Physics 129A

Introduction to Particle Physics

September 2, 2004

Introductory Lecture Part II

Announcements:

Problem set I is posted on the new Class web site

http://kamland.lbl.gov/~courses/129A/

Good news: No lecture or section meeting Tuesday Sept. 7

Happy Labor Day

Next week: review of relativity

Please read Chapter 3 in Griffiths

and review the text you used to learn special relativity

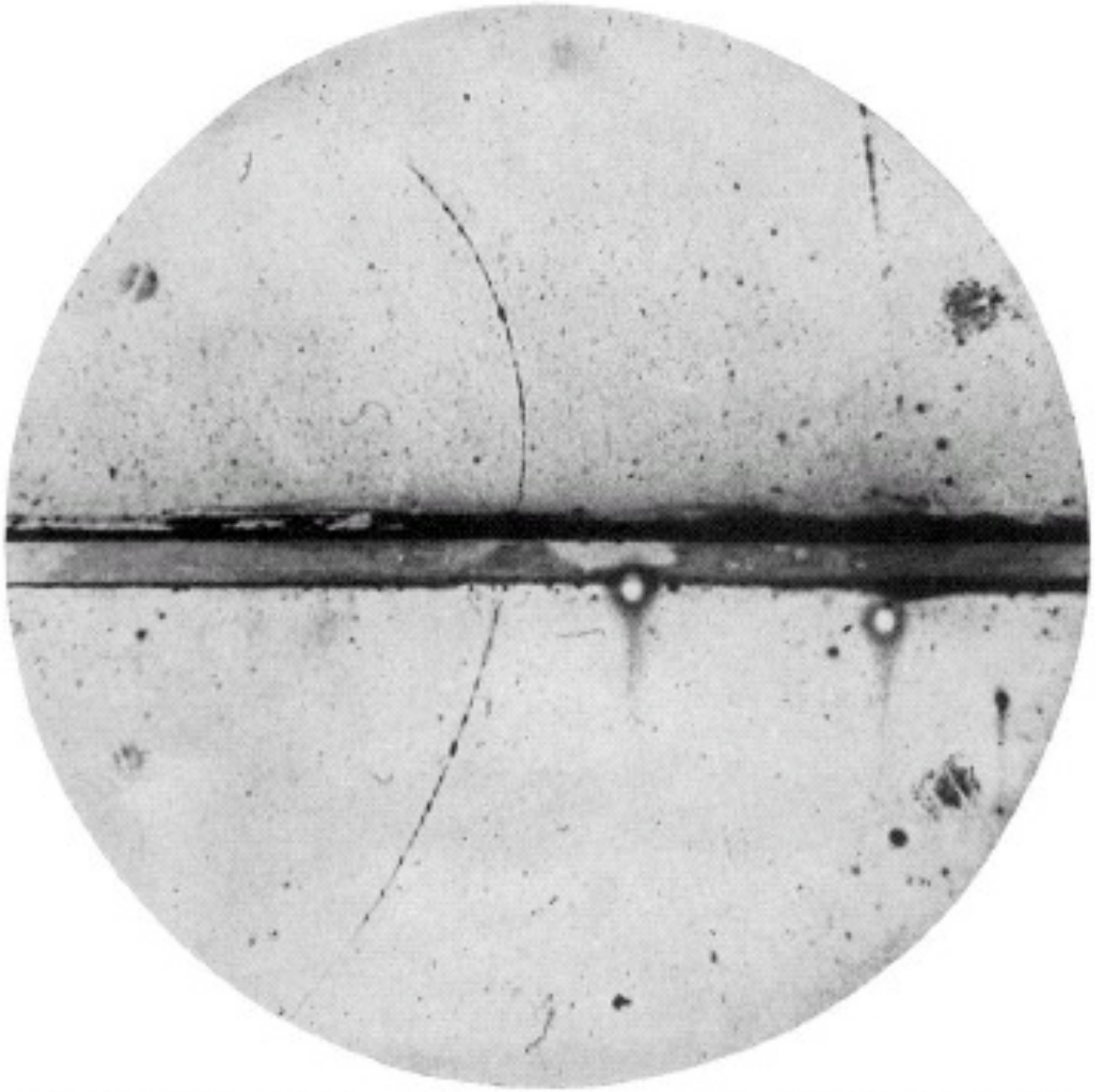
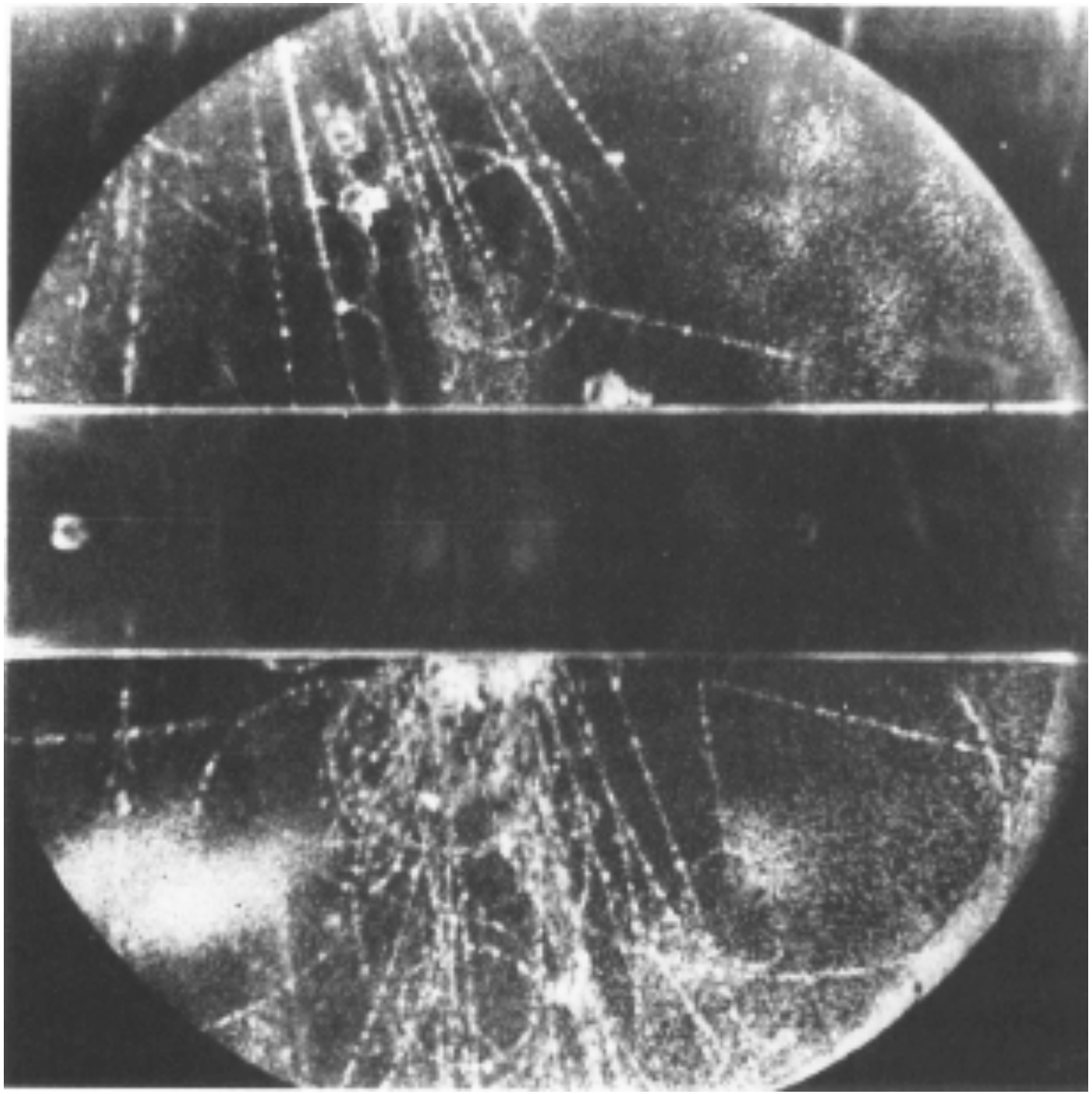


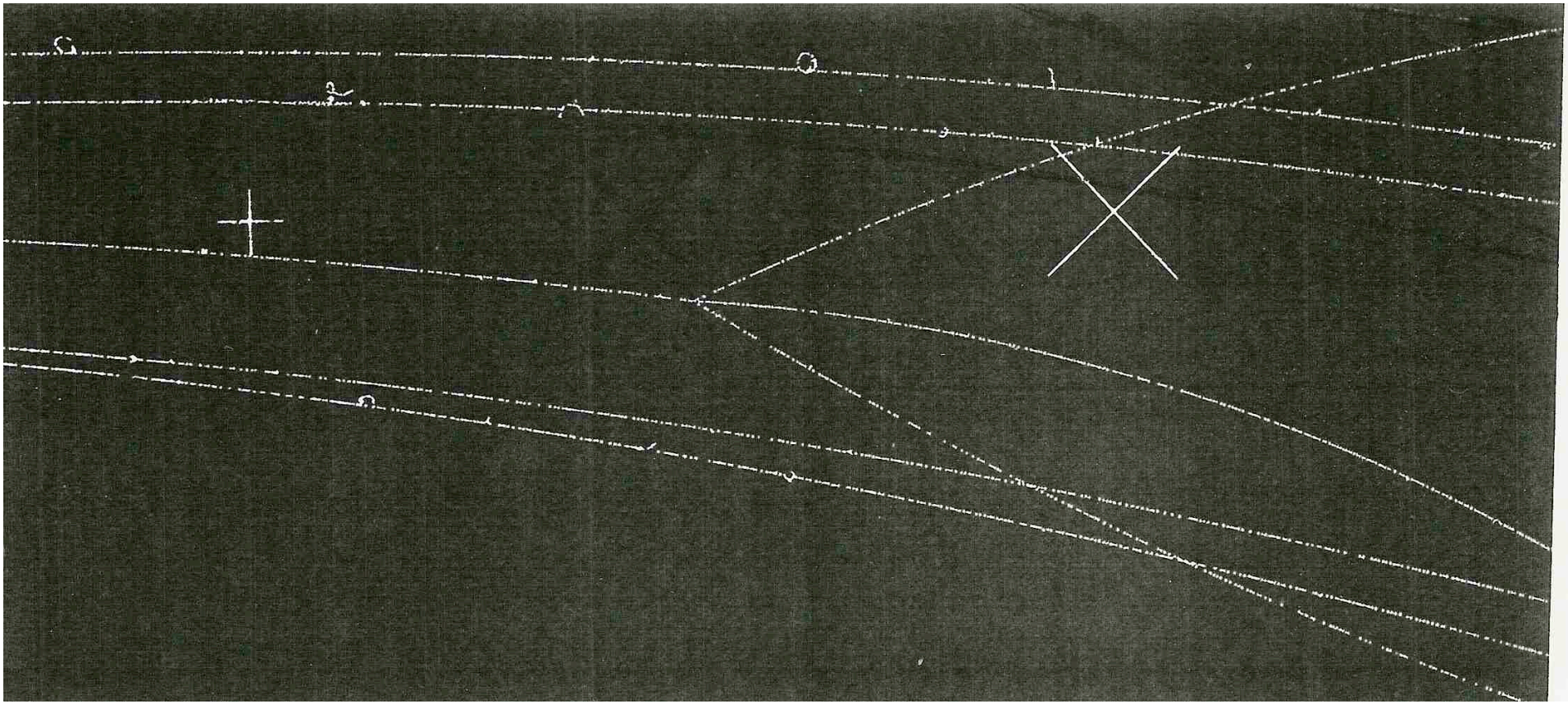
FIG. 1. A 63 million volt positron ($H\rho = 2.1 \times 10^5$ gauss-cm) passing through a 6 mm lead plate and emerging as a 23 million volt positron ($H\rho = 7.5 \times 10^4$ gauss-cm). The length of this latter path is at least ten times greater than the possible length of a proton path of this curvature.

Segre

Chamberlain

Bevatron





$K^+ - \pi^+ + \pi^+ + \pi^-$

Particle Physics <-> High Energy Physics

$$\lambda = \frac{h}{p}$$

$$\hbar c \approx 200 \quad MeVfm \quad = \quad 0.2 \quad GeVfm$$

CERN

SLAC

Fermilab

TABLE 1.2

Table of Elementary Particles (Compiled by W. H. Barkas and A. H. Rosenfeld). Errors Are Not Shown

Family	Particle	Spin	Mass (Mev.)	Mean life (second)
Photon	γ	1	0	stable
Leptons	$\nu(\bar{\nu})$	$\frac{1}{2}$	$<2 \times 10^{-4}$	stable
	$e^-(e^+)$	$\frac{1}{2}$	0.511	stable
	$\mu^-(\mu^+)$	$\frac{1}{2}$	105.7	2.26×10^{-6}
Mesons	$\pi^+(\pi^-)$	0	139.6	2.6×10^{-8}
	π°	0	135.0	2×10^{-16}
	$K^+(K^-)$	0	494	1.2×10^{-8}
	$K^\circ(\bar{K}^\circ)$	0	498	K_1°: 1.0×10^{-10}
	$(\lvert m(K_1^\circ) - m(K_2^\circ)\rvert \sim 5 \times 10^{-12})$			K_2°: $\sim 7 \times 10^{-8}$
Baryons	$p(\bar{p})$	$\frac{1}{2}$	938.2	stable
	$n(\bar{n})$	$\frac{1}{2}$	939.5	1.0×10^3
	$\Lambda^\circ(\bar{\Lambda}^\circ)$	$\frac{1}{2}$	1115.5	2.5×10^{-10}
	$\Sigma^+(\overline{\Sigma^+})$	$\frac{1}{2}$	1189	0.8×10^{-10}
	$\Sigma^-(\overline{\Sigma^-})$	$\frac{1}{2}$	1197	1.6×10^{-10}
	$\Sigma^\circ(\overline{\Sigma^\circ})$	$\frac{1}{2}$	1193	theory $\sim 10^{-19}$
	$\Xi^-(\overline{\Xi^-})$	?	1318	1.3×10^{-10}
	$\Xi^\circ(\overline{\Xi^\circ})$	?	~ 1312	$\sim 2 \times 10^{-10}$

TABLE 1.1

The Validity of Invariance Principles

Symmetry operations or conserved quantities	Strong	Electromagnetic	Weak
Parity (space inversion)	yes	yes	no
Charge conjugation	yes	yes	no
Time reversal	yes	yes	yes?
Electric charge	yes	yes	yes
Baryon number	yes	yes	yes
Isospin	yes	no	no
Strangeness	yes	yes	no

Isospin: The first abstract concept in particle physics

Mesons

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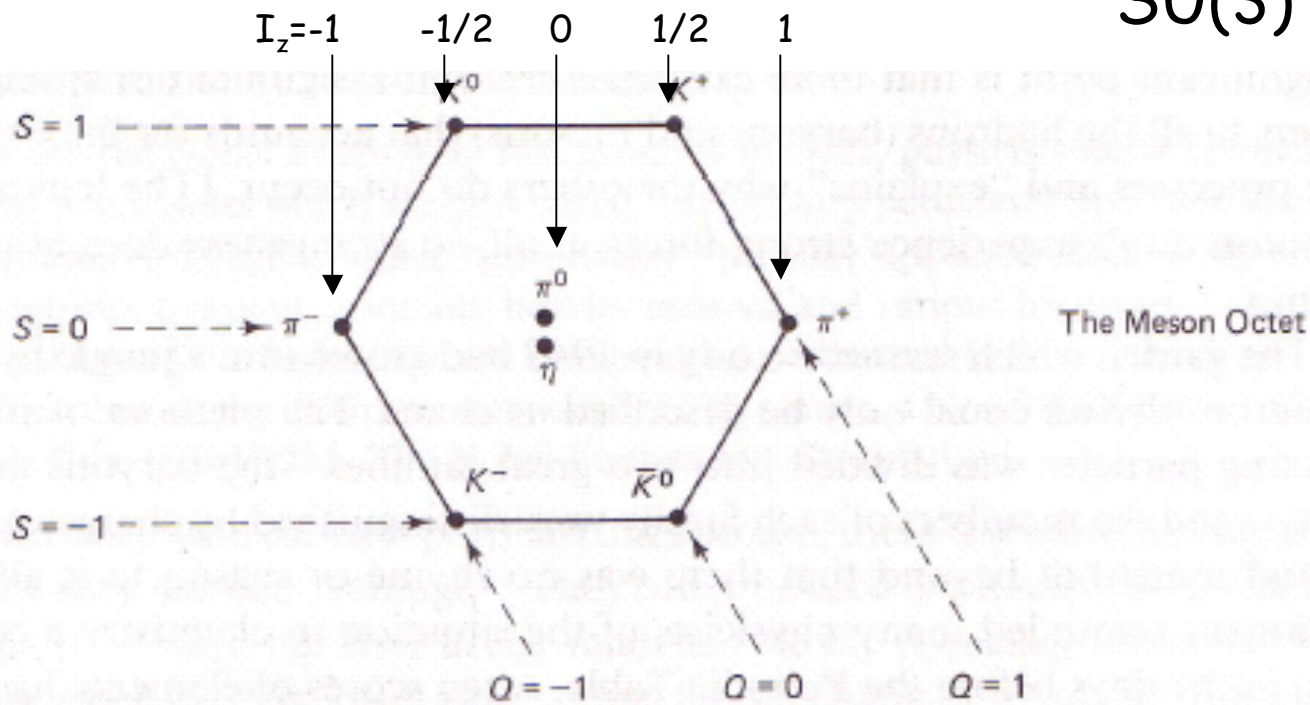


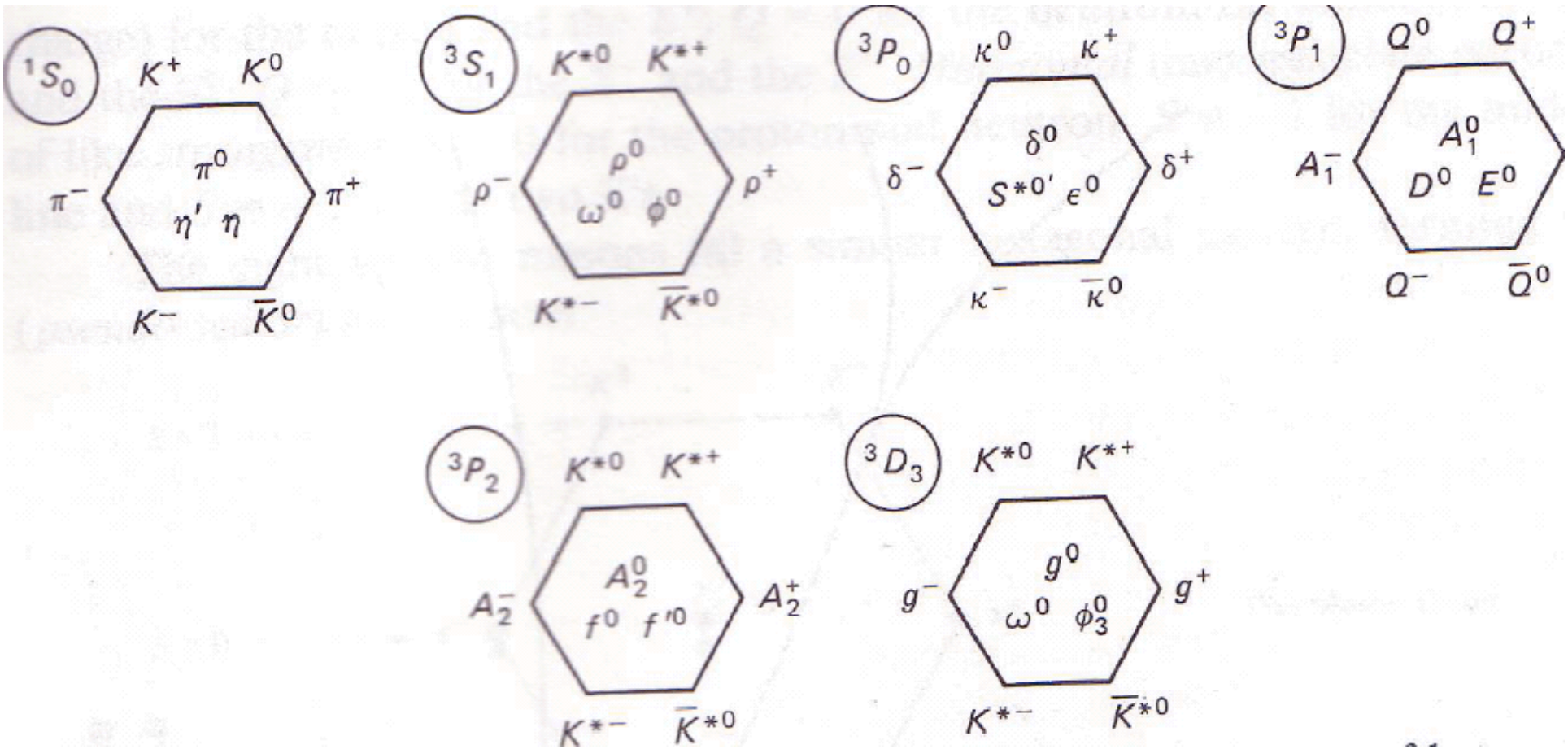
The Meson Octet

THE MESON NONET

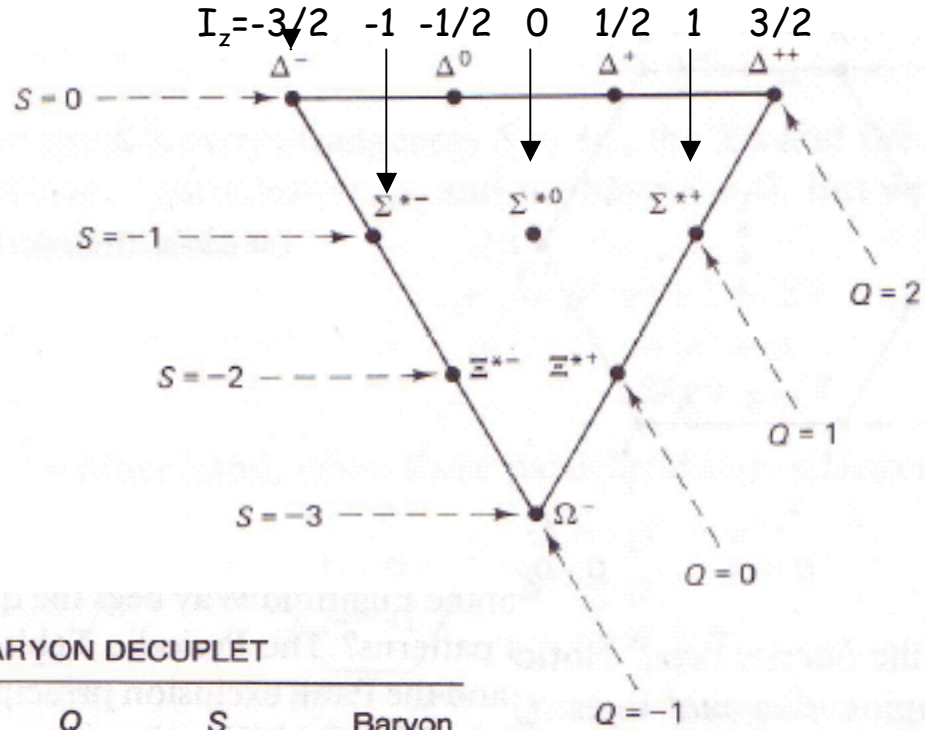
$q\bar{q}$	Q	S	Meson
$u\bar{u}$	0	0	π^0
$u\bar{d}$	1	0	π^+
$d\bar{u}$	−1	0	π^-
$d\bar{d}$	0	0	η
$u\bar{s}$	1	1	K^+
$d\bar{s}$	0	1	K^0
$s\bar{u}$	−1	−1	K^-
$s\bar{d}$	0	−1	$\bar{K}^0$
$s\bar{s}$	0	0	??

$$3 \otimes \bar{3} = 1 \oplus 8$$

Excitations of the Meson Octet



Baryon Decuplet



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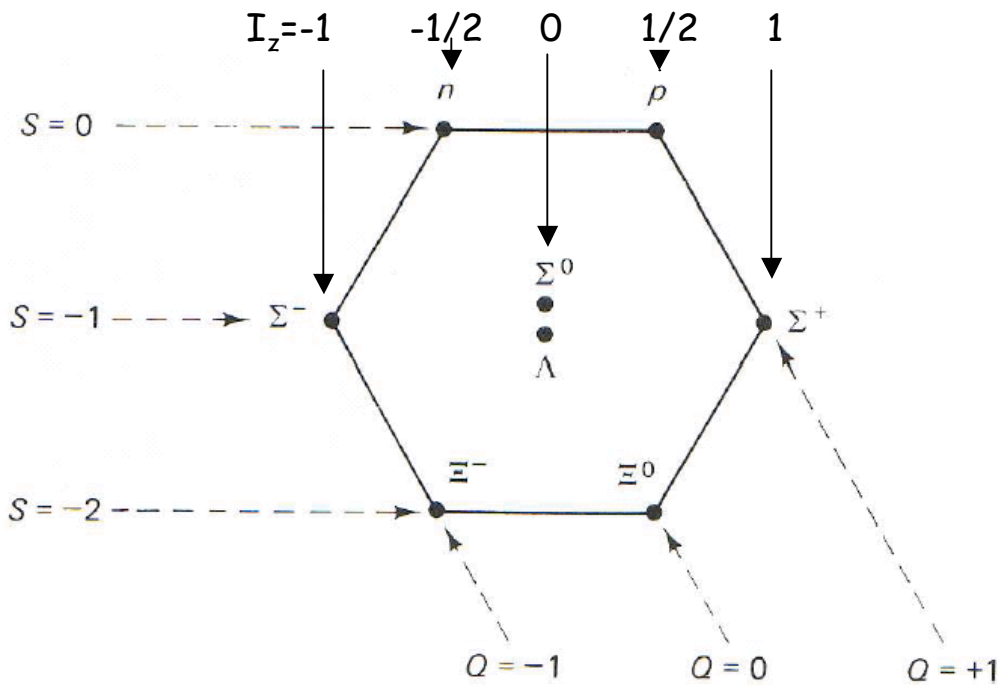
The Baryon Decuplet

THE BARYON DECUPLET

qqq	*Q*	*S*	Baryon
uuu	2	0	Δ^{++}
uud	1	0	Δ^{+}
udd	0	0	Δ^{0}
ddd	−1	0	Δ^{-}
uus	1	−1	Σ^{*+}
uds	0	−1	Σ^{*0}
dds	−1	−1	Σ^{*-}
uss	0	−2	Ξ^{*0}
dss	−1	−2	Ξ^{*-}
sss	−1	−3	Ω^{-}

Baryon Octet



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The Baryon Octet