; $\pi e\nu$ 35%; $\pi^+\pi^-$.15%; $\pi^0\pi^0$ seen; $\gamma\gamma$ seen
* K^* (893, 49)	$1/2(1^-)$	$K\pi$ only mode seen; $M_0 - M_\pm = 6 \pm 4$ MeV
? K_A (1230, ~60)	$1/2(A?)$	$K\pi\pi + K^*\pi(+K\rho(?))$ dominant
"C"		
K_A (1320, ~60)	$1/2(A?)$	$K\pi\pi + K^*\pi + K\rho$, dominant
* K_V (1419, 89)	$1/2(2^+)^+$	$K\pi$ 51%; $K^*\pi$ 33%; $K\rho$ 12%; $K\omega$ 2%; $K\eta$ 2%
K_A (1780, ~70)	$1/2(A?)$	$K^*\pi \sim 24\%$; $K_V(1419)\pi \sim 16\%$; $K\rho \sim 10\%$; remaining $K\pi\pi \sim 45\%$, $K\omega \sim 5\%$
"L"		

* = well established

$J^P = V$ means $0^+, 1^-, \dots$; $J^P = A$ means $0^-, 1^+, \dots$

V(A) if $\pi\pi$, KK mode seen (not seen)

BARYONS

NAME(M, Γ), MeV	J^P	DECAY MODES and REMARKS
$Y = 1$		
* p(938.3)	$1/2(1/2^+)$	Stable; $\mu_p = 2.79276 \mu_{nuc}$
* n(939.6)	$1/2(1/2^+)$	$\tau = 1.01 \times 10^3$ sec; $\mu_n = -1.91315 \mu_{nuc}$
* N(1470, 210) P ₁₁	$1/2(1/2^+)$	N π 65%; N $\pi\pi$ (mostly N σ) 35%
* N(1525, 115) D ₁₃	$1/2(3/2^-)$	N π 55%; N $\pi\pi$ (mostly $\Delta(1236)\pi$) 45%, N $\eta \sim 0.5\%$.
* N(1550, 130) S ₁₁	$1/2(1/2^-)$	N $\pi \sim 30\%$; N $\eta \sim 70\%$, N $\pi\pi$ small.
* N(1680, 170) D ₁₅	$1/2(5/2^-)$	N π 40%; N $\pi\pi$ dominant inelastic.
* N(1688, 130) F ₁₅	$1/2(5/2^+)$	N π 65%; N $\pi\pi$ dominant inelastic.
* N(1710, 300) S ₁₁	$1/2(1/2^-)$	N π 80%.
* N(2190, 250) G ₁₇	$1/2(7/2^-)$	N π 30%.
N(2650, 360)	$1/2(?^-)$	N π : $(J + \frac{1}{2})x = 0.45$
N(3030, 400)	$1/2(?^?)$	N π : $(J + \frac{1}{2})x = 0.05$
* $\Delta(1236, 120)$ P ₃₃	$3/2(3/2^+)$	N π 100%.
* $\Delta(1640, 180)$ S ₃₁	$3/2(1/2^-)$	N π 30%; N $\pi\pi$ dominant inelastic.
* $\Delta(1920, 220)$ F ₃₇	$3/2(7/2^+)$	N π 40%; ΣK seen
$\Delta(2420, 310)$	$3/2(11/2^+)$	N π 11%
$\Delta(2850, 400)$	$3/2(?^+)$	N π : $(J + \frac{1}{2})x = 0.25$
$\Delta(3230, 440)$	$3/2(?^?)$	N π : $(J + \frac{1}{2})x = 0.05$
$Y = 2$		
? Z ₀ (1865, 180)	0 (? ?)	NK: $(J + \frac{1}{2})x = 0.35$
$Y = 0$		
* $\Lambda(1115.5)$	0 ($1/2^+$)	$\tau = 2.52 \times 10^{-10}$; p π^- 65%; n π^0 35%; p ν 0.9×10^{-3} ; p $\mu\nu$ 1.4×10^{-4}
* $\Lambda(1405, 50)$ S ₀₁	0 ($1/2^-$)	$\Sigma\pi$ 100%.
* $\Lambda(1520, 16)$ D ₀₃	0 ($3/2^-$)	N \bar{K} 45%; $\Sigma\pi$ 45%; $\Lambda\pi\pi$ 10%
* $\Lambda(1670, 18)$ S ₀₁	0 ($1/2^-$)	N \bar{K} , $\Lambda\eta$
* $\Lambda(1690, 45)$ D ₀₃	0 ($3/2^-$)	N \bar{K} 20%; $\Sigma\pi$ 58%
* $\Lambda(1815, 74)$ F ₀₅	0 ($5/2^+$)	N \bar{K} 63%; $\Sigma\pi$ 11%; $\Sigma(1385)\pi$ 11%; $\Lambda\eta \sim 1\%$
* $\Lambda(1830, 76)$ D ₀₅	0 ($5/2^-$)	$\Sigma\pi$ 42%; N \bar{K} 8%
* $\Lambda(2100, 140)$ G ₀₇	0 ($7/2^-$)	N \bar{K} 33%; $\Sigma\pi$ 4%; $\Xi K \sim 1\%$
$\Lambda(2350, 210)$	0 (? ?)	N \bar{K} : $(J + \frac{1}{2})x = 0.7$
* $\Sigma^+(1189.5)$	1 ($1/2^+$)	$\tau = 0.8 \times 10^{-10}$; p π^0 53%; n π^+ 47%; $\Lambda e^+\nu$ 2.2×10^{-5}
* $\Sigma^0(1192.5)$	1 ($1/2^+$)	$\tau < 10^{-14}$; $\Delta\gamma$ 100%; Λe^+e^- 0.5%
* $\Sigma^-(1197.4)$	1 ($1/2^+$)	$\tau = 1.7 \times 10^{-10}$; n π 100%; n $e^-\nu$.13%; n $\mu^-\nu$ 0.06%; $\Lambda e^-\nu$ 0.66×10^{-4}
* $\Sigma(1385, 37)$ P ₁₃	1 ($3/2^+$)	$\Lambda\pi$ 91%; $\Sigma\pi$ 9%
$\Sigma(1660, 50)$ D ₁₃	1 ($3/2^-$)	$\Lambda(1405)\pi$ large; N \bar{K} small; $\Sigma\pi$
$\Sigma(1690, 110)$	1 (? ?)	$\Lambda\pi$ large; N \bar{K} small; $\Sigma\pi$ not dis- entangled.
* $\Sigma(1770, 95)$ D ₁₅	1 ($5/2^-$)	N \bar{K} 46%; $\Lambda\pi$ 15%; $\Lambda(1520)\pi$ 15%; $\Sigma(1385)\pi$ 14%; $\Sigma\eta$ 0.5%; $\Sigma\pi \sim 1\%$
$\Sigma(1910, 60)$ F ₁₅	1 ($5/2^+$)	N \bar{K} 8%; $\Lambda\pi$ 10%; $\Sigma\pi$ 3%
* $\Sigma(2030, 120)$ F ₁₇	1 ($7/2^+$)	N \bar{K} 11%; $\Lambda\pi$ 36%; $\Sigma\pi$ 9%
$\Sigma(2250, 200)$	1 (? ?)	N \bar{K} : $(J + \frac{1}{2})x = 0.3$
$\Sigma(2455, \sim 140)$	1 (? ?)	N \bar{K} : $(J + \frac{1}{2})x = 0.26$
$\Sigma(2595, \sim 140)$	1 (? ?)	N \bar{K} : $(J + \frac{1}{2})x = 0.26$
$Y = -1$		
* $\Xi^-(1321)$	$1/2(1/2^+)$	$\tau = 1.7 \times 10^{-10}$; $\Lambda\pi$ 100%; $\Lambda e\nu$.09%
* $\Xi^0(1315)$	$1/2(1/2^+)$	$\tau = 2.9 \times 10^{-10}$; $\Lambda\pi$ 100%
* $\Xi(1530, 7)$ P ₁₃	$1/2(3/2^+)$	$\Xi\pi$ 100%
$\Xi(1815, 16)$	$1/2(?^?)$	$\Lambda\bar{K} \sim 65\%$; $\Xi\pi\pi$ (mostly $\Xi(1530)\pi$) $\sim 25\%$; $\Xi\pi \sim 10\%$
? $\Xi(1930, 140)$	$1/2(?^?)$	$\Xi\pi$ seen
$Y = -2$		
* $\Omega^-(1672)$	$0(3/2^+)$	$\tau \sim 1.1 \times 10^{-10}$; $\Xi\pi$, ΛK seen

* Established, fairly well studied.

MISCELLANEOUS CONSTANTS

N = 6.02252×10^{23} mole ⁻¹	\hbar = 6.5819×10^{-22} MeV sec
c = 2.997925×10^{10} cm sec ⁻¹	$\hbar c$ = 1.9732×10^{-11} MeV cm
e = 1.60210×10^{-19} coulomb	k = 8.6171×10^{-11} MeV deg ⁻¹
$\alpha = e^2/\hbar c = 1/137.0388$	$r_e = e^2/m_e c^2 = 2.81777 \times 10^{-13}$ cm