Appendix B

STRUCTURE OF KNOWN PARTICLES

The quark and lepton model of particle physics divides charges in quarks to ±2e/3 and ±e/3. The electrino model of particle physics does not do that. Instead, it divides charges in electrinos to ±e, ±e/2, ±e/4, and ±e/8. The electrino model of particle physics does not hold that the quark and lepton model of particle physics is correct. Nevertheless, to facilitate cross referencing with the existing data, this volume will employ quark model titles and classifications in the subsequent classification of particles.

The chonomic structures contained in the following material are the author's, but the particle data come from C. Amsler *et al.* (Particle Data Group), PL **B667**, 1 (2008) (URL: http//pdg.lbl.gov). and S. Eidelman *et al.* (Particle Data Group), Phys Lett B **592** (2004) (URL: http://pdg.lbl.gov). The author's chonomic structures in this appendix are induced from the following eight criteria: particle charge, spin, parity, mass, spin feasibility, preceding particles (to avoid duplication), decay schemes, and the Pauli Exclusion Principle. The use of isospin in the precursor data instead of the simple charge made the author's work difficult; so too the convention of listing any charge π as π, and decay products of baryons as N . . ., where N can stand for many different baryons. For accurate results, please change to precise reporting conventions. These results are highly valuable, and worth doing right.

This appendix is a draft, and may contain some errors. We hope to find and correct those errors when the masses of all the particles in this appendix are solved for. This appendix proves that all known matter, light, and gravitons can better be constructed of electrinos rather than quarks and leptons. All particles may be formulated with yachons and echons, or with +, -, o's, and ●'s. For the most part, in this appendix, n replaces a ● and a +. The key to understanding chonomics is in Chapter 10.

Particle state levels are listed at the left side of the chonomic structures. The bottom state level is called 0 or ground state.

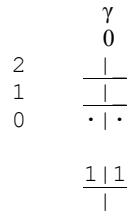
In the higher chonomic structures there can appear the symbols no, which do not mean the word no, but neutron and pion.

This document, "Structure of Known Particles," is a necessary adjunct to *Prediction of the Masses of Every Known Particle, Step 2 and Step 3*. The investigator needs to know the particle structures he/she is calculating the masses for.

GAUGE AND HIGGS BOSONS

γ $I(J^{PC}) = 0,1(1^{--})$

Mass $m < 1 \times 10^{-18}$ eV
Charge $q < 5 \times 10^{-30}$ e
Mean life τ_γ = Stable



g
or gluon

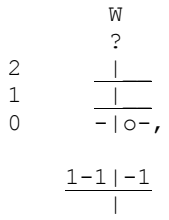
$I(J^P) = 0(1^-)$

Mass m = 0
SU(3) color octet

No electrino formulation of gluon in system.

W

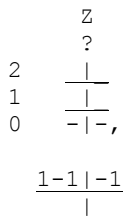
J = 1
Charge = ±1 e
Mass m = 80.398 ± 0.025 GeV
$m_Z - m_W = 10.4 \pm 1.6$ GeV
$m_{W+} - m_{W-} = -0.2 \pm 0.6$ GeV
Full width $\Gamma = 2.141 \pm 0.041$ GeV



The listed mass corresponds to energy at which system ionizes. Particle mass is much less.

Z

J = 1
Charge = 0
Mass m = 91.1876 ± 0.0021 GeV
Full width $\Gamma = 2.4952 \pm 0.0023$ GeV



The listed mass corresponds to energy at which system ionizes. Particle mass is much less.

Higgs Bosons – H^0 and $H^{\pm}$, Searches for

H^0 Mass m > 114.4 GeV, CL = 95%

$H_1{}^0$ **In Supersymmetric Models** $\left(m_{H_1^0} < m_{H_2^0}\right)$

Mass m > 92.8 GeV, CL = 95%

A^0 Pseudoscalar Higgs Boson in Supersymmetric Models

Mass m > 93.4 GeV, CL = 95% tanβ>0.4

$H^{\pm}$ Mass m > 79.3 GeV, CL = 95%

No formulation in system.

Unknown heavy or light bosons, searches for, are not covered in this appendix. This appendix covers known particles.

LEPTONS

e J = ½

Mass m = 0.510998910 ± 0.000000013 MeV

= (548.57990943 ± 0.00000023) x 10^{-6} u

$\left(m_{e^+} - m_{e^-}\right)/m < 8\,x10^{-8},\ CL = 90\%$

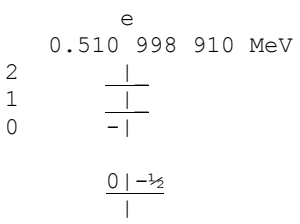
$|q_{e^+} + q_{e^-}|/e < 4\,x10^{-8}$

Magnetic moment μ = 1.0011596521811 ± 0.0000000000007 μ_B

$\left(g_{e^+} - g_{e^-}\right)/g_{average} = (-0.5 \pm 2.1)\,x10^{-12}$

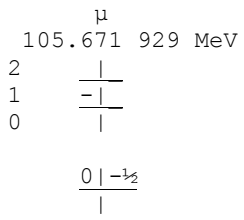
Electric dipole moment d = (0.07 ± 0.07) x 10^{-26} e cm

Mean life τ > 4.6 x 10^{26} yr, CL = 90%



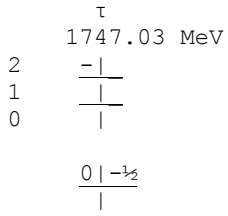
μ J = ½

Mass m = 105.658367 ± 0.000004 MeV
= 0.1134289256 ± 0.0000000029 u
Mean life τ = (2.197019 ± 0.000021) x 10^{-6} s (S = 1.1)
Magnetic moment μ = 1.0011659208 ± 0.0000000006 eℏ/2$m_μ$



τ J = ½

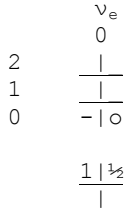
$$Mass\ m = 1776.84 \pm 0.17 MeV$$



Neutrinos

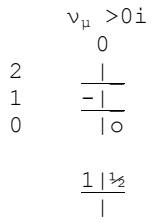
ν_e J = ½

Mass m >0i MeV
< 0.000003 MeV



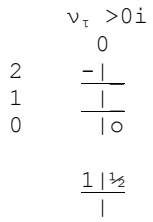
ν_μ J = ½

Mass m < 0.19 MeV, CL = 90%



ν_τ J = ½

Mass m < 18.2 MeV, CL = 95%



QUARKS

No formulation of quarks in the electrino system.

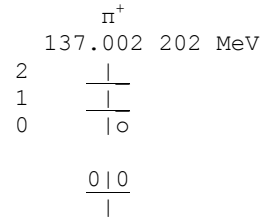
ELECTRINOS

See Gordon L. Ziegler and Iris I Koch, *Prediction of the Masses of Every Known Particle (as of 2008) Step 2, Part 1* (http://benevolententerprises.org Book List), pp. 17, 18.

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

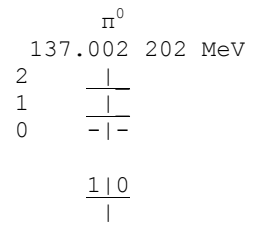
$\pi^{\pm}$ $I^G(J^P) = 1^-(0^-)$

Mass m = 139.57018 ± 0.00035 MeV (S = 1.2)



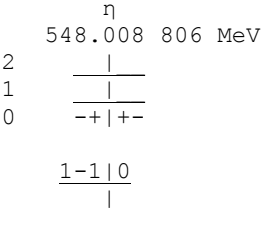
π^0 $I^G(J^{PC}) = 1^-(0^{-+})$

Mass m = 134.9766 ± 0.0006 MeV (S = 1.1)



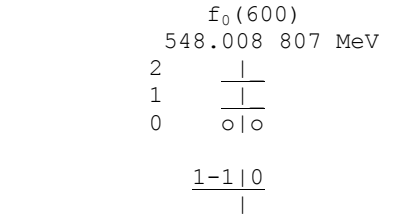
η $I^G(J^{PC}) = 0^+(0^{-+})$

Mass m = 547.853 ± 0.024 MeV



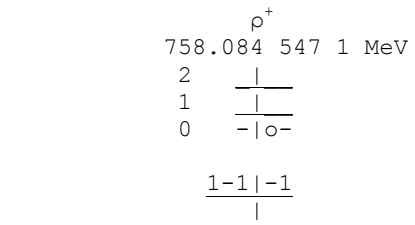
$f_0(600)$ or σ $\quad I^G(J^{PC}) = 0^+(0^{++})$

Mass m = (400-1200) MeV



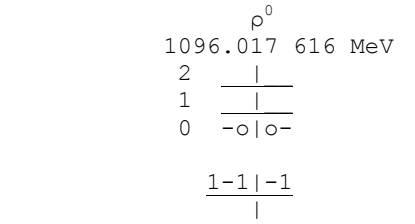
$\rho(770)^{\pm}$ $\quad I^G(J^{PC}) = 1^+(1^{--})$

Mass m = 775.49 ± 0.34 MeV



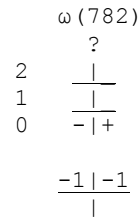
$\rho(770)^0$ $\quad I^G(J^{PC}) = 1^+(1^{--})$

Mass m = 775.49 ± 0.34 MeV (S = 1.8)



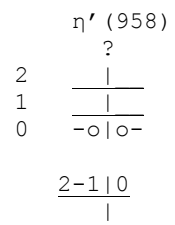
ω(782) $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 782.65 ± 0.12 MeV (S = 1.9)



η'(958) $I^G(J^{PC}) = 0^+(0^{-+})$

Mass m = 957.66 ± 0.24 MeV



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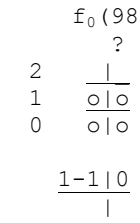
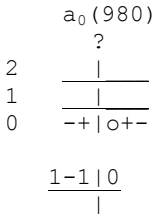
f_0(980) $I^G(J^{PC}) = 0^+(0^{++})$

Mass m = 980 ± 10 MeV



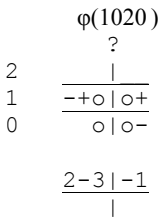
$a_0(980)$ $I^G(J^{PC}) = 1^-(0^{++})$

Mass m = 984.7 ± 1.2 MeV (S = 1.5)



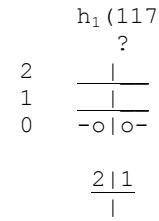
$\varphi(1020)$ $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 1019.455 ± 0.020 MeV (S = =1.1)



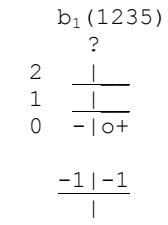
$h_1(1170)$ $I^G(J^{PC}) = 0^-(1^{+-})$

Mass m = 1170 ± 20 MeV



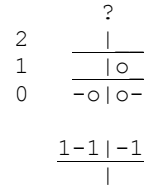
$b_1(1235)$ $I^G(J^{PC}) = 1^+(1^{+-})$

Mass m = 1229.5 ± 3.2 MeV (S = 1.6)



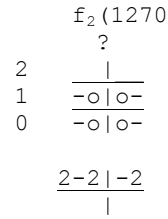
$a_1(1260)$ $I^G(J^{PC}) = 1^-(1^{++})$

Mass m = 1230 ± 40 MeV



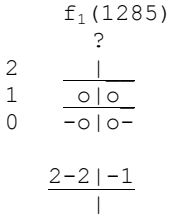
$f_2(1270)$ $I^G(J^{PC}) = 0^+(2^{++})$

Mass m = 1275.1 ± 1.2 MeV (S = 1.1)



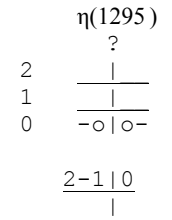
$f_1(1285)$ $I^G(J^{PC}) = 0^+(1^{++})$

Mass m = 1281.8 ± 0.6 MeV (S = 1.6)



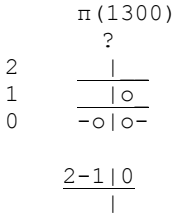
$\eta(1295)$ $I^G(J^{PC}) = 0^+(0^{-+})$

Mass m = 1294 ± 4 MeV (S = 1.6)



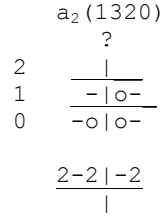
$\pi(1300)$ $I^G(J^{PC}) = 1^-(0^{-+})$

Mass m = 1300 ± 100 MeV



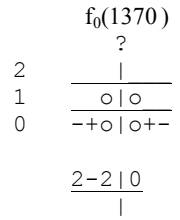
$a_2(1320)$ $I^G(J^{PC}) = 1^-(2^{++})$

Mass m = 1318.3 ± 0.6 MeV (S = 1.2)



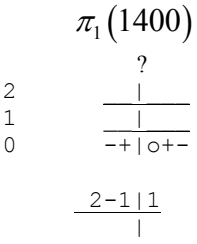
$f_0(1370)$ $I^G(J^{PC}) = 0^+(0^{++})$

Mass m = 1200 to 1500 MeV



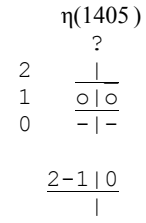
$\pi_1(1400)$ $I^G(J^{PC}) = 1^-(1^{-+})$

Mass m =1351 ± 30 MeV (S = 2.0)



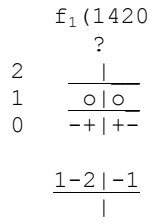
$\eta(1405)$ $I^G(J^{PC}) = 0^+(0^{-+})$

Mass m = 1409.8 ± 2.5 MeV (S = 2.2)



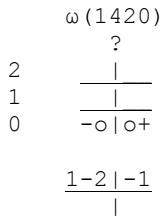
$f_1(1420)$ $I^G(J^{PC}) = 0^+(1^{++})$

Mass m = 1426.4 ± 0.9 MeV (S = 1.1)



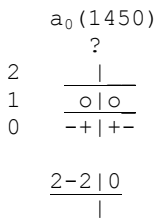
$\omega(1420)$ $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 1400 ± 1450 MeV



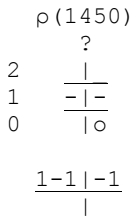
$a_0(1450)$ $I^G(J^{PC}) = 1^-(0^{++})$

Mass m = 1474 ± 19 MeV



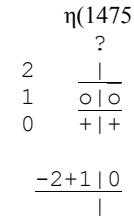
$\rho(1450)$ $I^G(J^{PC}) = 1^+(1^{--})$

Mass m = 1465 ± 25 MeV



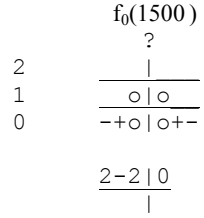
$\eta(1475)$ $I^G(J^{PC}) = 0^+(0^{-+})$

Mass m = 1476 ± 4 MeV (S = 1.3)



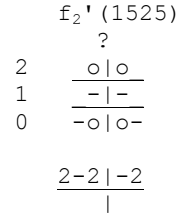
$f_0(1500)$ $I^G(J^{PC}) = 0^+(0^{++})$

Mass m = 1505 ± 6 MeV (S = 1.3)



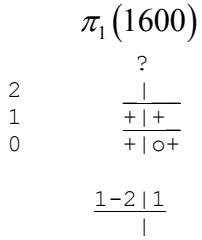
$f_2'(1525)$ $I^G(J^{PC}) = 0^+(2^{++})$

Mass m = 1525 ± 5 MeV



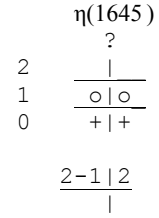
$\pi_1(1600)$ $I^G(J^{PC}) = 1^-(1^{-+})$

Mass m = 1662^{+15}_{-11} MeV (S = 1.2)



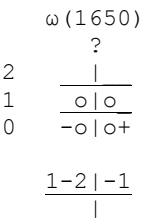
$\eta_2(1645)$ $I^G(J^{PC}) = 0^+(2^{-+})$

Mass m = 1617 ± 5 MeV (S = 1.6)



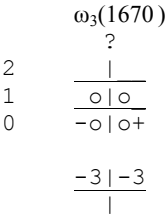
$\omega(1650)$ $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 1670 ± 30 MeV



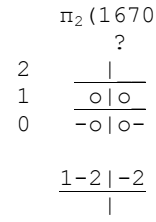
$\omega_3(1670)$ $I^G(J^{PC}) = 0^-(3^{--})$

Mass m = 1667 ± 4 MeV



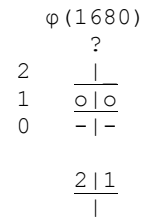
$\pi_2(1670)$ $I^G(J^{PC}) = 1^-(2^{-+})$

Mass m = 1672.4 ± 3.2 MeV



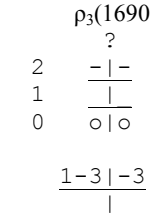
$\varphi(1680)$ $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 1680 ± 20 MeV



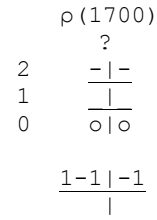
$\rho_3(1690)$ $I^G(J^{PC}) = 1^+(3^{--})$

Mass m = 1688.8 ± 2.1 MeV



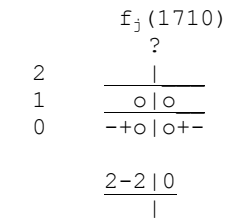
$\rho(1700)$ $I^G(J^{PC}) = 1^+(1^{--})$

Mass m = 1720 ± 20 MeV



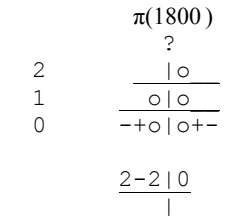
$f_j(1710)$ $I^G(J^{PC}) = 0^+(0^{++})$

Mass m = 1724 ± 7 MeV (S = 1.5)



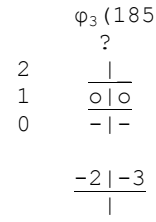
$\pi(1800)$ $I^G(J^{PC}) = 1^-(0^{-+})$

Mass m = 1816 ± 14 MeV (S = 2.3)



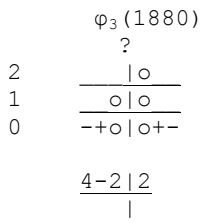
$\varphi_3(1850)$ $I^G(J^{PC}) = 0^-(3^{--})$

Mass m = 1854 ± 7 MeV



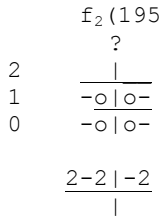
$\pi_2(1880)$ $I^G(J^{PC}) = 1^-(2^{-+})$

Mass m = 1895 ± 16 MeV



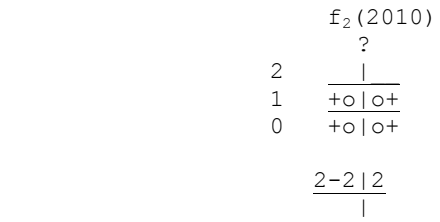
$f_2(1950)$ $I^G(J^{PC}) = 0^+(2^{++})$

Mass m = 1944 ± 12 MeV (S = 1.5)



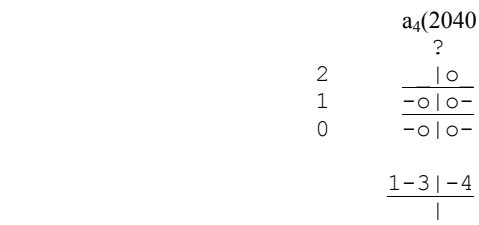
$f_2(2010)$ $I^G(J^{PC}) = 0^+(2^{++})$

Mass m = 2011^{+60}_{-80} MeV



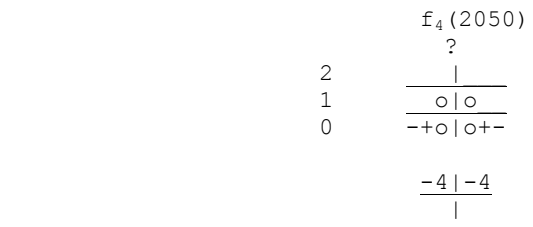
$a_4(2040)$ $I^G(J^{PC}) = 1^-(4^{++})$

Mass m = 2020 ± 16 MeV



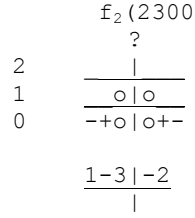
$f_4(2050)$ $I^G(J^{PC}) = 0^+(4^{++})$

Mass m = 2018 ± 2.1 MeV (S = 2.1)



$f_2(2300)$ $I^G(J^{PC}) = 0^+(2^{++})$

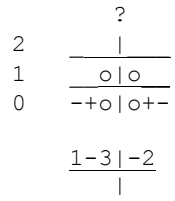
Mass m = 2297 ± 28 MeV



$f_2(2340)$ $I^G(J^{PC}) = 0^+(2^{++})$

Mass m = 2339 ± 60 MeV

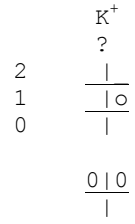
This appears to be the identical particle as $f_2(2300)$. It has the same characteristics, the same decay products, and the mass of $f_2(2300)$ is within the error bar of the mass of $f_2(2340)$.



STRANGE MESONS
(S = ± 1, C = B = 0)

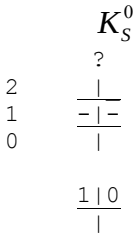
$K^{\pm}$ $I(J^P) = ½(0^-)$

Mass m = 493.677 ± 0.016 MeV (S = 2.8)



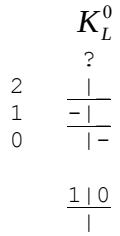
K_S^0 $I(J^P) = ½(0^-)$

Mass m = 497.614 ± 0.024 MeV (S = 1.6)



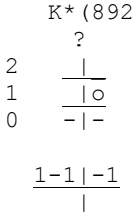
K_L^0 $I(J^P) = ½(0^-)$

Mass m = 497.614 ± 0.024 MeV (S = 1.6)



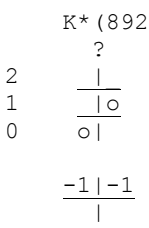
$K^*(892)^\pm$ $I(J^P) = ½(1^-)$

Mass m = 891.66 ± 0.26 MeV



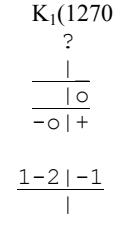
$K^*(892)^0$ $I(J^P) = \frac{1}{2}(1^-)$

Mass m = 896.00 ± 0.25 MeV (S = 1.4)



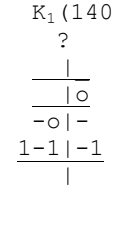
$K_1(1270)$ $I(J^P) = \frac{1}{2}(1^+)$

Mass m = 1272 ± 7 MeV



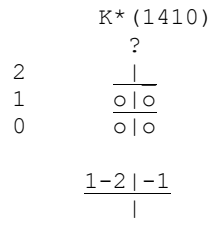
$K_1(1400)$ $I(J^P) = \frac{1}{2}(1^+)$

Mass m = 1403 ± 7 MeV



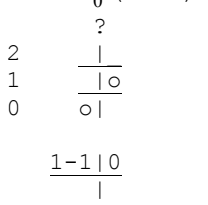
K*(1410) $I(J^P) = \frac{1}{2}(1^-)$

Mass m = 1414 ± 15 MeV (S = 1.3)



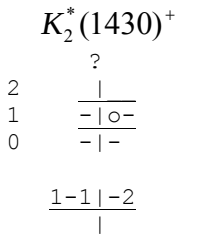
$K_0^*(1430)$ $I(J^P) = \frac{1}{2}(0^+)$

Mass m = 1425 ± 50 MeV



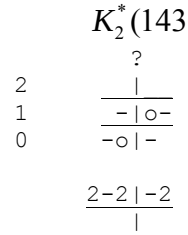
$K_2^*(1430)^+$ $I(J^P) = \frac{1}{2}(2^+)$

Mass m = 1425.6 ± 1.5 MeV (S = 1.1)



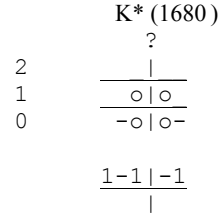
$K_2^*(1430)^0$ $I(J^P) = ½(2^+)$

Mass m = 1432.4 ± 1.3 MeV



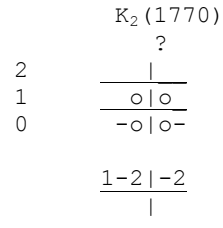
$K^*(1680)$ $I(J^P) = ½(1^-)$

Mass m = 1717 ± 27 MeV (S = 1.4)



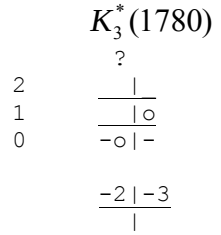
$K_2(1770)$ $I(J^P) = ½(2^-)$

Mass m = 1773 ± 8 MeV



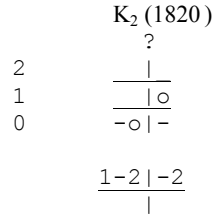
$K_3^*(1780)$ $I(J^P) = \frac{1}{2}(3^-)$

Mass m = 1776 ± 7 MeV (S = 1.1)



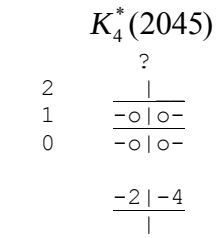
$K_2(1820)$ $I(J^P) = \frac{1}{2}(2^-)$

Mass m = 1816 ± 13 MeV



$K_4^*(2045)$ $I(J^P) = \frac{1}{2}(4^+)$

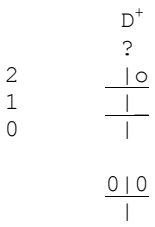
Mass m = 2045 ± 9 MeV (S = 1.1)



CHARMED MESONS
(C = ± 1)

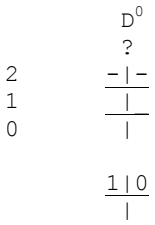
$D^{\pm}$ $I(J^P) = \frac{1}{2}(0^-)$

Mass m = 1869.62 ± 0.20 MeV (S = 1.1)



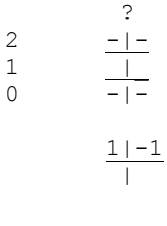
D^0 $I(J^P) = \frac{1}{2}(0^-)$

Mass m = 1864.84 ± 0.17 MeV (S = 1.1)



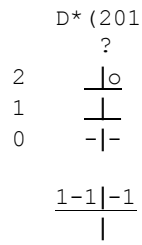
$D^*(2007)^0$ $I(J^P) = \frac{1}{2}(1^-)$ I, J, P need confirmation

Mass m = 2006.97 ± 0.19 MeV (S = 1.1)



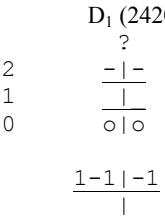
$D^*(2010)^{\pm}$ $I(J^P) = \frac{1}{2}(1^-)$ I, J, P need confirmation.

Mass m = 2010.27 ± 0.17 MeV (S = 1.1)



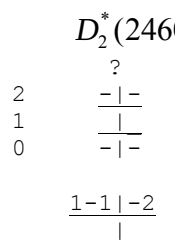
$D_1(2420)^0$ $I(J^P) = \frac{1}{2}(1^+)$ I, J, P need confirmation.

Mass m = 2422.3 ± 1.3 MeV (S = 1.2)



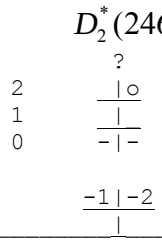
$D_2^*(2460)^0$ $I(J^P) = \frac{1}{2}(2^+)$ $J^P = 2^+$ assignment strongly favored.

Mass m = 2461.1 ± 1.6 MeV (S = 1.3)



$D_2^*(2460)^+$ I(J^P) = ½(2$^+$) J^P = 2$^+$ assignment strongly favored.

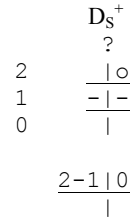
Mass m = $2460.1^{+2.6}_{-3.5}$ MeV (S = 1.5)



CHARMED, STRANGE MESONS
(C = S = ± 1)

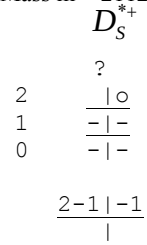
$D_S^\pm$ was $F^\pm$ I(J^P) = 0(0$^-$)

Mass m = 1968.49 ± 0.34 MeV (S = 1.3)



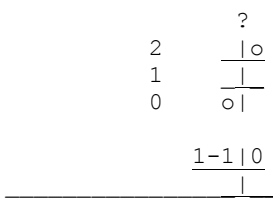
$D_S^{*\pm}$ I(J^P) = 0(?$^?$) J^P is natural, width and decay modes consistent with 1$^-$

Mass m = 2112.3 ± 0.5 MeV (S = 1.1)



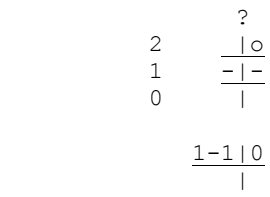
$D_{s0}^{*}(2317)^{\pm}$ I(J^{P}) = 0(0^{+}) J, P need confirmation.

Mass m = 2317.8 ± 0.6 MeV (S = 1.1)



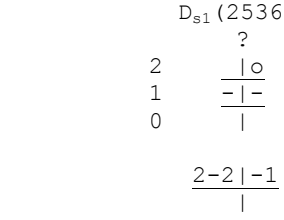
$D_{s1}(2460)^{\pm}$ I(J^{P}) = 0(1^{+})

Mass m = 2459.6 ± 0.6 MeV (S = 1.1)

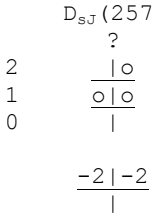


$D_{s1}(2536)^{\pm}$ I(J^{P}) = 0(1^{+}) J, P need confirmation.

Mass m = 2535.35 ± 0.34 MeV

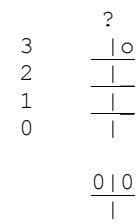


$D_{s2}(2573)^{\pm}$ I(J^P) = 0(?$^?$) J^P is natural, width and decay
Mass m = 2572.6 ± 0.9 MeV modes consistent with 2^+.

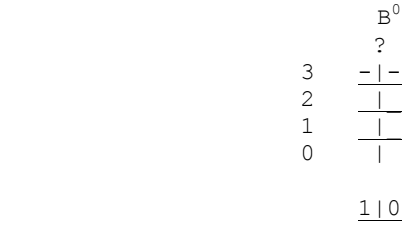


BOTTOM MESONS
(B = ±1)

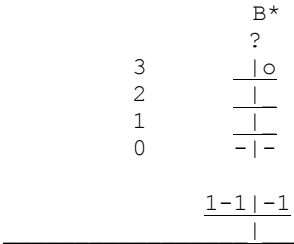
$B^{\pm}$ I(J^P) = ½(0$^-$) I, J, P need confirmation. Quantum
Mass m = 5279.15 ± 0.31 MeV numbers shown are quark-model predictions.



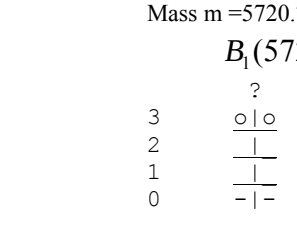
B^0 $I(J^P) = ½(0^-)$ I, J, P need confirmation. Quantum numbers shown are quark-model predictions.
Mass m = 5279.53 ± 0.33 MeV



B* $I(J^P) = ½(1^-)$ I, J, P need confirmation. Quantum numbers shown are quark-model predictions.
Mass m =5325.1 ± 0.5 MeV



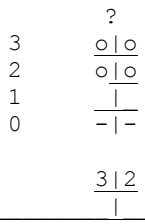
$B_1(5721)^0$ $I(J^P) = ½(1^+)$ I, J, P need confirmation.
Mass m =5720.7 ± 0.5 MeV



$B_2^*(5747)^0$ I(J^P) = 1/2(2+) I, J, P need confirmation.

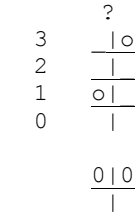
Mass m = 5746.9 ± 2.9 MeV

$B_2^*(5747)^0$

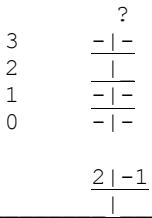


BOTTOM, STRANGE MESONS
(B = ±1, S = ∓1)

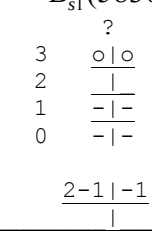
B_S^0 $I(J^P) = 0(0^-)$ I, J, P need confirmation. Quantum numbers
Mass m = 5366.3 ± 0.6 MeV shown are quark-model
B_S^0 predictions.



B_s^* $I(J^P) = 0(1^-)$ I, J, P need confirmation. Quantum numbers
Mass m = 5412.8 ± 1.3 MeV shown are quark-model
B_S^* predictions.



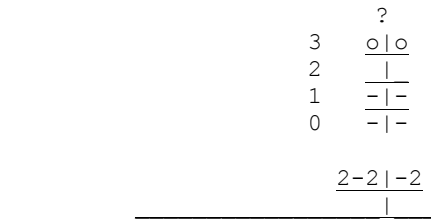
$B_{s1}(5830)^0$ $I(J^P) = ½(1^+)$ I, J, P need confirmation.
Mass m = 5829.4 ± 0.7 MeV
$B_{s1}(5830)^0$



$B_{s2}^{*}(5840)^{0}$ $I(J^{P}) = ½(2^{+})$ I, J, P need confirmation.

Mass m = 5839.7 ± 0.6 MeV

$B_{s1}(5840)^{0}$

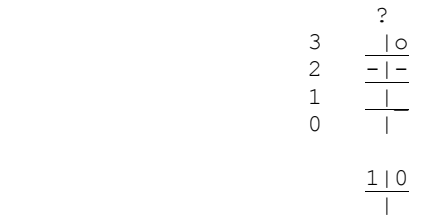


BOTTOM, CHARMED MESONS
(B = C = ± 1)

$B_{c}^{\pm}$ $I(J^{P}) = 0(0^{-})$ I, J, P need confirmation. Quantum numbers shown are quark-model predictions.

Mass m = 6276 ± 4 MeV

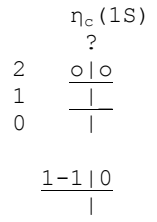
B_{c}^{+}



$c\bar{c}$ MESONS

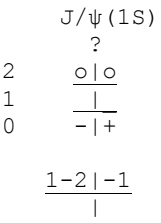
$\eta_c(1S)$ $I^G(J^{PC}) = 0^+(0^{-+})$

Mass m = 2980.3 ± 1.2 MeV (S = 1.7)



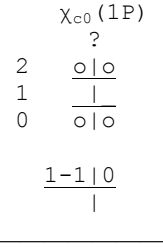
$J/\psi(1S)$ $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 3096.916 ± 0.011 MeV



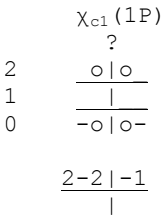
$\chi_{c0}(1P)$ $I^G(J^{PC}) = 0^+(0^{++})$

Mass m = 3414.75 ± 0.31 MeV



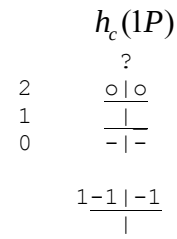
$\chi_{c1}(1P)$ $I^G(J^{PC}) = 0^+(1^{++})$

Mass m = 3510.66 ± 0.07 MeV



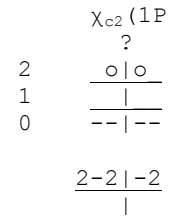
$h_c(1P)$ $I^G(J^{PC}) = ?^?(1^{+-})$

Mass m = 3525.93 ± 0.27 MeV (S = 1.5)



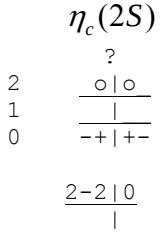
$\chi_{c2}(1P)$ $I^G(J^{PC}) = 0^+(2^{++})$

Mass m = 3556.20 ± 0.09 MeV



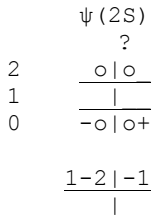
$\eta_c(2S)$ $I^G(J^{PC}) = 0^+(0^{-+})$

Mass m = 3637 ± 4 MeV (S = 1.7)



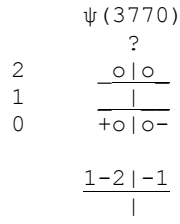
ψ(2S) $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 3686.09 ± 0.04 MeV (S = 1.6)



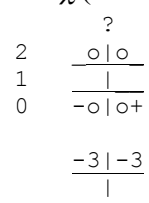
ψ(3770) $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 3772.92 ± 0.35 MeV (S = 1.1)



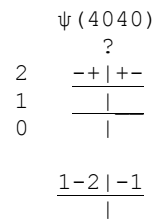
$\chi(3872)$ $I^G(J^{PC}) = 0^?(?^{?+})$

Mass m = 3872.2 ± 0.8 MeV (S = 2.5)



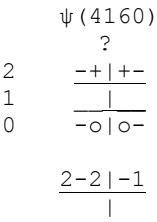
$\psi(4040)$ $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 4039 ± 1 MeV



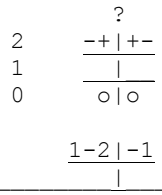
$\psi(4160)$ $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 4159 ± 20 MeV



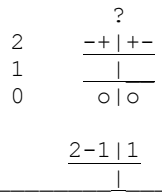
$\chi(4260)$ $I^G(J^{PC}) = ?^?(1^{--})$

Mass m = 4263^{+8}_{-9} MeV (S = 1.1)



$\psi(4415)$ $I^G(J^{PC}) = 0^-(1^{--})$

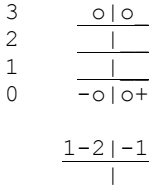
Mass m = 4421 ± 4 MeV



$b\bar{b}$ MESONS

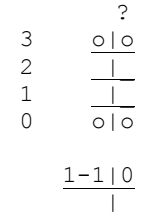
Y(1S) $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 9460.30 ± 0.26 MeV (S = 3.3)



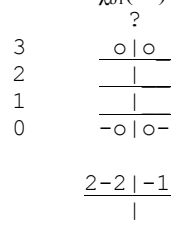
$\chi_{b0}(1P)$ $I^G(J^{PC}) = 0^+(0^{++})$ J needs confirmation.

Mass m = 9859.44 ± 0.42 MeV



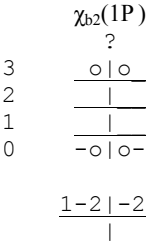
$\chi_{b1}(1P)$ $I^G(J^{PC}) = 0^+(1^{++})$ J needs confirmation.

Mass m = 9892.78 ± 0.26 MeV



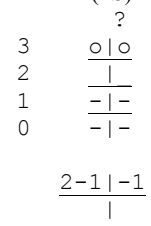
$\chi_{b2}(1P)$ $I^G(J^{PC}) = 0^+(2^{++})$ J needs confirmation.

Mass m = 9912.21 ± 0.26 MeV



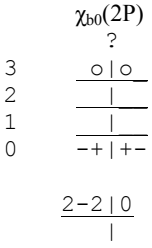
Y(2S) $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 10.02326 ± 0.00031 GeV



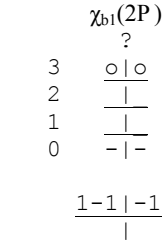
$\chi_{b0}(2P)$ $I^G(J^{PC}) = 0^+(0^{++})$ J needs confirmation.

Mass m = 10.2325 ± 0.0005 GeV



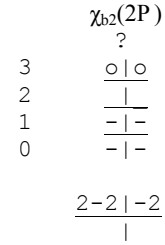
$\chi_{b1}(2P)$ $I^G(J^{PC}) = 0^+(1^{++})$ J needs confirmation.

Mass m = 10.25546 ± 0.00022 GeV



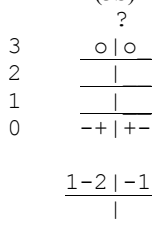
$\chi_{b2}(2P)$ $I^G(J^{PC}) = 0^+(2^{++})$ J needs confirmation.

Mass m = 10.26865 ± 0.00022 GeV



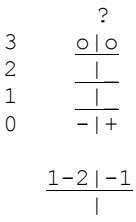
Y(3S) $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 10.3553 ± 0.0005 GeV



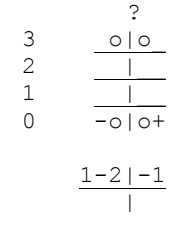
Y(4S) or Y(10580) $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 10.5794 ± 0.0012 GeV



Y(10860) $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 10.865 ± 0.008 GeV (S = 1.1)



Y (11020) $I^G(J^{PC}) = 0^-(1^{--})$

Mass m = 11.019 ± 0.008 GeV

Y (11020)

?

3 o|o

2 _|_

1 _|_

0 |

1|1

|

N BARYONS
(S = 0, I = ½)

p $I(J^P) = ½(½^+)$

Mass m = 938.27203 ± 0.00008 MeV

p

?

2 |___

1 |___

0 |no

1-1|½

|

---

n $I(J^P) = ½(½^+)$

Mass m = 939.56536 ± 0.00008 MeV

n

933.948 3545 MeV

2 _|_

1 _|_

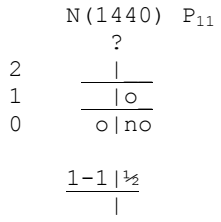
0 |n

-1|-½

|

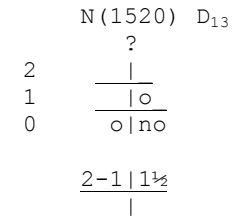
N(1440) P_{11} $I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$

Breit-Wigner mass = 1420 to 1470 (≈ 1440) MeV



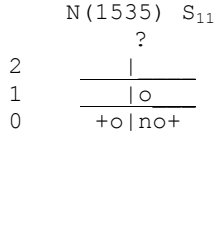
N(1520) D_{13} $I(J^P) = \frac{1}{2}(3/2^-)$

Breit-Wigner mass = 1515 to 1525 (≈ 1520) MeV



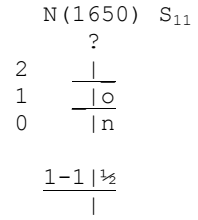
N(1535) S_{11} $I(J^P) = \frac{1}{2}(\frac{1}{2}^-)$

Breit-Wigner mass = 1525 to 1545 (≈ 1535) MeV



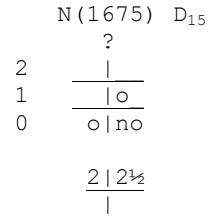
N(1650) S_{11} $I(J^P) = \frac{1}{2}(\frac{1}{2}^-)$

Breit-Wigner mass = 1645 to 1670 (≈ 1655) MeV



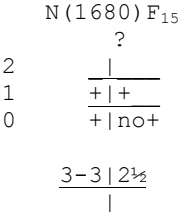
N(1675) D_{15} $I(J^P) = \frac{1}{2}(5/2^-)$

Breit-Wigner mass = 1670 to 1680 (≈ 1675) MeV



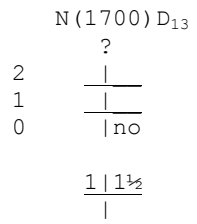
N(1680) F_{15} $I(J^P) = \frac{1}{2}(5/2^+)$

Breit-Wigner mass = 1680 to 1690 (≈ 1685) MeV



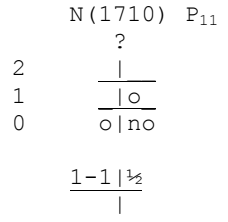
N(1700) D_{13} $I(J^P) = \frac{1}{2}(3/2^-)$

Breit-Wigner mass = 1650 to 1750 (≈ 1700) MeV



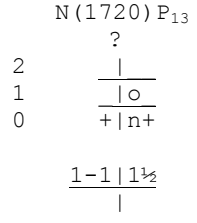
N(1710) P_{11} $I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$

Breit-Wigner mass = 1680 to 1740 (≈ 1710) MeV



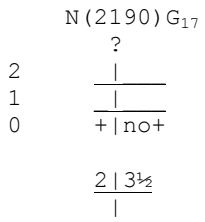
N(1720) P_{13} $I(J^P) = \frac{1}{2}(3/2^+)$

Breit-Wigner mass = 1700 to 1750 (≈ 1720) MeV



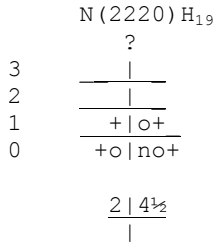
N(2190) G_{17} $I(J^P) = ½(7/2^-)$

Breit-Wigner mass = 2100 to 2200 (≈ 2190) MeV



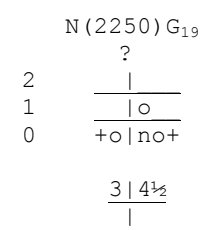
N(2220) H_{19} $I(J^P) = ½(9/2^+)$

Breit-Wigner mass = 2200 to 2300 (≈ 2250) MeV



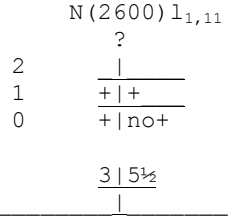
N(2250) G_{19} $I(J^P) = ½(9/2^-)$

Breit-Wigner mass = 2200 to 2350 (≈ 2275) MeV



$N(2600)\ I_{1,11}$ $I(J^P) = ½(11/2^{--})$

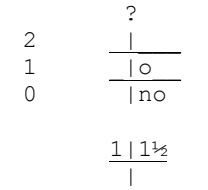
Breit-Wigner mass = 2550 to 2750 (≈ 2600) MeV



Δ BARYONS
(S = 0, I = 3/2)

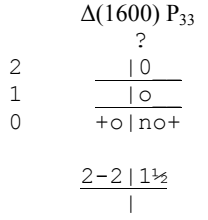
$\Delta(1232)\ P_{33}$ $I(J^P) = 3/2(3/2^+)$

Breit-Wigner mass (mixed charges) = 1231 to 1233 (≈ 1232) MeV



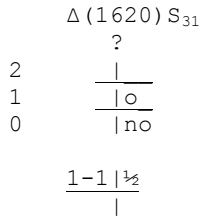
$\Delta(1600)\ P_{33}$ $I(J^P) = 3/2(3/2^+)$

Breit-Wigner mass = 1550 to 1700 (≈ 1600) MeV



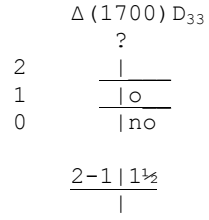
$\Delta(1620)\ S_{31}$ $I(J^P) = 3/2(1/2^-)$

Breit-Wigner mass = 1600 to 1660 (≈ 1630) MeV



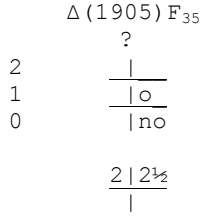
$\Delta(1700)\ D_{33}$ $I(J^P) = 3/2(3/2^-)$

Breit-Wigner mass = 1670 to 1750 (≈ 1700) MeV



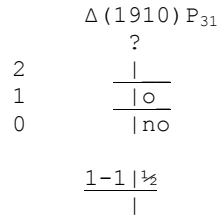
$\Delta(1905)\ F_{35}$ $I(J^P) = 3/2(5/2^+)$

Breit-Wigner mass = 1865 to 1915 (≈ 1890) MeV



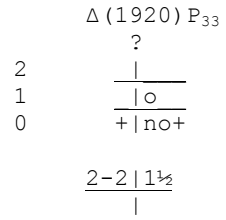
$\Delta(1910)\ P_{31}$ $I(J^P) = 3/2(1/2^+)$

Breit-Wigner mass = 1870 to 1920 (≈ 1910) MeV



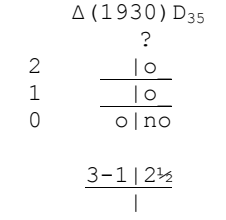
$\Delta(1920)\ P_{33}$ $I(J^P) = 3/2(3/2^+)$

Breit-Wigner mass = 1900 to 1970 (≈ 1920) MeV



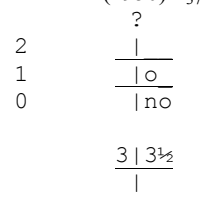
$\Delta(1930)\ D_{35}$ $I(J^P) = 3/2(5/2^-)$

Breit-Wigner mass = 1900 to 2020 (≈ 1960) MeV



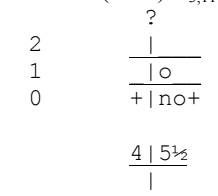
$\Delta(1950)\ F_{37}$ $\quad I(J^P) = 3/2(7/2^+)$

Breit-Wigner mass = 1915 to 1950 (≈ 1930) MeV



$\Delta(2420)\ H_{3,11}$ $\quad I(J^P) = 3/2(11/2^+)$

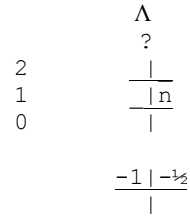
Breit-Wigner mass = 2300 to 2500 (≈ 2420) MeV



Λ BARYONS
(S = -1, I = 0)

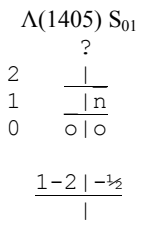
Λ $\quad I(J^P) = 0(½^+)$

Mass m = 1115.683 ± 0.006 MeV



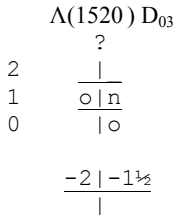
$\Lambda(1405)\ S_{01}$ $\quad I(J^P) = 0(1/2^-)$

Mass m = 1406 ± 4 MeV



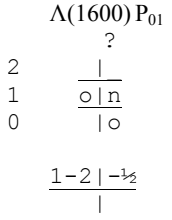
$\Lambda(1520)\ D_{03}$ $\quad I(J^P) = 0(3/2^-)$

Mass m = 1519.5 ± 1.0 MeV



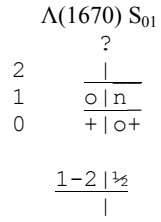
$\Lambda(1600)\ P_{01}$ $\quad I(J^P) = 0(1/2^+)$

Mass m = 1560 to 1700 (≈ 1600) MeV



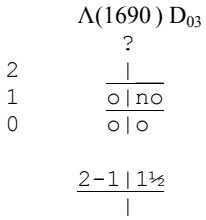
$\Lambda(1670)\ S_{01}$ $I(J^P) = 0(1/2^-)$

Mass m = 1660 to 1680 (≈ 1670) MeV



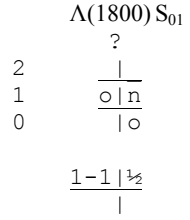
$\Lambda(1690)\ D_{03}$ $I(J^P) = 0(3/2^-)$

Mass m = 1685 to 1695 (≈ 1690) MeV



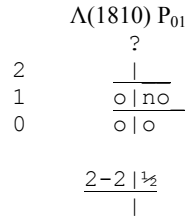
$\Lambda(1800)\ S_{01}$ $I(J^P) = 0(1/2^-)$

Mass m = 1720 to 1850 (≈ 1800) MeV



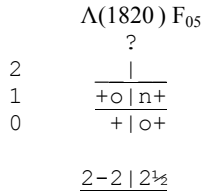
$\Lambda(1810)\ P_{01}$ $\quad I(J^P) = 0(1/2^+)$

Mass m = 1750 to 1850 (≈ 1810) MeV



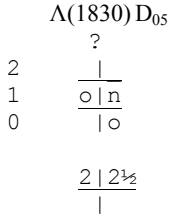
$\Lambda(1820)\ F_{05}$ $\quad I(J^P) = 0(5/2^+)$

Mass m = 1815 to 1825 (≈ 1820) MeV



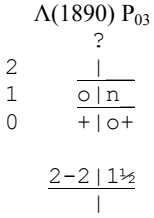
$\Lambda(1830)\ D_{05}$ $\quad I(J^P) = 0(5/2^-)$

Mass m = 1810 to 1830 (≈ 1830) MeV



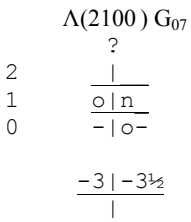
$\Lambda(1890)\ P_{03}$ $I(J^P) = 0(3/2^+)$

Mass m = 1850 to 1910 (≈ 1890) MeV



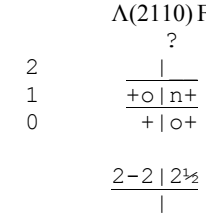
$\Lambda(2100)\ G_{07}$ $I(J^P) = 0(7/2^-)$

Mass m = 2090 to 2110 (≈ 2100) MeV



$\Lambda(2110)\ F_{05}$ $I(J^P) = 0(5/2^+)$

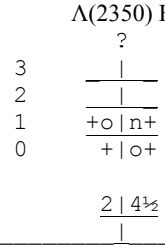
Mass m = 2090 to 2140 (≈ 2110) MeV



$\Lambda(2350)$ H_{09} $I(J^P) = 0(9/2^+)$

Mass m = 2340 to 2370 (≈ 2350) MeV

$\Lambda(2350)$ H_{09}

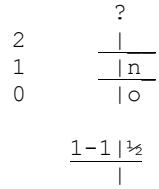


Σ BARYONS
(S = -1, I = 1)

Σ^+ $I(J^P) = 1(½^+)$

Mass m = 1189.37 ± 0.07 MeV (S = 2.2)

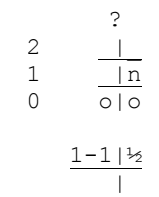
Σ^+



Σ^0 $I(J^P) = 1(½^+)$

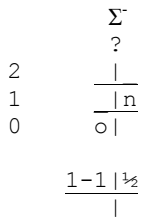
Mass m = 1192.642 ± 0.024 MeV

Σ^0



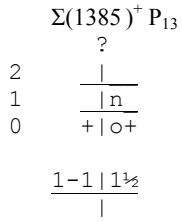
Σ^- $I(J^P) = 1(1/2^+)$

Mass m = 1197.449 ± 0.030 MeV (S = 1.2)



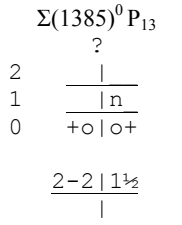
$\Sigma(1385)^+ P_{13}$ $I(J^P) = 1(3/2^+)$

Mass m = 1382.8 ± 0.4 MeV (S = 2.0)



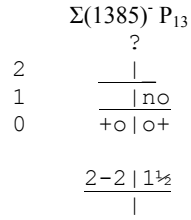
$\Sigma(1385)^0 P_{13}$ $I(J^P) = 1(3/2^+)$

Mass m = 1383.7 ± 1.0 MeV (S = 1.4)



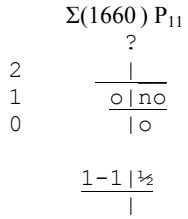
$\Sigma(1385)^-$ P_{13} $I(J^P) = 1(3/2^+)$

Mass m = 1387.2 ± 0.5 MeV (S = 2.2)



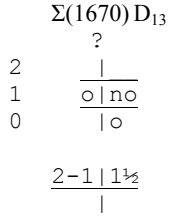
$\Sigma(1660)$ P_{11} $I(J^P) = 1(1/2^+)$

Mass m = 1630 to 1690 (≈ 1660) MeV



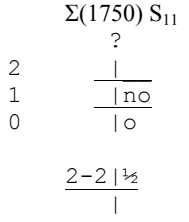
$\Sigma(1670)$ D_{13} $I(J^P) = 1(3/2^-)$

Mass m = 1665 to 1685 (≈ 1670) MeV



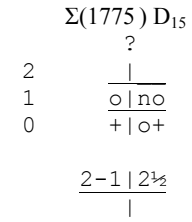
$\Sigma(1750)\ S_{11}$ $I(J^P) = 1(1/2^-)$

Mass m = 1730 to 1800 (≈ 1750) MeV



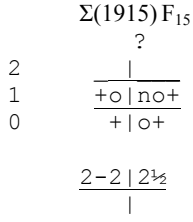
$\Sigma(1775)\ D_{15}$ $I(J^P) = 1(5/2^-)$

Mass m = 1770 to 1780 (≈ 1775) MeV



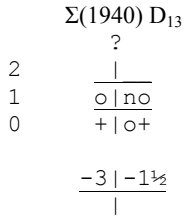
$\Sigma(1915)\ F_{15}$ $I(J^P) = 1(5/2^+)$

Mass m = 1900 to 1935 (≈ 1915) MeV



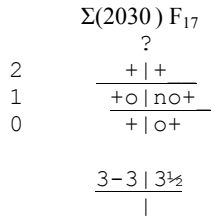
$\Sigma(1940)\ D_{13}$ $I(J^P) = 1(3/2^-)$

Mass m = 1900 to 1950 (≈ 1940) MeV



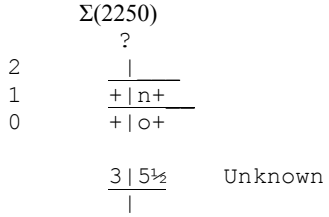
$\Sigma(2030)\ F_{17}$ $I(J^P) = 1(7/2^+)$

Mass m = 2025 to 2040 (≈ 2030) MeV



$\Sigma(2250)$ $I(J^P) = 1(?^?)$

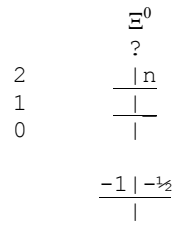
Mass m = 2210 to 2280 (≈ 2250) MeV



Ξ BARYONS
(S = -2, I = ½)

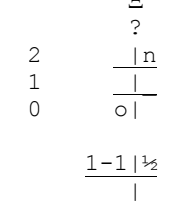
Ξ^0 $I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$ P is not yet measured; + is the quark model prediction.

Mass m = 1314.86 ± 0.20 MeV



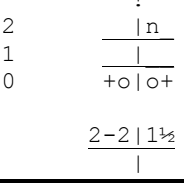
Ξ^- $I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$ P is not yet measured; + is the quark model prediction.

Mass m = 1321.71 ± 0.07 MeV



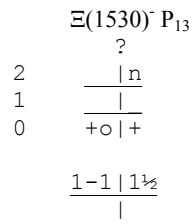
$\Xi(1530)^0\ P_{13}$ $I(J^P) = \frac{1}{2}(3/2^+)$

Mass m = 1531.80 ± 0.32 MeV (S = 1.3)



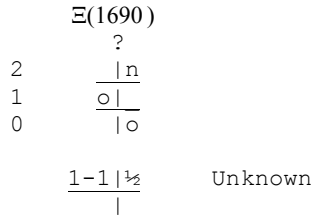
$\Xi(1530)^-$ P_{13} $I(J^P) = \frac{1}{2}(3/2^+)$

Mass m = 1535.0 ± 0.6 MeV



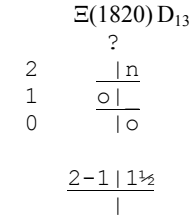
$\Xi(1690)$ $I(J^P) = \frac{1}{2}(?^?)$

Mass m = 1690 ± 10 MeV



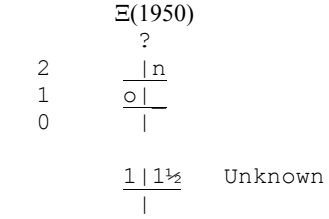
$\Xi(1820)$ D_{13} $I(J^P) = \frac{1}{2}(3/2^-)$

Mass m = 1823 ± 5 MeV



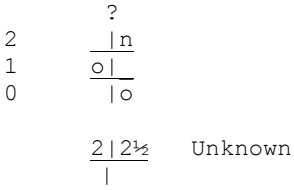
Ξ(1950) $I(J^P) = ½(?^?)$

Mass m = 1950 ± 15 MeV



Ξ(2030) $I(J^P) = ½(\geq 5/2^?)$

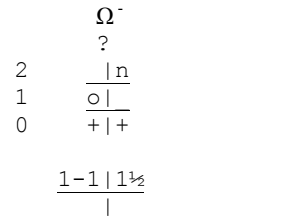
Mass m = 2025 ± 5 MeV



Ω BARYONS
(S = - 3, I = 0)

Ω⁻ $I(J^P) = 0(3/2^+)$ J^P is not yet measured; $3/2^+$ is the quark model prediction.

Mass m = 1672.45 ± 0.29 MeV



$\Omega(2250)^-$ $I(J^P) = 0(?^?)$

Mass m = 2252 ± 9 MeV

$\Omega(2250)^-$

?

2 | n

1 o | _

0 o | o

2 | 2½ Unknown

|

CHARMED BARYONS
(C = + 1)

Λ_c^+ $I(J^P) = 0(½^+)$ J not confirmed; ½ is the quark model prediction.

Mass m = 2286.46 ± 0.14 MeV

Λ_c^+

?

2 | no

1 | __

0 |

1-1 | ½

|

$\Lambda_c(2595)^+$ $I(J^P) = 0(½^-)$ The spin-parity follows from the fact that $\Sigma_c(2455)\pi$ decays, with little available space, are dominant.

Mass m = 2595.4 ± 0.6 MeV

$\Lambda_c(2595)^+$

?

2 | no

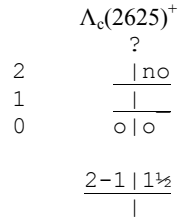
1 | __

0 o | o

1-1 | ½

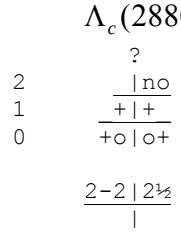
$\Lambda_c(2625)^+$ $I(J^P) = 0(3/2^-)$ J^P is expected to be $3/2^-$.

Mass m = 2628.1 ± 0.6 MeV (S = 1.5)



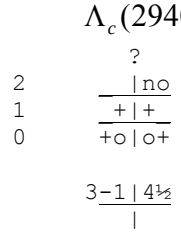
$\Lambda_c(2880)^+$ $I(J^P) = 0(5/2^+)$ There is some good evidence that indeed $J^P = 5/2^+$.

Mass m = 2881.53 ± 0.35 MeV



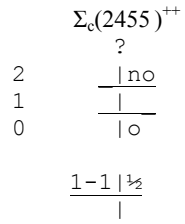
$\Lambda_c(2940)^+$ $I(J^P) = 0(?^?)$

Mass m = $2939.3^{+1.4}_{-1.5}$ MeV



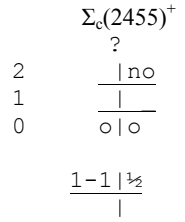
$\Sigma_c(2455)^{++}$ $I(J^P) = 1(1/2^+)$ J^P not confirmed; $1/2^+$ is the quark model prediction.

Mass m = 2454.02 ± 0.18 MeV



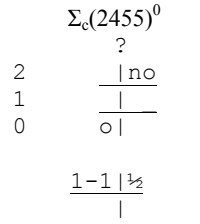
$\Sigma_c(2455)^{+}$ $I(J^P) = 1(1/2^+)$ J^P not confirmed; $1/2^+$ is the quark model prediction.

Mass m = 2452.9 ± 0.4 MeV



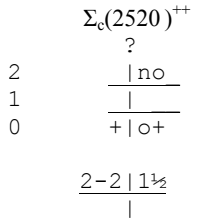
$\Sigma_c(2455)^{0}$ $I(J^P) = 1(½^+)$ J^P not confirmed; $1/2^+$ is the quark model prediction.

Mass m = 2453.76 ± 0.18 MeV



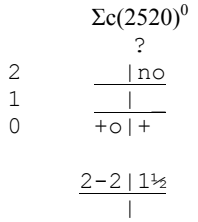
$\Sigma_c(2520)^{++}$ $I(J^P) = 1(3/2^+)$

Mass m = 2518.4 ± 0.6 MeV



$\Sigma_c(2520)^0$ $I(J^P) = 1(3/2^+)$

Mass m = 2518.0 ± 0.5 MeV



$\Sigma_c(2800)$ $I(J^P) = 1(?^?)$ Unknown structures.

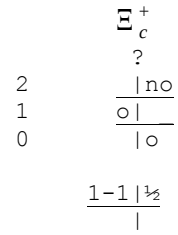
$\Sigma_c(2800)^{++}$ mass m = 2801^{+4}_{-6} MeV

$\Sigma_c(2800)^{+}$ mass m = 2792^{+14}_{-5} MeV

$\Sigma_c(2800)^{0}$ mass m = 2802^{+4}_{-7} MeV

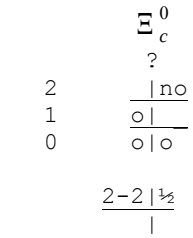
Ξ_c^+ $I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$ $I(J^P)$ not confirmed; $\frac{1}{2}(\frac{1}{2}^+)$ is the quark model prediction.

Mass m = 2467.9 ± 0.4 MeV



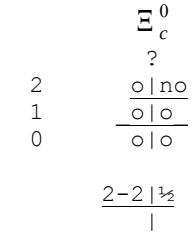
Ξ_c^0 $I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$ $I(J^P)$ not confirmed; $\frac{1}{2}(\frac{1}{2}^+)$ is the quark model prediction.

Mass m = 2471.0 ± 0.4 MeV



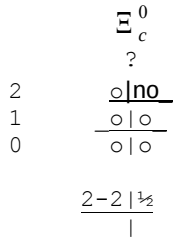
$\Xi_c'^+$ $I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$ $I(J^P)$ not confirmed; $\frac{1}{2}(\frac{1}{2}^+)$ is the quark model prediction.

Mass m = 2575.7 ± 3.1 MeV



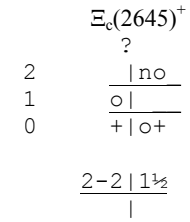
$\Xi_c^{'0}$ $I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$ $I(J^P)$ not confirmed; $\frac{1}{2}(\frac{1}{2}^+)$ is the quark model prediction.

Mass m = 2578.0 ± 2.9 MeV



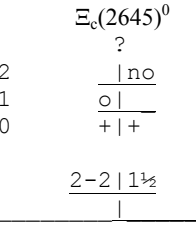
$\Xi_c(2645)^+$ $I(J^P) = \frac{1}{2}(3/2^+)$

Mass m = 2646.6 ± 1.4 MeV (S = 1.6)



$\Xi_c(2645)^0$ $I(J^P) = 1/2(3/2^+)$

Mass m = 2646.1 ± 1.2 MeV



$\Xi_c(2790)^+$ $I(J^P) = 1/2(1/2^-)$

J^P has not been measured; ½⁻ is the quark model prediction.

Mass m = 2789.2 ± 3.2 MeV

$\Xi_c(2790)^0$ $I(J^P) = 1/2(1/2^-)$

J^P has not been measured; ½⁻ is the quark model prediction.

Mass m = 2791.9 ± 3.3 MeV

$\Xi_c(2815)^+$ $I(J^P) = 1/2(3/2^-)$

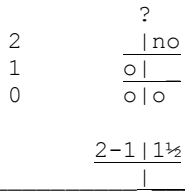
J^P has not been measured; ½⁻ is the quark model prediction.

Mass m = 2816.5 ± 1.2 MeV

$\Xi_c(2815)^0$ $I(J^P) = 1/2(3/2^-)$

J^P has not been measured; $\frac{1}{2}^-$ is the quark model prediction.

Mass m = 2818.2 ± 1.2 MeV



$\Xi_c(2980)$ $I(J^P) = 1/2(?^?)$ Unknown structures.

$\Xi_c(2980)^+$ m = 2974 ± 5 MeV (S = 2.3)

$\Xi_c(2980)^0$ m = 2974 ± 4 MeV

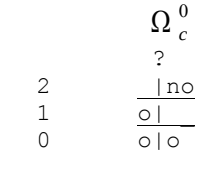
$\Xi_c(3080)$ $I(J^P) = 1/2(?^?)$ Unknown structures.

$\Xi_c(3080)^+$ m = 3077.0 ± 0.4 MeV

$\Xi_c(3080)^0$ m = 3079.9 ± 1.4 MeV

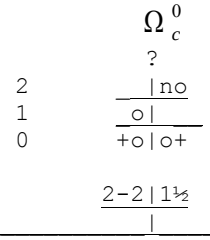
Ω_c^0 $I(J^P) = 0(\frac{1}{2}^+)$ $I(J^P)$ not confirmed; $0(\frac{1}{2}^+)$ is the quark model prediction.

Mass m = 2697.5 ± 2.6 MeV (S = 1.2)



$\Omega_c(2770)^0$ $I(J^P) = 0(3/2^+)$ $I(J^P)$ not confirmed; $0(½^+)$ is the quark model prediction.

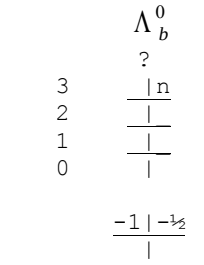
Mass m = 2768.3 ± 3.0 MeV (S = 1.2)



BOTTOM BARYONS
(B = - 1)

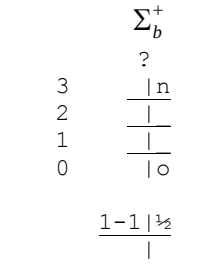
Λ_b^0 $I(J^P) = 0(1/2^+)$ $I(J^P)$ not yet measured; $0(1/2^+)$ is the quark model prediction.

Mass m = 5620.2 ± 1.6 MeV



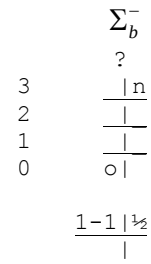
Σ_b^+ $I(J^P) = 1(1/2^+)$ I, J, P need confirmation.

Mass m = 5807.8 ± 2.7 MeV



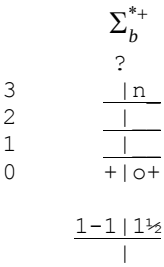
Σ_b^- $I(J^P) = 1(1/2^+)$ I, J, P need confirmation.

Mass m = 5815.2 ± 2.0 MeV



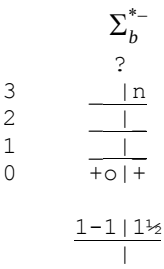
Σ_b^{*+} $I(J^P) = 1(3/2^+)$ I, J, P need confirmation.

Mass m = 5829.0 ± 3.4 MeV



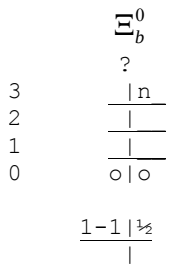
Σ_b^{*-} $I(J^P) = 1(3/2^+)$ I, J, P need confirmation.

Mass m = 5836.4 ± 2.8 MeV



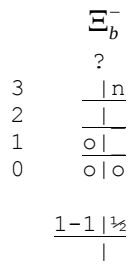
Ξ_b^0 I(J^P) = 1/2(1/2$^+$) I, J, P need confirmation.

Mass m = 5792.4 ± 3.0 MeV



Ξ_b^- I(J^P) = 1/2(1/2$^+$) I, J, P need confirmation.

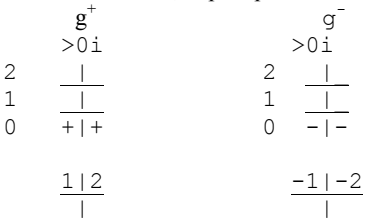
Mass m = 5792.4 ± 3.0 MeV



GRAVITONS

$g^{\pm}$ I(J) = 0(2)

Mass m undetermined; expect positive imaginary component.

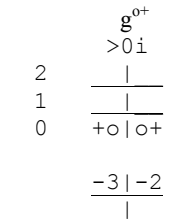


Higher energy state orbiting particle pairs can also compose $g^{\pm}$ gravitons.

---

g^{o+} I(J) = 0(2)

Mass m undetermined; expect positive imaginary component.



A negative + echon orbits a positive o echon with -1 orbital spin, forming a neutrino. A positive + echon orbits a negative o echon with -1 orbital spin, forming an anti-neutrino. The neutrino and anti- neutrino orbit each other with an additional -1 orbital spin. The result is a g^{o+} graviton with -2 spin.

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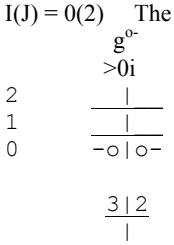
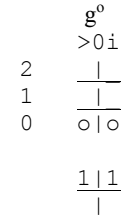
g^{o-} I(J) = 0(2) The spin conjugate graviton g^{o-} is also possible.



According to chonomic decay schemes, a 1 spin graviton also exists.

g^{o} I(J) = 0(1)

Mass m undetermined; expect positive imaginary component.



MAGNETONS

The magnetic moments cancel out in gravitons. Not so in magnetons. The ω(782) particle is a magneton, as are other ω particles.

ω(782) $I^G(J^{PC}) = 0^-(1^-)$

Mass m = 781.94 ± 0.12 MeV (S = 1.5)