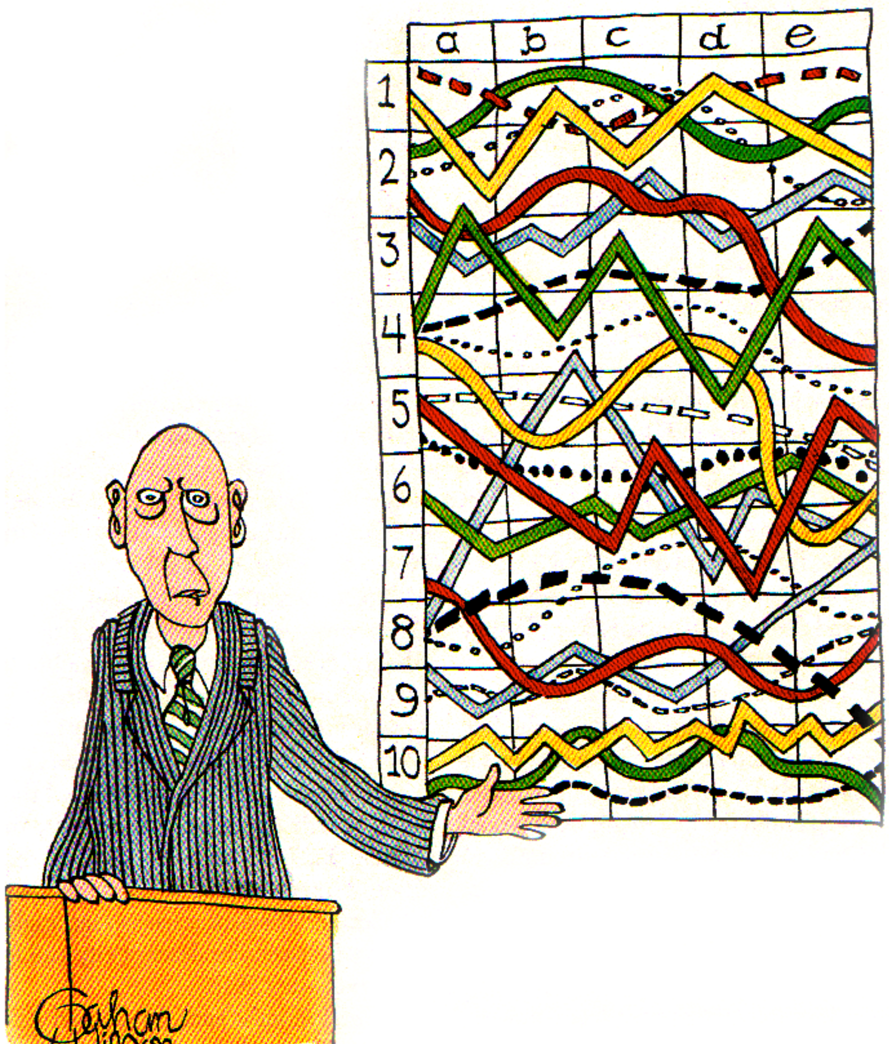
THE PARTICLE DATA GROUP:
A SHORT HISTORY AND HOW IT WORKS
(and some current issues)



"I'll pause for a moment so you can let this information sink in."

BEGINNINGS

W.H. Barkas & A.H. Rosenfeld, UCRL-8030, *Data for Elementary Particle Physics*, 1957 (not published).

Table II

Atomic and nuclear properties (dE/dx, collision mean free path, radiation length, etc) of materials used as absorbers and detectors

Material	Z	A	Cross section σ [a] (barns)	$\frac{dE}{dx}$ min [b] Mev/(g/cm²)	Collision[a] length, L_{coll} g/cm²	Collision length cm	Radiation[c] length, L_{rad} g/cm²	Radiation length cm	Density ρ (g/cm³)
H_2	1	1.01	0.063	4.14	26.5	374	58	819.0	0.0708
Li	3	6.94	0.23	1.72	50.4	94.3	77.5	145	0.534
C	6	12.00	0.33	1.86	60.4	39.0	42.5	27.4	1.55 (variable)
Al	13	26.97	0.57	1.66	79.2	29.3	23.9	8.86	2.70
Cu	29	63.57	1.00	1.45	105.4	11.8	12.8	1.44	8.9
Sn	50	118.70	1.55	1.27	129.7	17.8	8.54	1.17	7.30
Pb	82	207.21	2.20	1.12	156.2	13.8	5.8	0.51	11.34
U	92	238.07	2.42	1.095	163.6	8.75	5.5	0.29	18.7
Hydrogen (bubble chamber, -27.6°K)				0.243 Mev/cm	26.5	452	58	990	0.0586
Propane (C_3H_8, bubble chamber)				0.935 Mev/cm	48.9	119.3	44.7	109.0	0.41
Polystyrene (CH scintillator)				2.14 Mev/cm	54.9	52.3	43.4	41.3	~ 1.05
Ilford emulsion				5.49 Mev/cm	103	27.0	11.2	2.91	3.815

Table III

Multiple scattering (Coulomb only) calculated from Molière theory.

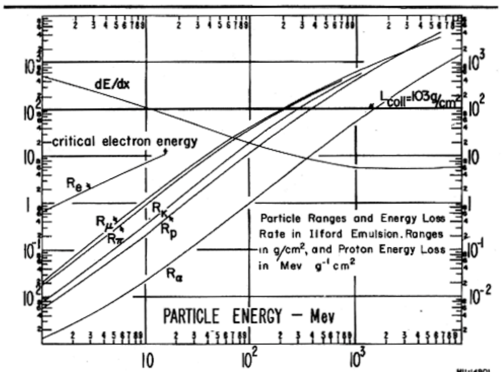
θ_{mp} is the mean projected angle in radians between tangents to the particle trajectories:

$$|\theta|_{average} = \theta_{mp} = z\,\frac{12(\mathrm{Mev})}{pv(\mathrm{Mev})}\sqrt{\frac{L}{L_{rad}}}\,(1+\epsilon)\ ^{*}$$

L is the thickness, and L_{rad} the radiation length (from Table II) for the absorber (atomic number Z).
For particles of charge ze and velocity βc, the following table for ε applies:

Z \ L/L_{rad}	10^{-3}	10^{-2}	10^{-1}	1	10	
1	-0.20	-0.14	-0.08	-0.03	+0.02	
6	-0.14	-0.07	-0.00	+0.06	+0.12	β/z = 0.1
29	-0.18	-0.10	-0.01	+0.06	+0.13	(4.7-Mev proton)
82	-0.27	-0.16	-0.07	+0.02	+0.10	
1	-0.26	-0.20	-0.14	-0.08	-0.03	
6	-0.20	-0.12	-0.05	+0.01	+0.07	β/z = 0.3
29	-0.20	-0.11	-0.03	+0.05	+0.12	(45-Mev proton)
82	-0.28	-0.17	-0.07	+0.08	+0.09	
1	-0.31	-0.24	-0.18	-0.12	-0.07	
6	-0.26	-0.18	-0.10	+0.03	+0.03	β/z = 0.7
29	-0.25	-0.15	-0.06	+0.02	+0.09	(380-Mev proton)
82	-0.29	-0.17	-0.08	-0.01	+0.09	
1	-0.34	-0.26	-0.20	-0.14	-0.08	
6	-0.29	-0.20	-0.12	-0.05	-0.01	β/z = 1.0
29	-0.34	-0.23	-0.13	-0.05	-0.03	
82	-0.31	-0.19	-0.09	-0.00	-0.08	

*Note that in the Gaussian approximation the root-mean-square projected angle is obtained from the formula above by substituting 15 for the coefficient 12.



Barkas and Rosenfeld UCRL-8030 Table I

Masses and mean lives of elementary particles; November, 1957
(The antiparticles are assumed to have the same spins, masses, and mean lives as the particles listed)

	Particle	Spin	Mass (Errors represent standard deviation) (Mev)	Mass difference (Mev)	Mean life (sec)	Decay rate (number per second)
Photon	γ	1	0		stable	0
Leptons	ν	½	0		stable	0
	e^-	½	0.510976 (a)		stable	0
	μ^-	½	105.70 ± 0.06 (a)		$(2.22 \pm 0.02)\times10^{-6}$	0.45×10^{6}
Mesons	π^+	0	139.63 ± 0.06 (a)	4.6 (a)	$(2.56 \pm 0.05)\times10^{-8}$ (a)	0.39×10^{8}
	π^0	0	135.04 ± 0.16 (a)		$<4 \times10^{-16}$ (d)	$>2.5 \times 10^{15}$
	K^+	0	494.0 ± 0.2 (g)	0.4 ± 1.8	$(1.224 \pm 0.013)\times10^{-8}$ (h)	0.815×10^{8}
	K^0	0	494.4 ± 1.8 (i)		K_1: $(0.95 \pm 0.08)\times10^{-10}$ (e)	1.05×10^{10}
					K_2: $(4<\tau<13)\times10^{-8}$ (c)	$(0.07<\tau<0.25)\times10^{8}$
Baryons	p	½	938.213 ± 0.01 (a)		stable	0.0
	n	½	939.506 ± 0.01 (a)		$(1.04 \pm 0.13)\times10^{+3}$ (a)	0.96×10^{-3}
	Λ	½	1115.2 ± 0.14 (j)		$(2.77 \pm 0.15)\times10^{-10}$ (k)	0.36×10^{10}
	Σ^+	½	1189.4 ± 0.25 (l)	7.1 ± 0.4	$(0.83\ ^{+.06}_{-.05})\times10^{-10}$ (m)	1.21×10^{10}
	Σ^-	½	1196.5 ± 0.5 (n)	$6.0^{+1.4}_{-0.9}$	$(1.67 \pm 0.17)\times10^{-10}$ (o)	0.60×10^{10}
	Σ^0	½	$1190.5^{+0.9}_{-1.4}$ (p)		$(<0.1)\times10^{-10}$ (b) theoretically $\sim10^{-19}$	$>10 \times 10^{10}$ theoretically $\sim10^{19}$
	Ξ^-	?	1320.4 ± 2.2 (q)		$(4.6<\tau<200)\times10^{-10}$ (f)	$(>0.005, <0.2)\times10^{10}$
	Ξ^0	?	?		?	

Table IV

Atomic and nuclear constants in units of Mev, cm, and sec[a]

GENERAL ATOMIC CONSTANTS

$N = 6.0249 \times 10^{23}$ molecules/gram
$c = 2.99793 \times 10^{10}$ cm/sec
$e = 4.80286 \times 10^{-10}$ esu $= 1.6021\times10^{-19}$ coulomb.
1 Mev $= 1.6021 \times10^{-6}$ erg [1 ev = e(10⁸/c)]
$\hbar = 6.5817 \times 10^{-22}$ Mev sec $= 1.054\times10^{-27}$ erg sec.
$\hbar c = 1.9732 \times 10^{-11}$ Mev cm [$= ƛ$ for p = 1Mev/c]
$k = 8.6167 \times 10^{-11}$ Mev/°C [Boltzmann constant]
$\alpha = \frac{e^2}{\hbar c} = 1/137.037$; $e^2 = 1.44\times10^{-13}$ Mev cm

QUANTITIES DERIVED FROM THE ELECTRON MASS, m

Mass and Energy
$m = 0.510976$ Mev $= 1/1836.12\ m_p = 1/273.26\ m_\pi$
Rydberg, $R_\infty = \frac{me^4}{2\hbar^2} = mc^2 \times \frac{\alpha^2}{2} = 13.605$ ev

Length (1 fermi = 10^{-13} cm; 1 Å = 10^{-8} cm)
$r_e = e^2/mc^2 = 2.81785$ fermi
$ƛ_{Compton} = \frac{\hbar}{mc} = r_e\alpha^{-1} = 3.8612\times10^{-11}$ cm
$a_{\infty\ Bohr} = \frac{\hbar^2}{me^2} = r_e\alpha^{-2} = 0.52917$ Å

Cross Section
$\sigma_{Thompson} = \frac{8}{3}\pi r_e^2 = 0.6652\times10^{-24}$ cm² $= 0.6652$ barn

Magnetic Moment and Cyclotron Angular Frequency
$\mu_{Bohr} = \frac{e\hbar}{2mc} = 0.57883 \times 10^{-14}$ Mev/gauss
$\frac{1}{2}\omega_{cyclotron} = \frac{e}{2mc} = 8.7945 \times 10^{6}$ rad sec⁻¹/gauss
$g_{electron} = 2[1 + \frac{\alpha}{2\pi} + 0.328(\frac{\alpha}{\pi})^2] = 2[1.001163]$[b]
$g_{muon} = 2[1 + \frac{\alpha}{2\pi} + 0.75(\frac{\alpha}{\pi})^2] = 2[1.001172]$[b]

QUANTITIES DERIVED FROM THE PROTON MASS, m_p
Rest mass $= 938.211$ Mev/c² $= 1836.12\ m_e = 6.719\ m_\pi$
$= 1.007593\ m_1$ (m_1 = 1 amu = $\frac{1}{16}$ O¹⁶)

Magnetic Moment and Cyclotron Angular Frequency
$\mu_p = \frac{e\hbar}{2m_pc} = 3.1524 \times 10^{-18}$ Mev/gauss
$\frac{1}{2}\omega_{cyclotron} = \frac{e}{2m_pc} = 4.7896 \times 10^{3}$ rad sec⁻¹/gauss
$g_p = \frac{\mu}{\mu_p}\Big)_{proton} = 2.79275$; $g_n = \frac{\mu}{\mu_p}\Big)_{neutron} = -1.9128$

(continued below)

Table IV (continued)

QUANTITIES DERIVED FROM THE MASS OF THE CHARGED PION, m_π

Rest mass $= 139.63$ Mev/c² $= 273.26\ m_e = 0.14882\ m_p$

Length
$\frac{\hbar}{m_\pi c} = 1.4132$ fermi ($\sim\sqrt{2}$ fermi)

Natural (= "geometrical") Nucleon Cross Section
$\pi\left(\frac{\hbar}{m_\pi c}\right)^2 = 62.7344$ mb (1 mb = 10^{-27} cm²)

(3/2, 3/2)πp Resonance
Center-of-mass momentum: $p_\pi = 230$ Mev/c
Lab-system momentum: $P_\pi = 303$ Mev/c ($T_\pi = 194$ Mev)

RADIOACTIVITY
1 curie $= 3.7 \times 10^{10}$ disintegrations/sec
1 r $= 87.8$ ergs/g air $= 5.49\times10^{7}$ Mev/g air
Fluxes (per cm²) to liberate 1 r in carbon:
3×10^{7} minimum ionising singly charged particles
0.9×10^{9} photons of 1 Mev energy.
(These fluxes are are actually correct to within a factor of two for all materials.)
Natural background: 100 mr/year
"Tolerance" 100 millirem/week [Note, 1 r may produce up to 10 "rem" (r equivalent for man), depending on type of radiation.]

MISCELLANEOUS

Physical Constants
1 year $= 3.1536\times10^{7}$ sec ($\approx \pi \times 10^{7}$ sec)
Density of air = 1.205 mg/cm³ at 20°C
Acceleration by gravity = 980.67 cm/sec²
1 calorie = 4.184 joules
1 atmosphere = 1033.2 g/cm²

Numerical Constants
1 radian = 57.29578 deg; e = 2.71828
ln 2 = 0.69315; $\log_{10} e = 0.43429$;
ln 10 = 2.30259; $\log_{10} 2 = 0.30103$.

Stirling's approximation
$\sqrt{2\pi n}\,(\frac{n}{e})^n < n! < \sqrt{2\pi n}\,(\frac{n}{e})^n(1 + \frac{1}{12n-1})$

Gaussianlike Distributions
For n > -1 but not necessarily integral:
$\int_0^\infty x^{2n+1}\exp\left[-\frac{x^2}{2\sigma^2}\right]dx = 2^n\,n!\,\sigma^{2n+2}$; $(\frac{1}{2})! = \sqrt{\pi}/2$

Relation between standard deviation σ and mean deviation α:
$2\sigma^2 = \pi\alpha^2$; σ = 1.4826 probable error.

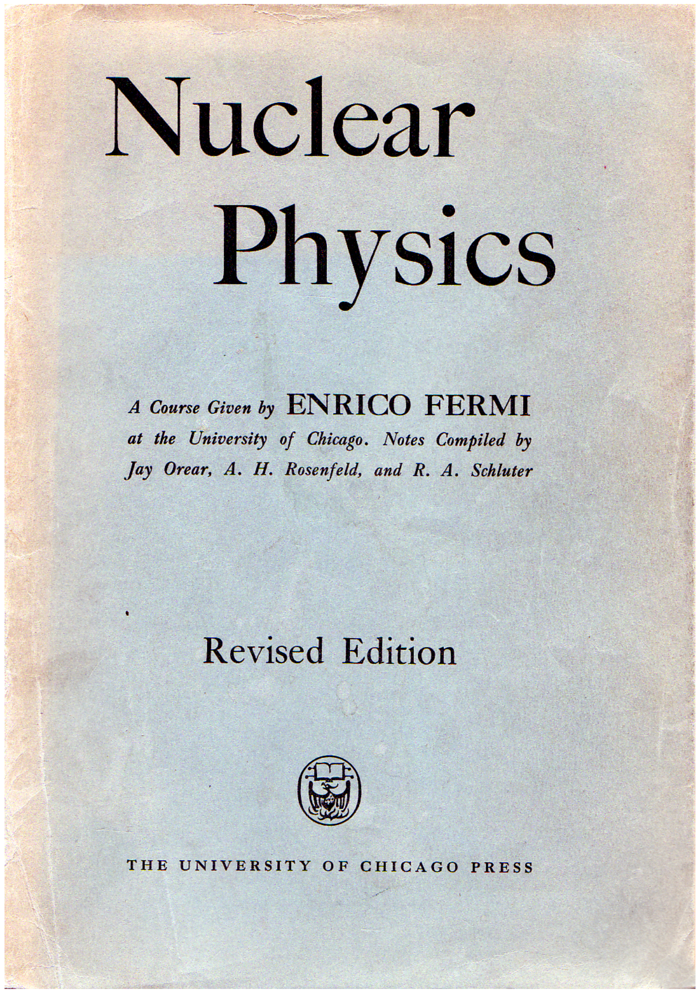
Odds against exceeding one standard deviation = 2.15:1
two, 21:1; three, 370:1; four, 16,000:1;
five, 1,700,000:1

[a]Based mainly on Cohen, Crowe, and Dumond, The Fundamental Constants of Physics (Interscience, New York, 1957).
[b]C. Sommerfield, Phys. Rev. 107, 328 (1957).

The first Wallet Card, 1958.

WHO IS ROSENFELD?

Enrico Fermi's last graduate student:



One of the pillars of the Alvarez Group. Spearheaded the effort beginning in the late 1950s to "computerize" data analysis of photos taken in the series of larger and larger Alvarez Group hydrogen bubble chambers running at the Berkeley Bevatron.

After the first gas crisis in 1973, left particle physics for energy conservation, especially in buildings and appliances. Winner of the Enrico Fermi Award (2006), and many other awards.

WHY BERKELEY? WHY THE ALVAREZ GROUP?

Because particles (but not N^*s) were being discovered by the Alvarez Group in bubble chambers at the Bevatron.

Discovered by the Alvarez Group (list not complete):

1960 $\Sigma(1385)$

1961 $K^*(892)$, $\Lambda(1405)$, $\omega(782)$

1962 $\Lambda(1520)$

1963 $\Sigma(1775)$

1966 $\Sigma(2030)$, $\Lambda(2100)$

Discovered in the Alvarez 72-in chamber by other groups:

1961 $\eta(548)$ (Johns Hopkins U.)

1962 $\Xi(1530)$ (UCLA).

The 1968 Nobel Prize in Physics, awarded to Luis W. Alvarez:

"For his decisive contributions to elementary particle physics, in particular the discovery of a large number of resonant states, made possible through his development of the technique of using hydrogen bubble chambers and data analysis."

GROWTH

1968: The first *Particle Data Booklet*, and the "Particle Data Group."

ROSENFELD ET AL. *Data on Particles and Resonant States* 83

BARYONS - January, 1968.

	Particle or resonance	$I(J^P)$ —— = estab.	Beam π, K (BeV) (BeV/c)	Mass (MeV)	Γ (MeV)	$M^2 \pm \Gamma M$ (BeV^2)	Partial decay modes: Mode	Fraction (%)	p or $p^{‡}_{max}$ (MeV/c)	$4\pi ƛ^2$ (mb)
N	p n	$1/2(1/2^+)$		938.3 939.6		0.880 0.883	See Table S			
	N' (1470)	$1/2(1/2^+)\ P_{11}$	T=0.53πp p=0.66	1470	210	2.16 ±0.31	Nπ Nππ [Nσ][a]	65 35 [domin]	420	27.8
See footnote c.	N(1518)	$1/2(3/2^-)\ D_{13}$	T=0.62 p=0.75	1525	115	2.33 ±0.18	Nπ Nππ [Δ(1236)π][a] Nη	55 45 [domin] ~0.5	460 414 229 161	23.2
	N(1550)	$1/2(1/2^-)\ S_{11}$	T=0.66 p=0.79	1550	130	2.40 ±0.20	Nπ Nη Nππ	30 70 small	477 210 434	21.5
	N(1680)	$1/2(5/2^-)\ D_{15}$	T=0.88 p=1.02	1680	170	2.82 ±0.29	Nπ Nππ [Δ(1236)π][a] ΛK Nη	40 dom. inel. [?] <1.6 <2.5	567 533 365 218 379	15.2
	N(1688)	$1/2(5/2^+)\ F_{15}$	T=0.90 p=1.03	1690	130	2.86 ±0.22	Nπ Nππ [Δ(1236)π][a] ΛK Nη	65 dom. inel. [?] <.13 <1.5	574 540 374 234 390	14.9
	N' (1710)	$1/2(1/2^-)\ S_{11}$	T=0.94 p=1.07	1710	300	2.92 ±0.51	Nπ	80	587	14.2
	N(2190)	$1/2(7/2^-)\ G_{17}$	T=1.96 p=2.10	2200	250	4.84 ±0.55	Nπ	30	894	6.13
	N(2650)	$1/2(\ ?^-)$	T=3.12 p=3.26	2650	360	7.02 ±0.95	Nπ	(J+1/2)x=0.45[b]	1154	3.67
‡‡	N(3030)	$1/2(\ ?\ )$	T=4.26 p=4.40	3030	400	9.18 ±1.21	Nπ	(J+1/2)x=0.05[b]	1377	2.62
Δ (See footnote c.)	Δ(1236)	$3/2(3/2^+)\ P_{33}$	T=0.195 p=0.304	(++) 1236.0 ±0.6	120 ±2	1.53 ±0.15	Nπ $N\pi^+\pi^-$	100 0	231 89	91.9
		$m_0 - m_{++} = 0.45 \pm 0.85$	$m_- - m_{++} = 7.9 \pm 6.8$							
	Δ(1640)	$3/2(1/2^-)\ S_{31}$	T=0.81 p=0.94	1640	180	2.69 ±0.30	Nπ Nππ	30 dom. inel.	540	16.8
	Δ(1920)	$3/2(7/2^+)\ F_{37}$	T=1.41 p=1.54	1950	220	3.80 ±0.43	Nπ ΣK	40 seen	741 453	8.91
	Δ(2420)	$3/2(11/2^+)$	T=2.50 p=2.64	2420	310	5.86 ±0.75	Nπ	11	1024	4.67
	Δ(2850)	$3/2(\ ?^+)$	T=3.71 p=3.85	2850	400	8.12 ±1.14	Nπ	(J+1/2)x=0.25[b]	1266	3.05
	Δ(3230)	$3/2(\ ?\ )$	T=4.94 p=5.08	3230	440	10.4 ±1.4	Nπ	(J+1/2)x=0.05[b]	1475	2.24
Z	$Z_0(1865)$	$0(\ ?\ )$	$p=1.15\ K^+p$	1865	180	3.47 ±0.34	NK	(J+1/2)x=0.35[b]	579	14.6
		Resonance interpretation not established.								
	Λ	$0(1/2^+)$		1115.5		1.24	See Table S			
	Λ(1405)	$0(1/2^-)\ S_{01}$	$p<0\ K^-p$	1405	50	1.97 ±0.07	Σπ	100	140	
	Λ(1520)	$0(3/2^-)\ D_{03}$	p=0.392	1518.8 ±1.5	16 ±2	2.31 ±0.02	$N\bar{K}$ Σπ Λππ	45±4 } S=1.8* 45±4 10±1	235 258 251	83.6

→ at left of Table indicates a candidate that has been omitted because the evidence for the existence of the effect and/or for its interpretation as a resonance is open to considerable question. See listings for information on the following: $N_?(3245)$, N(3690), $Z_1^*(1900)$, Λ(1860) F_{07}, Σ(1780), Σ(3000), and Ξ(1705).

* Quoted error includes an S(scale) factor. See footnote to Table S.

‡ For decay modes into ⩾ 3 particles p_{max} is the maximum momentum that any of the particles in the final state can have. The momenta have been calculated using the averaged central mass values, without taking into account the widths of the resonances.

a. Square brackets indicate a sub-reaction of the previous unbracketed decay mode.

b. J is not known; x is Γ_{el}/Γ.

c. Several new resonances have been reported by the CERN group (Donnachie et al.) as a result of their phase-shift analysis up to M = 2100 MeV. The other two groups working on phase-shift analysis (Berkeley, Saclay) have not claimed these states at this time; therefore we have to take them with some caution. For the time being, we classify the nine new CERN resonances as follows (the numbers in parentheses are M, Γ, Γ_{el}/Γ, slightly rounded): i) Strong candidates, D_{33}(1690, 270, 0.14), F_{35}(1910, 350, 0.16); ii) less certain, P_{31}(1930, 340, 0.30), P_{33}(1690, 280, 0.10), P_{11}(1750, 330, 0.32), F_{17}(1980, 220, 0.13); iii) require some imagination, D_{35}(1950, 310, 0.15), P_{13}(1860, 300, 0.21), D_{13}(2060, 290, 0.26).

In this era, the tables were commmonly referred to as "the Rosenfeld tables."

THE HEYDAY OF N^* PHYSICS

(at least as far as the Particle Data Group was concerned)

Handbook of Pion-Nucleon Scattering, Physics Data **12-1** (1979)
G. Höhler, Kaiser, R. Koch, E. Pietarinen,
Karlsruhe & Helsinki

"Pion-nucleon partial-wave amplitudes," Phys. Rev. **D20** (1979) 2839,
R.E. Cutkosky, C.P. Forsyth, R.E. Hendrick, R.L. Kelly,
Carnegie-Mellon & LBL.

Bob Kelly head of the Particle Data Group, $\approx$1975-1981.

Later history is probably better known to the audience than to me.

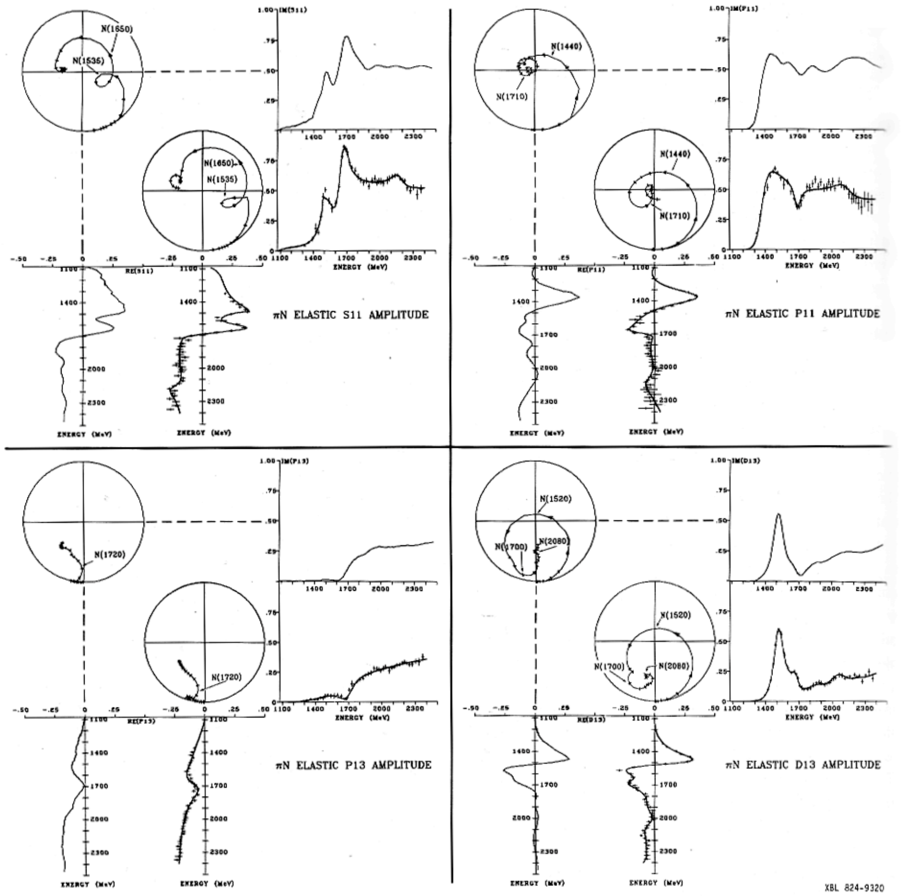


Fig. 1(a). The $L_{2I \cdot 2J} = S_{11}$, P_{11}, P_{13}, and D_{13} partial-wave amplitudes for πN elastic scattering. The upper plot for each amplitude is from HOEHLER 79 and the lower one is from CUTKOSKY 80. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots (in the projections of the CUTKOSKY 80 amplitudes, the "data points" are results of energy-independent fits, and the curves are from an energy-dependent fit to join them).

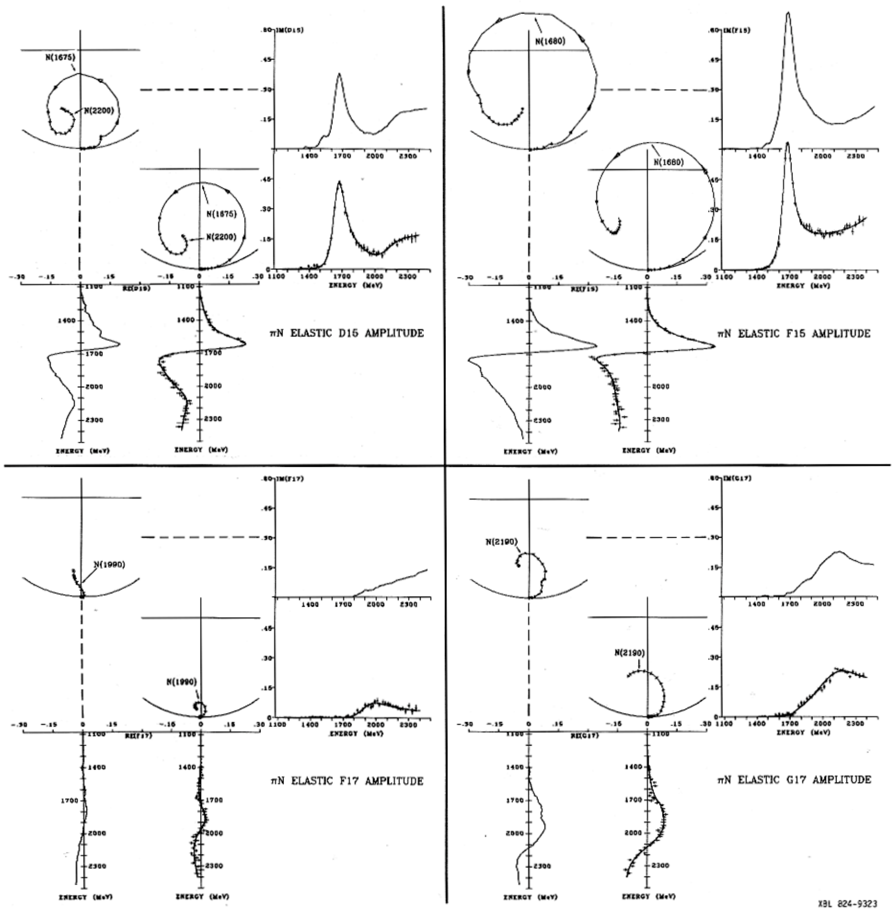


Fig. 1(b). The $L_{2I \cdot 2J} = D_{15}$, F_{15}, F_{17}, and G_{17} partial-wave amplitudes for πN elastic scattering. The upper plot for each amplitude is from HOEHLER 79 and the lower one is from CUTKOSKY 80. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots (in the projections of the CUTKOSKY 80 amplitudes, the "data points" are results of energy-independent fits, and the curves are from an energy-dependent fit to join them).

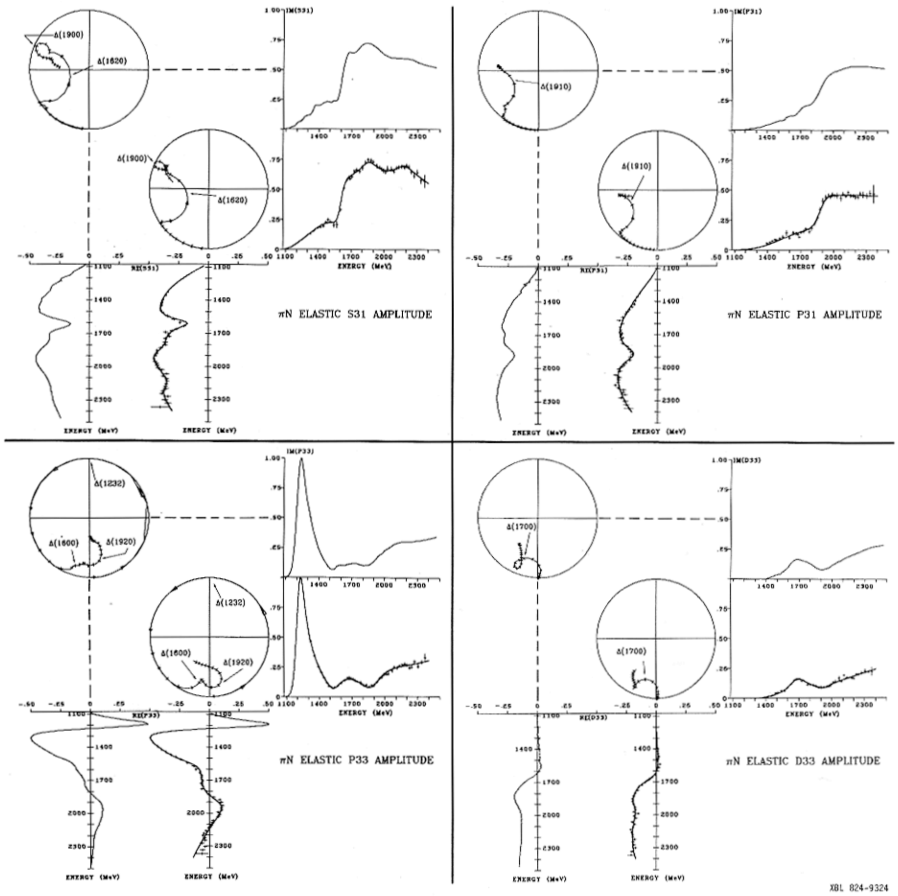
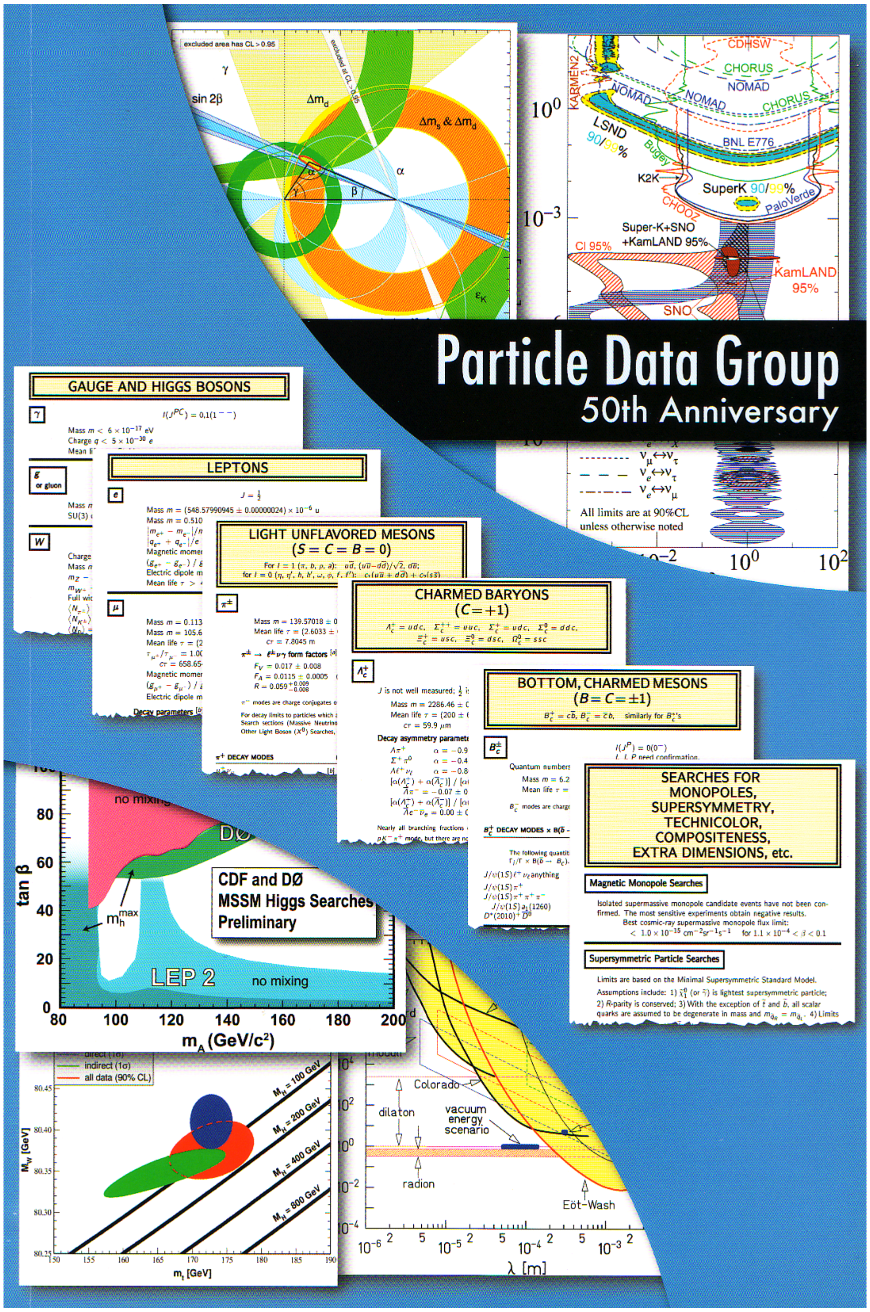


Fig. 1(d). The $L_{2I \cdot 2J} = S_{31}$, P_{31}, P_{33}, and D_{33} partial-wave amplitudes for πN elastic scattering. The upper plot for each amplitude is from HOEHLER 79 and the lower one is from CUTKOSKY 80. In the Argand plots, the ticks are at integral multiples of 50 MeV, and the established resonances are shown at their nominal positions. The real and imaginary parts of the amplitudes as functions of energy are shown projected in alignment with the Argand plots (in the projections of the CUTKOSKY 80 amplitudes, the "data points" are results of energy-independent fits, and the curves are from an energy-dependent fit to join them).

MORE THAN 50 YEARS



Booklet for the 50th anniversary party

HOW WE WORK
(mostly how Ron Workman and I work)

Two people independently scan about 20 journals for articles that need to be looked at for the next update of the *Review.*

Relevant subsets of the total list are sent out to the *overseers* and *encoders.* For example, I oversee the ground-state D mesons, and all the baryons except for those with a b quark. So I work with several encoders. Ron Workman has been the encoder for N^*s for many years. Before him, it was Mark Manley.

Ron reads the papers and sends me brief notes on them, and encodings of those with relevant data. I read Ron's notes and look at the papers, especially those with data to be added to the Particle Listings. Sometimes we discuss a bit.

> *What papers get encoded?! Only those papers that influence our estimates of values of N^* parameters!*

There are lots of interesting and valuable papers that *do not* tell us we can narrow, say, the range of our estimate of the width of the $N(1700)$.

All new encodings are entered into the database by the chief editor, Piotr Zyla (a physicist). After entry and checking, requests go out to one person per paper for verification. I see to corrections, conflicts, etc.

ISSUES & PROBLEMS

DEPENDENT ANALYSES:
What values should we give for N^* masses, widths, branching fractions, etc? For D mesons, I get completely independent measurements of branching fractions from CLEO (Cornell), BABAR (Stanford), and Belle (KEK, Japan). These measurements come with both statistical and systematic errors, and are perfect for averages and fits. Nothing like this happens with N^*s. The global analyses use heavily overlapping data sets. The lesser analyses often start from the results from the global fits. In most cases, all we can do is eye-ball a reasonable range for a mass, a width, a branching fraction.

ISOLATION:
There is little attention from the wider high-energy physics community. The situation is like a decades-long war: The battlefront is now a thousand miles away; this N^* back area is not nearly pacified, but nearly all attention is elsewhere. (Maybe this doesn't matter: all large branches of science are splintered into many subcultures.)

NOT TO MENTION:
More and better data are needed.

NOTATION:
Eberhard Klempt favors a change of notation:

$$\Delta(1232)\, P_{33} \rightarrow \Delta_{3/2^+}(1232) \ .$$

Variations: $\Delta(1232)\, 3/2^+$; $\Delta(1232,\, 3/2^+)$. A change would be fine. But perhaps we ought to think twice before changing a long-used notation.

THREE WAYS TO GO

CONSERVATIVE:

Keep going more or less the way we are now. I probably favor this option, but perhaps the community does not. I should say that the Particle Data Group is never going to go beyond its "name, rank, and serial number" treatment of the resonances.

LIBERAL:

Form an *outside* "Partial Wave Averaging Group (PWAG)," to provide best N^* numbers for the *Review*—such as those estimated best ranges of masses, widths, etc. There is an *outside* "Heavy Flavor Averaging Group (HFAG)" that does special topics, such as mixing and CP violation, in charm and (especially) bottom physics. We use some of its numbers directly.

The PWAG would be *independent* of the Particle Data Group (i.e., its problems wouldn't be our problems). Possible issues are reliability (e.g., being on time), partisanship.

RADICAL:

Break off the compilation of N^* parameters from the *Review*. Make a separate publication, linked to the Review. In the process, enlarge and specialize the coverage of subjects of particular interest and value to the N^* community.