[about 1965]

ν_e	ν_μ
e^-	μ^-

u	c?
d	s

~~Stat~~

["wouldn't it be charming ...?"]

November revolution (1974)

Heavy mesons discovered (~ 3000 MeV)

ψ [SLAC, Richter]

J [BNL, Ting]

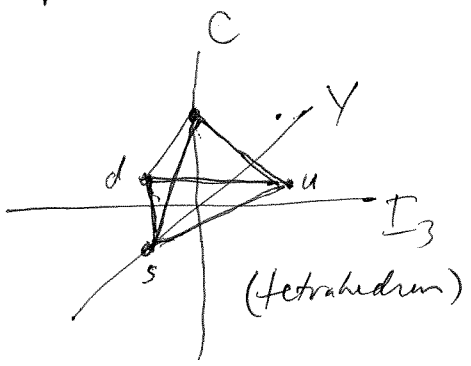
very narrow $\Rightarrow$ ~~long~~ [Phot]

$\Rightarrow \tau \sim 10^{-20}$ sec

Charmonium $c\bar{c}$ so $m_c \approx 1500$ MeV

4 flavors: fundamental of $SU(4)$, $\underline{4}$

τ rank 3



(tetrahedron)

[Not such a good symmetry

~~Symmetry~~.

1st gen. symm $\Rightarrow$ degeneracy

$SU(3) \Rightarrow m_s > m_u, m_d$

$SU(4) \Rightarrow m_c \gg m_s, m_{u,d}$

If masses were equal then hadrons in multiplets would be degenerate

mesons: $4 \times \bar{4} = 15 + 1$

τ cuboctahedron

baryons $4 \times 4 \times 4 = (10_S + 6_A) \times 4 = \underbrace{20}_{\text{pyramid}} + \underbrace{20_S + 20}_{\text{truncated pyramid}} + \bar{4}$

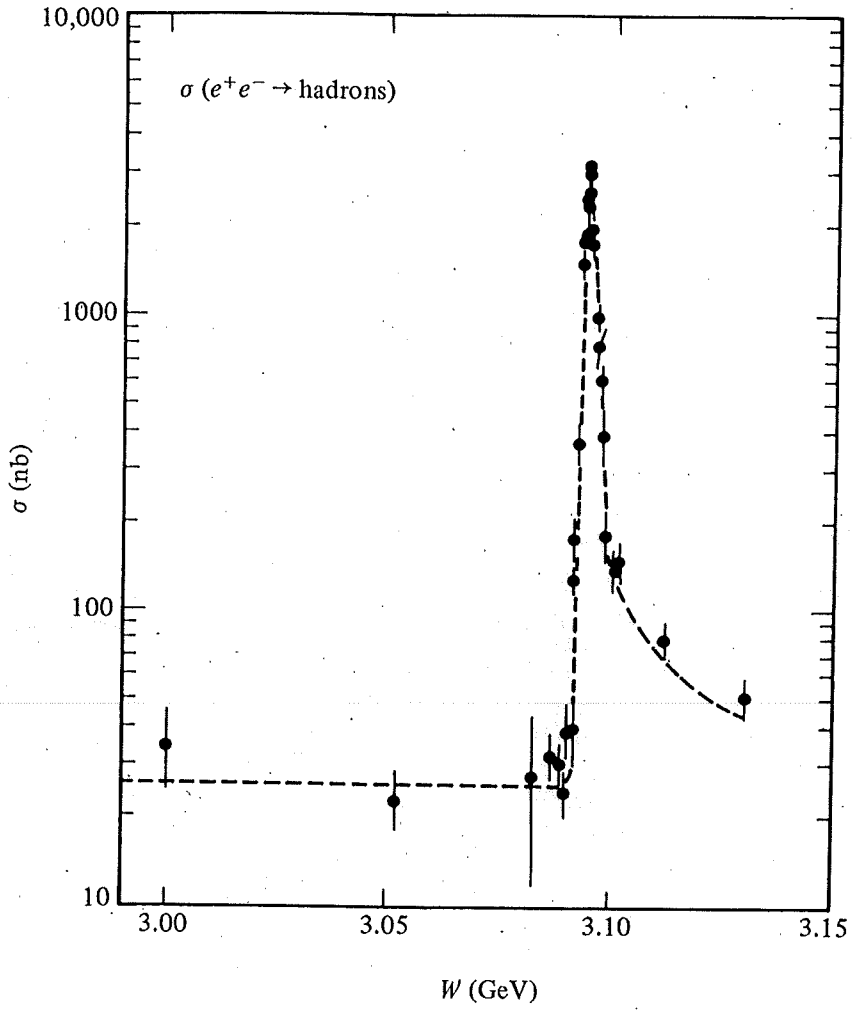


Fig. 10.23. Total hadron production cross section in e^+e^- collisions near 3.1 GeV and the J/ψ peak. [From A. M. Boyarski et al., *Phys. Rev. Lett.* **34,** 1357 (1975).]

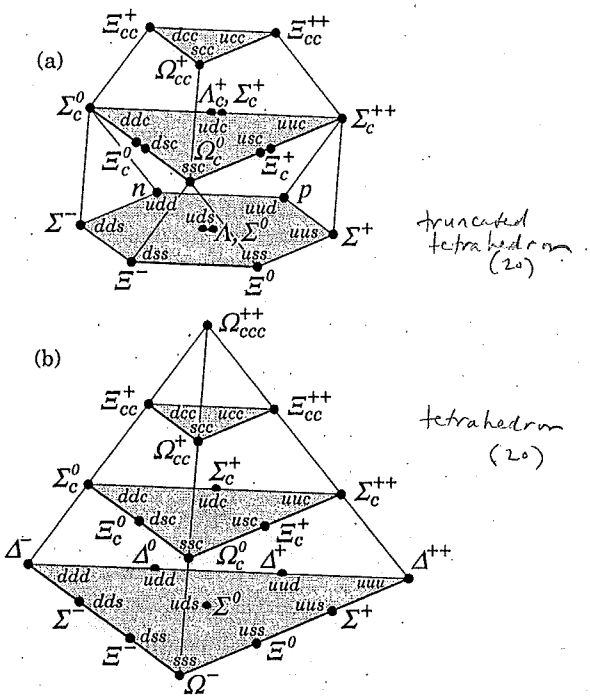


Figure 14.4: SU(4) multiplets of baryons made of u, d, s, and c quarks. (a) The 20-plet with an SU(3) octet. (b) The 20-plet with an SU(3) decuplet.

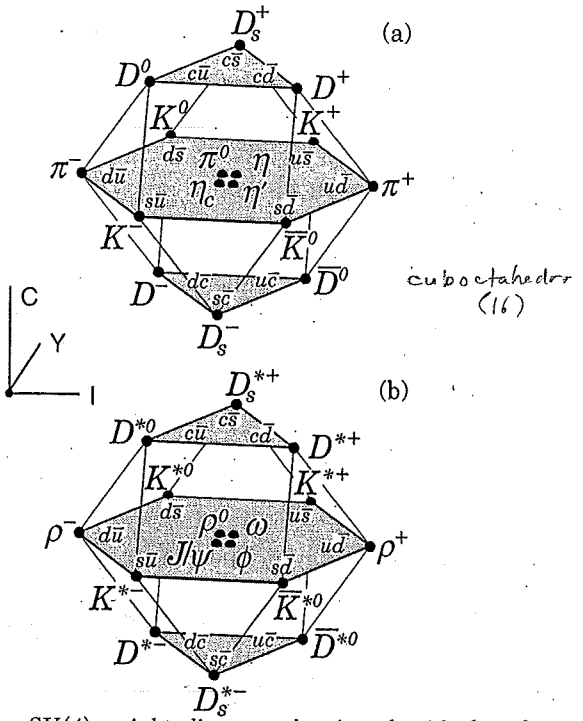


Figure 14.1: SU(4) weight diagram showing the 16-plets for the pseudoscalar (a) and vector mesons (b) made of the u, d, s and c quarks as a function of isospin I, charm C and hypercharge $Y = S + \mathcal{B} - \frac{C}{3}$. The nonets of light mesons occupy the central planes to which the $c\bar{c}$ states have been added.

Σ_c^+, Λ_c^+ udc u d

Σ_c^{++} ccuu

Σ_c^0 cdd

Ξ_{cc}^{++} ccu

Ξ_{cc}^{+} ccd

Ω_{ccc}^{++} ccc

D^0 $c\bar{u}$

D^+ $c\bar{d}$ (1976)

D_s^+ $c\bar{s}$

1975 τ discovered (before ν_τ)

2 more quarks expected
(t = top / truth
b = bottom / beauty)

$\Upsilon = b\bar{b}$ (upsilon) $\rightsquigarrow M =$
disc 1977

(1976 Lederman discovers "oops, Leon")

$\Lambda_b = udb$ (1981)

$B^0 = \bar{d}b$ (1983)
$B^- = \bar{u}b$
$\overline{B^0_s} = \bar{s}b$? $B^0_d = d\bar{b}$ $\overline{B^0_d} = \bar{d}b$ $B'_s = s\bar{b}$
$B^-_c = \bar{c}b$

t disc Fermilab 1994

→ decays so quickly no mesons see

[Now look at quark masses!]

Why 3 generations?
Why wide range of masses?