Strangeness and Spin in hadronic and e.m. interaction

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1) Strangeness content of the nucleon
2) hypernuclear states { potential, decay, Y-N int.
3) Strange resonances
4) Hyperon polarisation

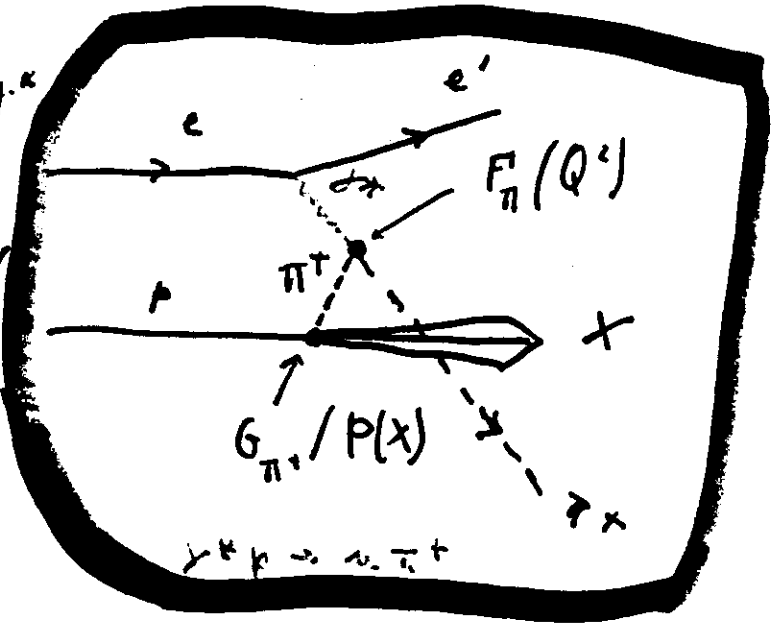
Quasi-elastic scattering on virtual π K

$\gamma^{*2} = (e-e')^2 = -Q^2$ = s.q. mass γ^*

$\nu = E - E'$ = en. loss of e

$s = (\gamma^* + p)^2 = W^2$ = s.q. mass $\gamma^* N$

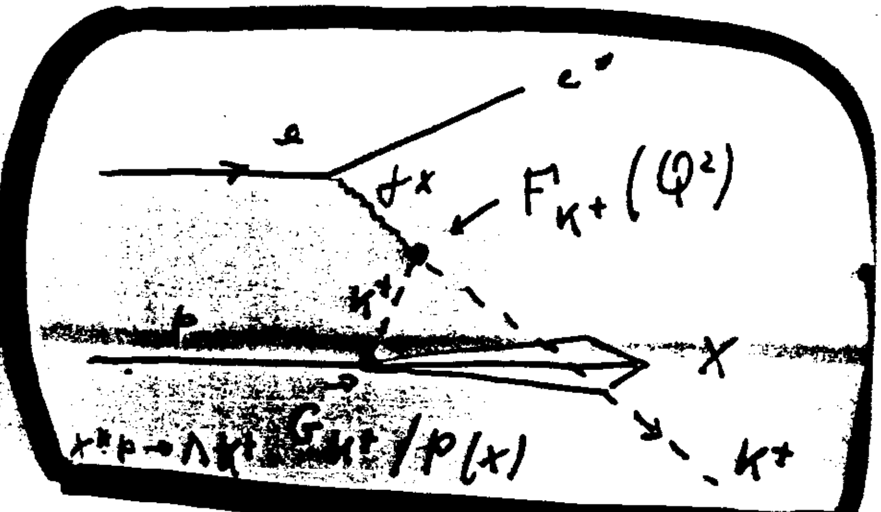
$t = (\gamma^* - \pi)^2$ = s.q. mom. onto N



$Q^2 \leq 1$ GeV

$\nu \geq 2.2$ GeV

$W \geq 2.1$ GeV



$$2\pi \frac{d^2\sigma}{dt\, d\varphi} = \frac{d\sigma_T}{dt} + \varepsilon \frac{d\sigma_L}{dt} + \varepsilon \cos(2\varphi) \frac{d\sigma_P}{dt} + \sqrt{2\varepsilon(\varepsilon+1)} \cos\varphi \frac{d\sigma_I}{dt}$$

σ_T → unpolarized transverse photons $\frac{1}{2}(\sigma_{11} + \sigma_{-1-1})$

σ_L → longitudinal polarized photons σ_{00} $\lambda = 0$

σ_P transverse linearly polarized photons $\frac{1}{2}(\sigma_{11} - \sigma_{-1-1})$ λ:

σ_I interference transverse - longitudinal polar. phot. σ_{01}

$$\frac{d^2\sigma_L(ep \to e'\pi X)}{dx\, dQ^2} = G_{\pi^*}/p(x) \; 2\pi \frac{d\sigma_{el}(e\pi^* \to e'\pi)}{dQ^2}$$

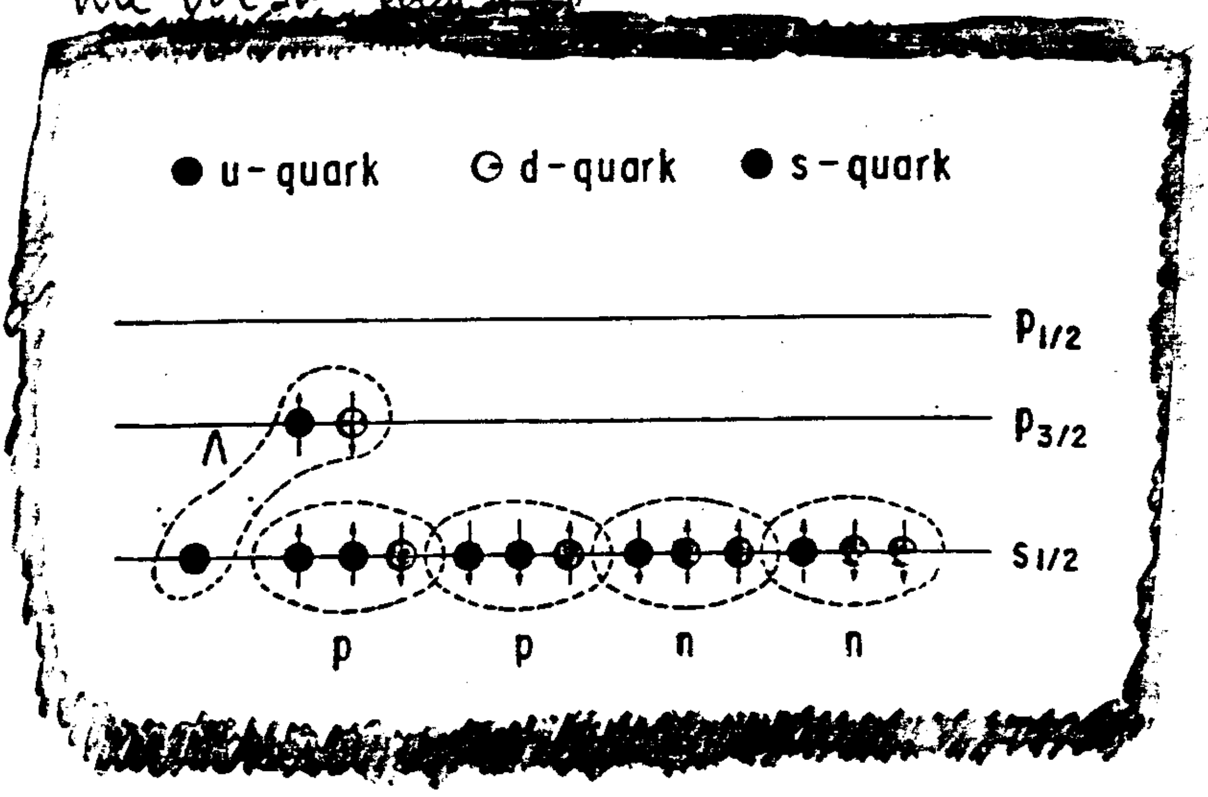
[illegible]

$$\frac{d\sigma}{d\Omega}_{Hyp\text{-}state} \sim N_{eff} \frac{d\sigma}{d\Omega}_{d.} |F(q)|^2$$

$$\Downarrow$$

Hypernuclei

1) Test nuclear model
2) hyperon nucleon interaction at low momenta
3) Different behaviour of a baryon when free or embedded in nuclear matter



$p + {}^{Z}A \rightarrow K^{+} + {}^{Z}_{Hyp}(A+1)$

$p + {}^{Z}A \rightarrow K^{+} + p + {}^{(Z-1)}_{Hyp}A$

associated production

$A + p \rightarrow {}^{Z}_{Hyp}(A+1) + K^{+}$

${}^{(Z-1)}_{Hyp}A + p + K^{+}$

$p + p \rightarrow p + \Lambda + K^{+}$

$T_p = 2.85$ GeV $\sigma_t = 51 \pm 12$ μb

${}^{Z}_{Hyp}A + n + K^{+}$

$\pi^{+} + {}^{Z}A \rightarrow {}^{Z}_{\Lambda}A + K^{+}$

$\pi^{+} + n \rightarrow \Lambda + K^{+}$

$e^{-} + {}^{Z}A \rightarrow {}^{Z-1}_{\Lambda}A + e^{-\prime} + K^{+}$

$e^{-} + p \rightarrow e^{-\prime} + K^{+} + \Lambda$

$\gamma + A \rightarrow {}^{Z}_{\Lambda}A + K^{+}$

$\gamma + p \rightarrow \Lambda + K^{+}$

$K^{-} + {}^{Z}A \rightarrow \pi^{-} + {}^{Z}_{\Lambda, \Sigma^0}A$

$\pi^{-} + {}^{(Z-1)}_{\Sigma^{+}}A$

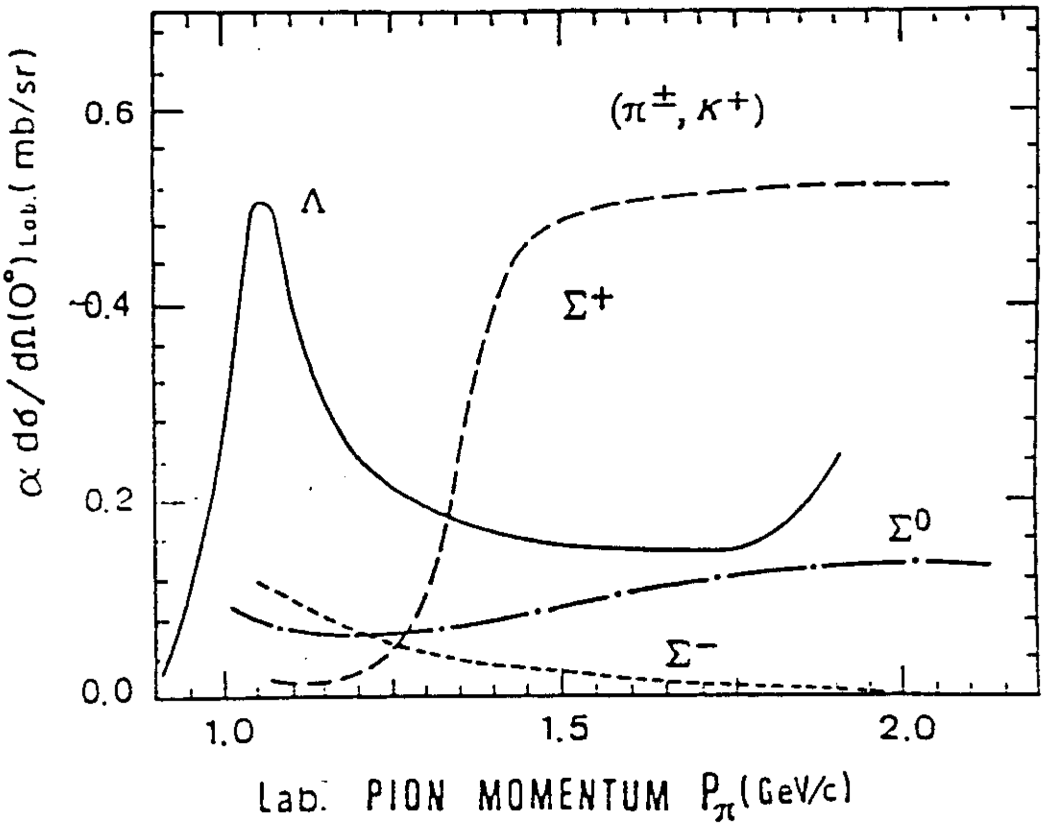
$\pi^{+} + {}^{(Z-1)}_{\Sigma^{-}}A$

strangeness exchange

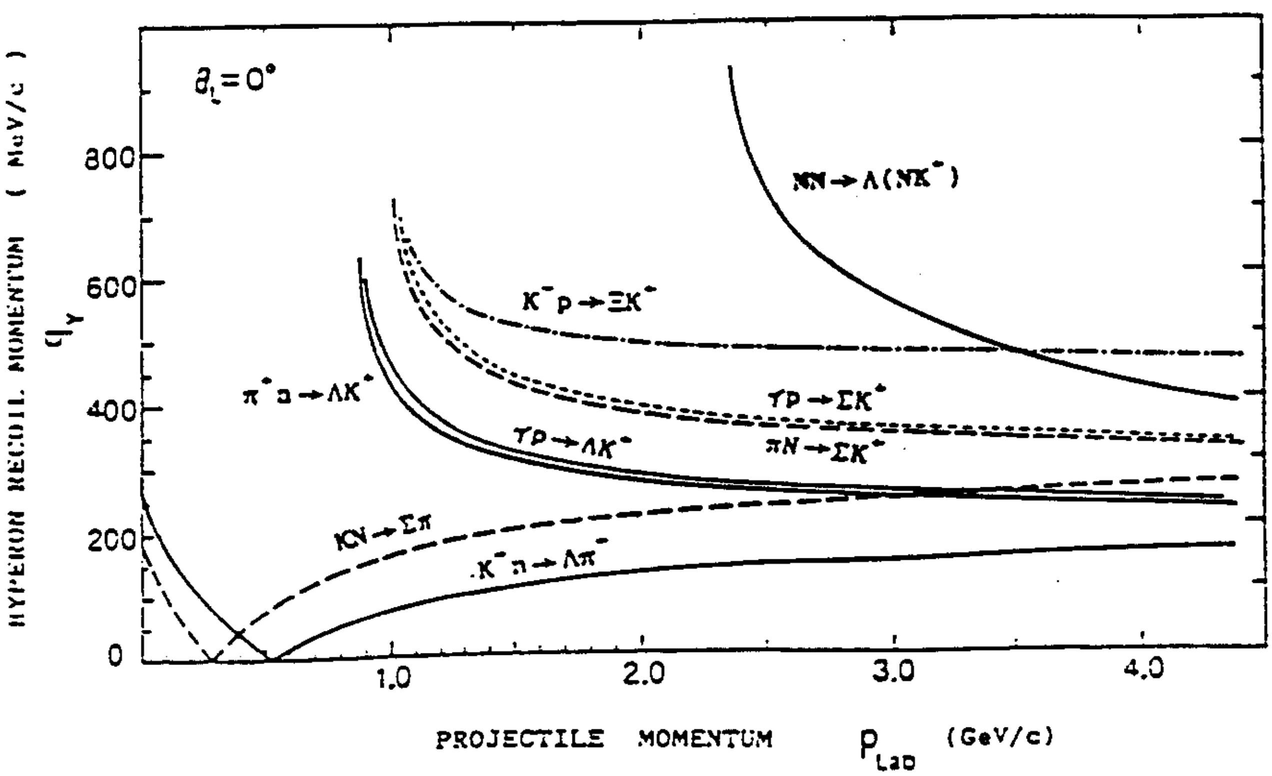
$K^{-} + n \rightarrow \pi^{-} + \Lambda, \Sigma_0$

$p \qquad \Sigma^{+}$

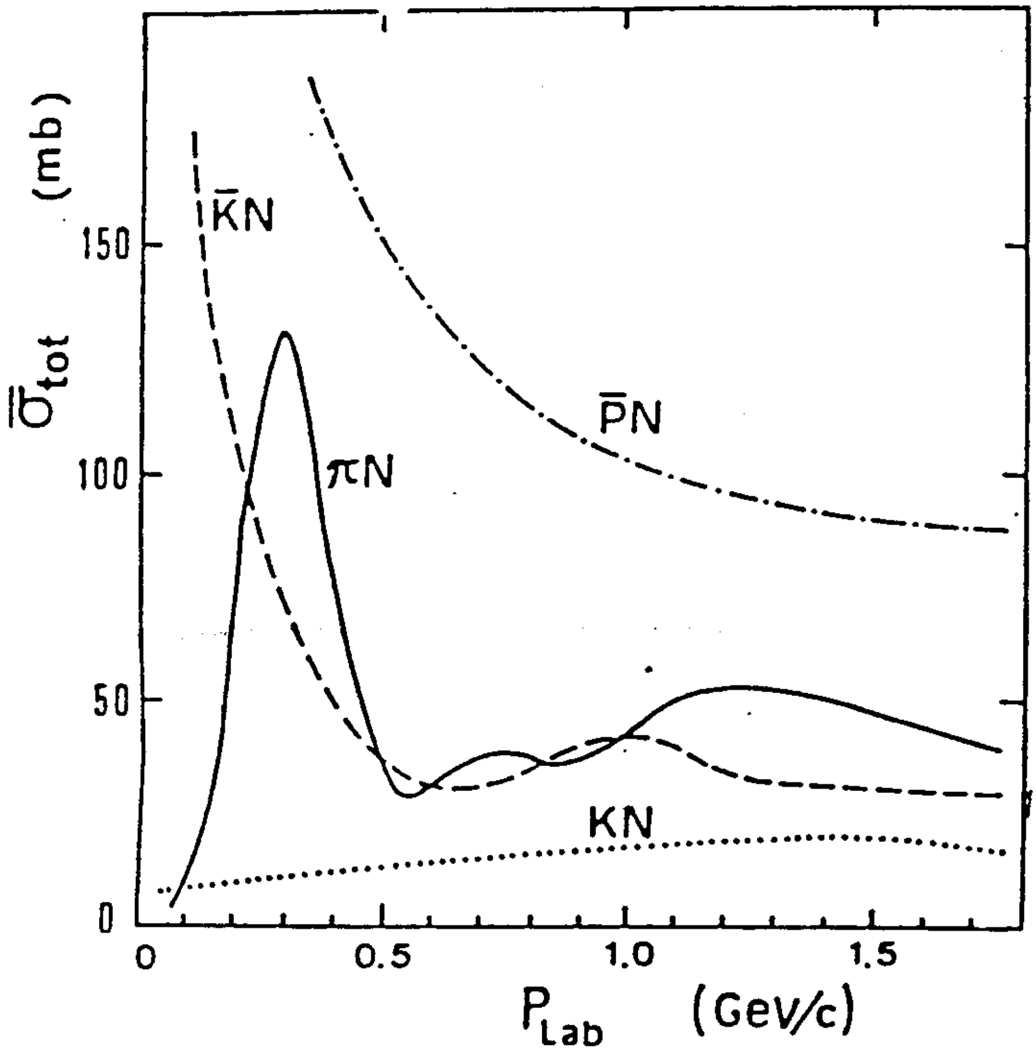
$+ p \rightarrow \pi^{+} + \Sigma^{-}$



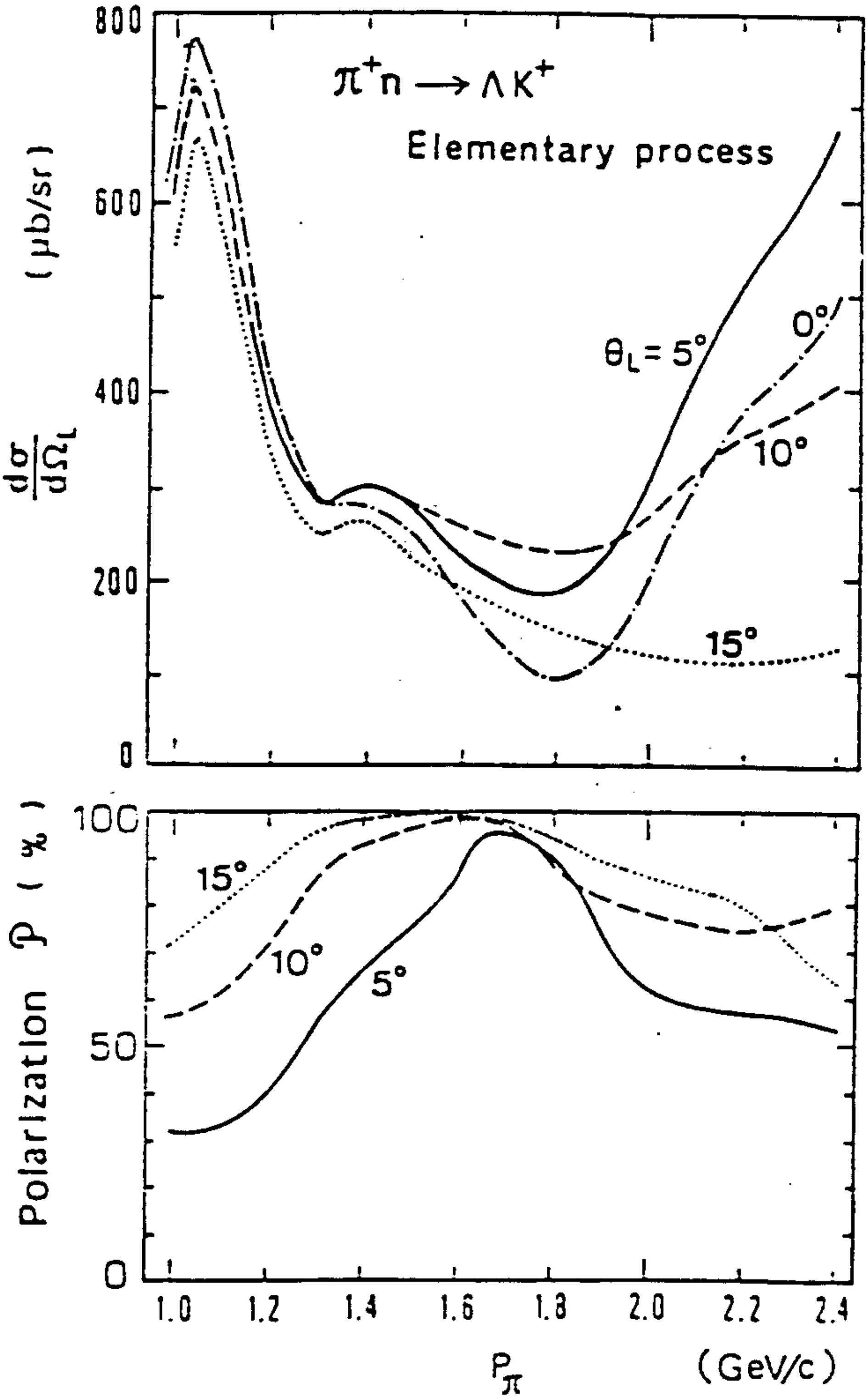
$(\pi^{\pm}, K^{+})$
Λ
Σ+
Σ0
Σ−
0.6
0.4
0.2
0.0
1.0
1.5
2.0
α dσ/dΩ(0°)Lab.(mb/sr)
Lab. PION MOMENTUM Pπ(GeV/c)



θ=0°
NN → Λ(NK+)
K−p → ΞK+
π+n → ΛK+
γp → ΣK+
γp → ΛK+
πN → ΣK+
K̄N → Σπ
K−n → Λπ−
800
600
400
200
0
1.0
2.0
3.0
4.0
HYPERON RECOIL MOMENTUM qY (MeV/c)
PROJECTILE MOMENTUM PLab (GeV/c)

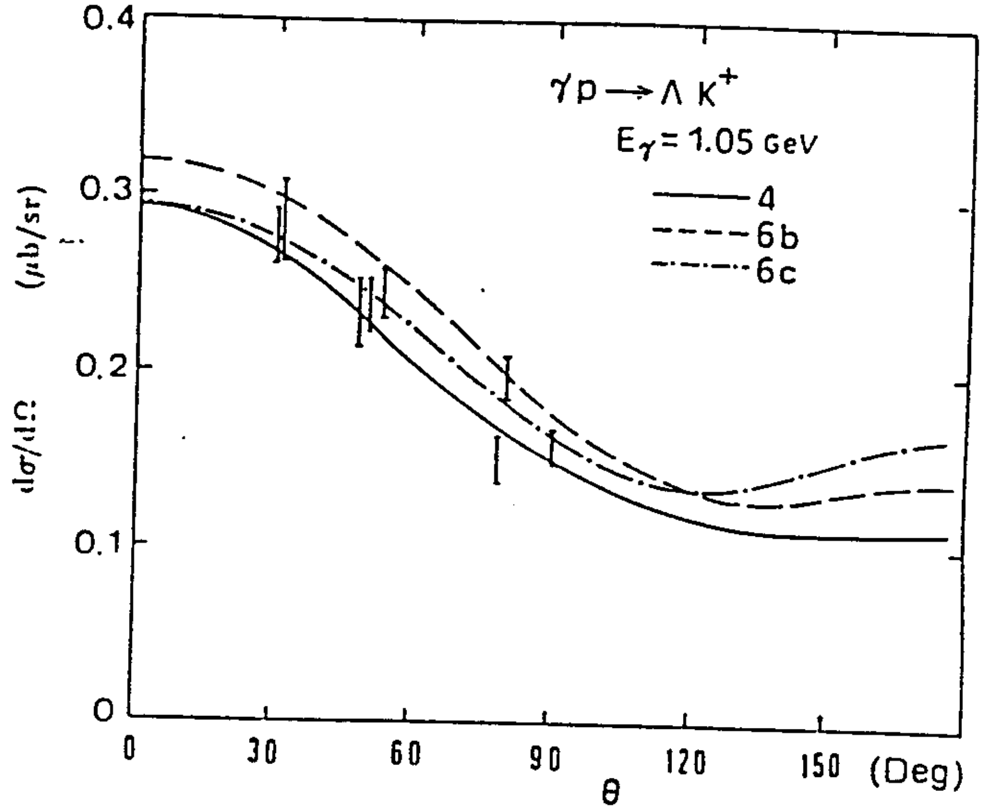


(mb)
$\bar{\sigma}_{tot}$
150
100
50
0
$\bar{K}N$
$\bar{P}N$
πN
KN
0
0.5
1.0
1.5
P_{Lab} (GeV/c)

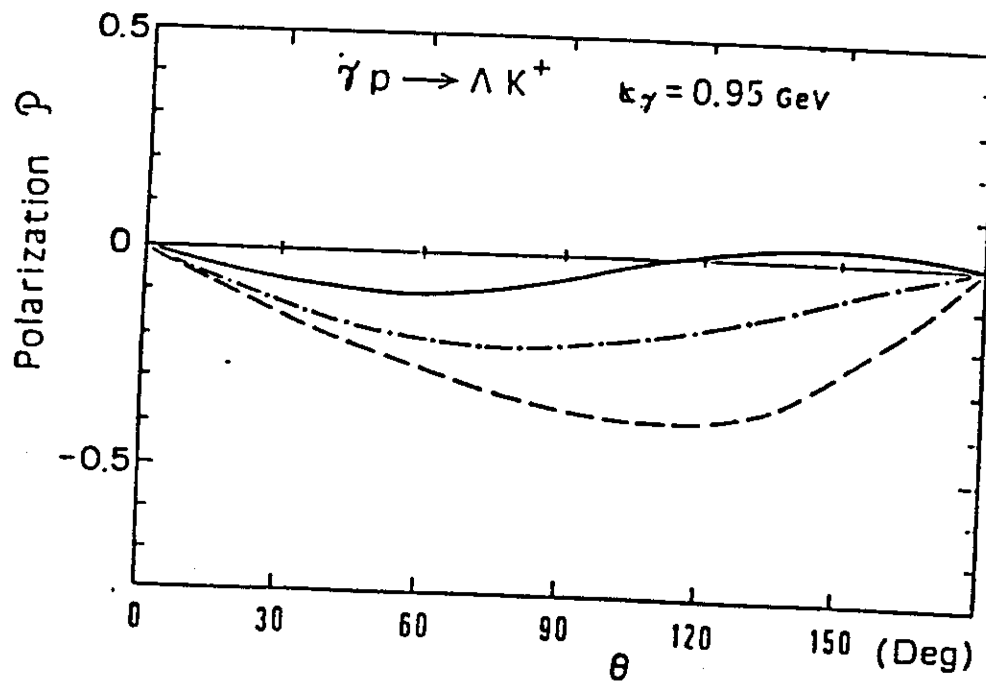


π⁺n → ΛK⁺
Elementary process
dσ/dΩ_L (μb/sr)
800
600
400
200
0
θ_L = 5°
0°
10°
15°
Polarization P (%)
100
50
0
15°
10°
5°
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
P_π (GeV/c)

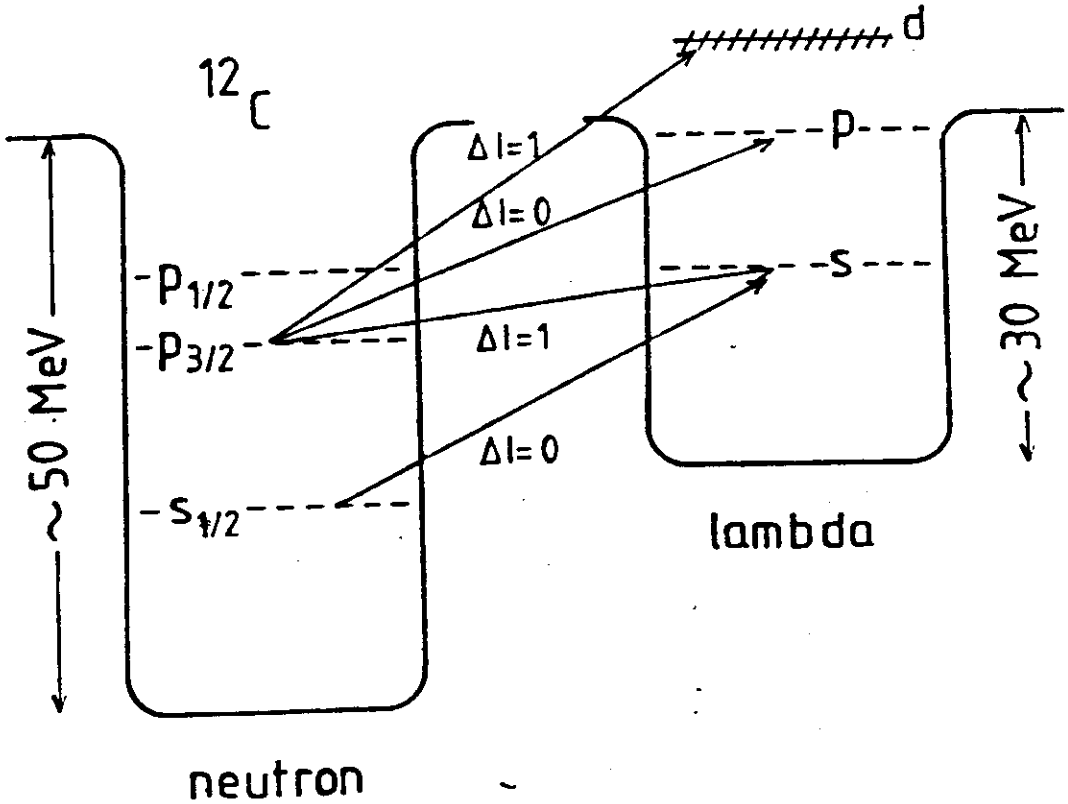
... J. Smith Int. J. Mod. Phys.
A 4 (89) 1



H. Bauli et al. Int. J. Mod. Phys.
to be publ.



$^{12}C(K^-,\pi^-)\,^{12}_{\Lambda}C$



$$\Gamma_{ph} = \Gamma_p \cdot \Gamma_h$$

$$E_K - E_\pi = M_{HY} - M_A + \cancel{T_{HY}} \qquad T_{HY} \simeq \frac{q^2}{2M_{H}}$$

$$= M_C + M_{\Lambda/\Sigma} - B_{\Lambda/\Sigma} - M_A$$

$$= \cancel{M_C} + M_{\Lambda/\Sigma} - B_{\Lambda/\Sigma} - \left(\cancel{M_C} + M_{n/p} - B_{n/p}\right)$$

$$= M_{\Lambda/\Sigma} - M_{n/p} - \left(B_{\Lambda/\Sigma} - B_{n/p}\right)$$

$$\downarrow$$

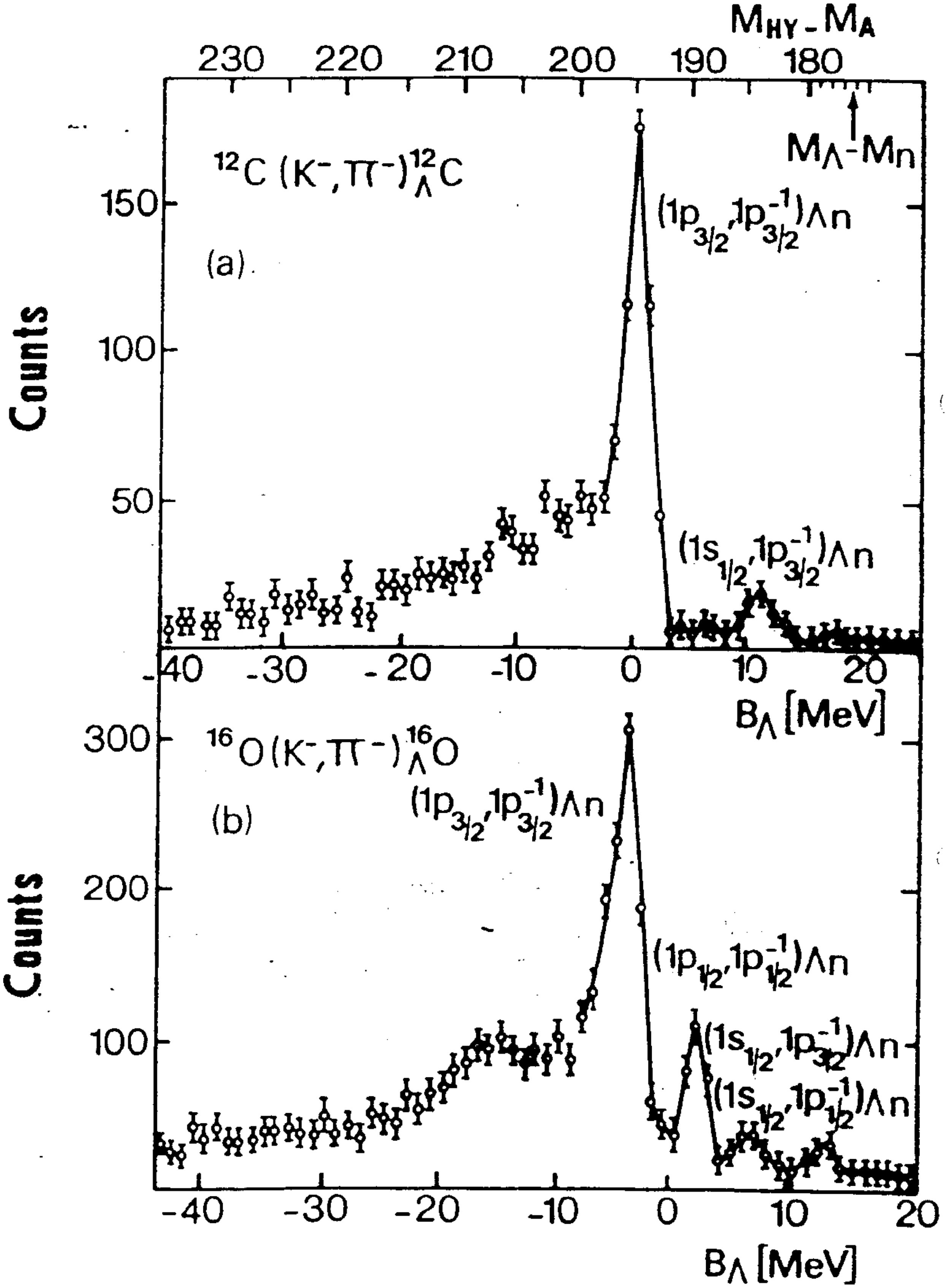
$$- \Delta B_{n/p\, \Lambda/\Sigma}$$

$$\Delta B_{n/p\, \Lambda/\Sigma} = M_{HY} - M_A - \left(M_{\Lambda/\Sigma} - M_{n/p}\right)$$

$$\downarrow$$

$$E_K - E_\pi$$

$p_K = 720$ MeV/c



W. Brückner et al. P.L. 79 B (1978) 157

Potential $V(r)$

Central

$$V(r) = -V_0 \, f(r)$$

$f(r) = (1+\exp((r-R)/a))$

$R = r_0 A^{1/3}$ $r_0 = 1.1$ fm

$a = .6$ fm.

Spin orbit term

$$+ \; V_{LS} \, \vec{\ell}\cdot\vec{\sigma} \left(\frac{\hbar}{m_\pi c}\right)^2 \frac{1}{r} \frac{df(r)}{dr}$$

$+$ Lane term

$$(V_1/A) \, \vec{t} \cdot \vec{T}_{A-1}$$

but

residual V_{YN} residual

interaction

Quasi free

No momentum limitation due to Pauli principle

$$-K_F \le K \le +K_F$$

$$\omega = M_\Lambda - U_\Lambda + (K+q)^2/2M_\Lambda - [M_N - U_N + K^2/2M_N] = E_K - E_\pi$$

$$\omega = M_\Lambda - U_\Lambda + (U_N - M_N) + \frac{q^2}{2M_\Lambda} + \frac{K_z q}{M_\Lambda} + \frac{K^2}{2M_\Lambda M_N}(M_N - M_\Lambda)$$

but $\bar{K}^2 \simeq \frac{k_F^2}{2}$

$$\omega = M_\Lambda - M_N + (U_N - U_\Lambda) + \frac{q^2}{2M_\Lambda} + \frac{K_z q}{M_\Lambda} + \frac{k_F^2}{4M_\Lambda M_N}(M_N - M_\Lambda)$$

if $K_z = $ [illegible]

$$\frac{dN}{dK_z} = \frac{3}{4K_F}\left(1 - K_z^2/K_F^2\right)$$

$$\frac{dN}{d\omega} = \frac{dN}{dK_z}\frac{dK_z}{d\omega} = \frac{dN}{dK_z}\frac{M_\Lambda}{q} = \frac{M_\Lambda}{q}\frac{3}{4K_F}\left(1 - K_z^2/K_F^2\right)$$

but $\omega - \bar{\omega} = \frac{K_z q}{M_\Lambda} \rightarrow K_z = (\omega - \bar{\omega})\frac{M_\Lambda}{q}$

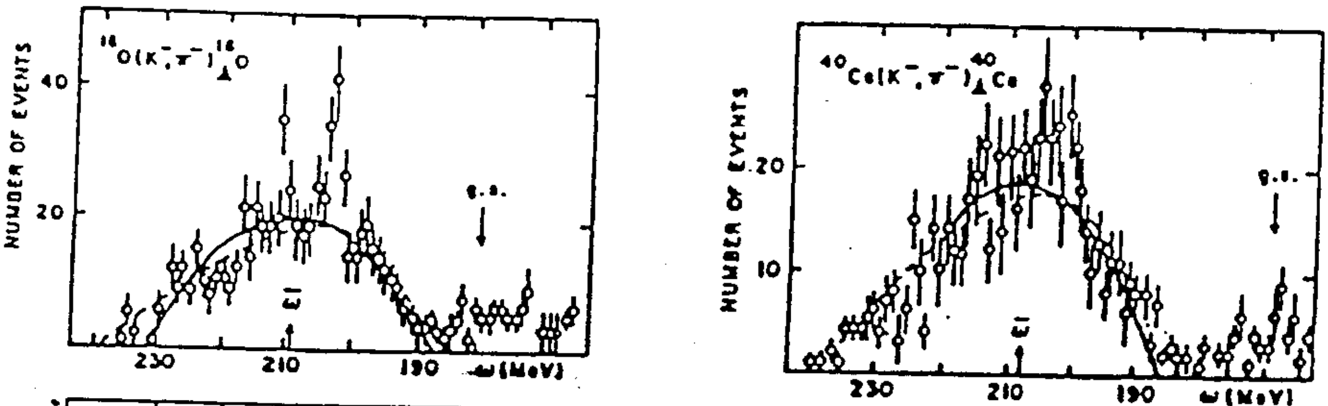
$$\frac{dN}{d\omega} = \frac{3}{4}\frac{M_\Lambda}{q K_F}\left(1 - \frac{M_\Lambda^2}{q K_z^2}(\omega - \bar{\omega})^2\right)$$

R. H. Dalitz and A. Gal Phys. Lett. 64 B (1976) 154

$p_K \simeq 900$ MeV/c

W. Brückner et al.
Phys. Lett. 62B (1976) 481

R. H. Dalitz and
A. Gal
Phys. Lett. 64B (1976)
154



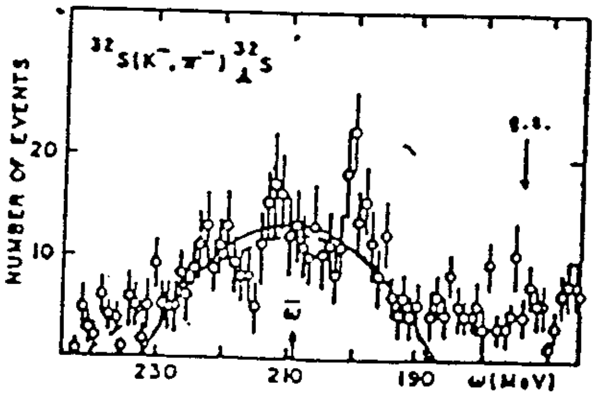


Fig. 10 - Hypernuclear excitation spectra for (K^-,π^-) reactions on ^{16}O, ^{32}S and ^{40}Ca. The solid line gives the quasi-free shape for a constant momentum transfer $\bar{q}$ and a linear dependence of the energy transfer ω on k_z. The dashed line gives the shape with the full k_z dependence for ω and q. The location of (normalized) shapes has been fitted (by eye) to the observed broad bump. $\bar{\omega}$ divides the area of the spectra into two equal parts /12/

↓

$V_0^{\Lambda} \simeq 30$ MeV

$$V_{\Lambda N}(r_\Lambda - r_N) = V(r_\Lambda - r_N)(1-\varepsilon' + \varepsilon' P_x)$$

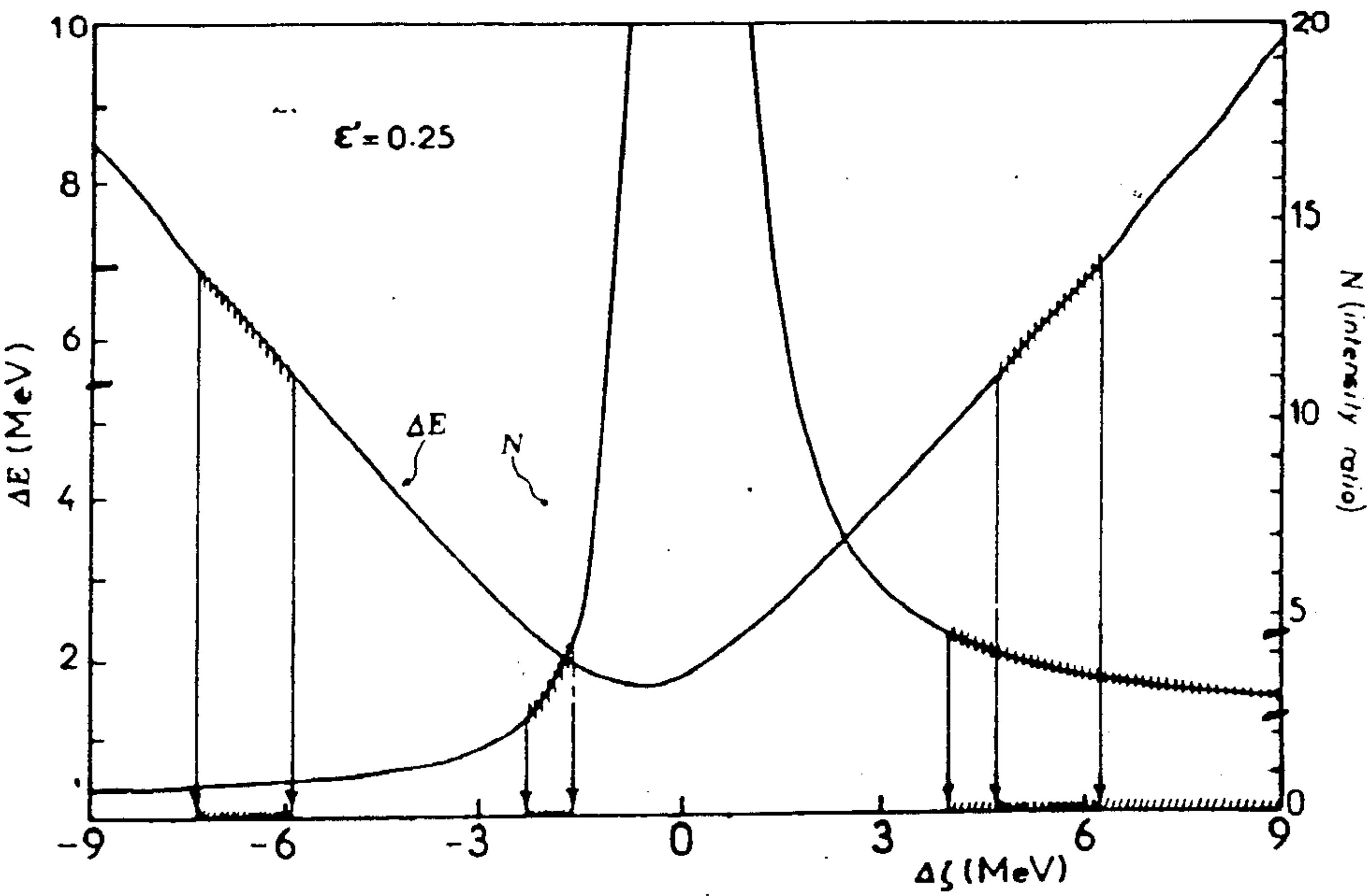
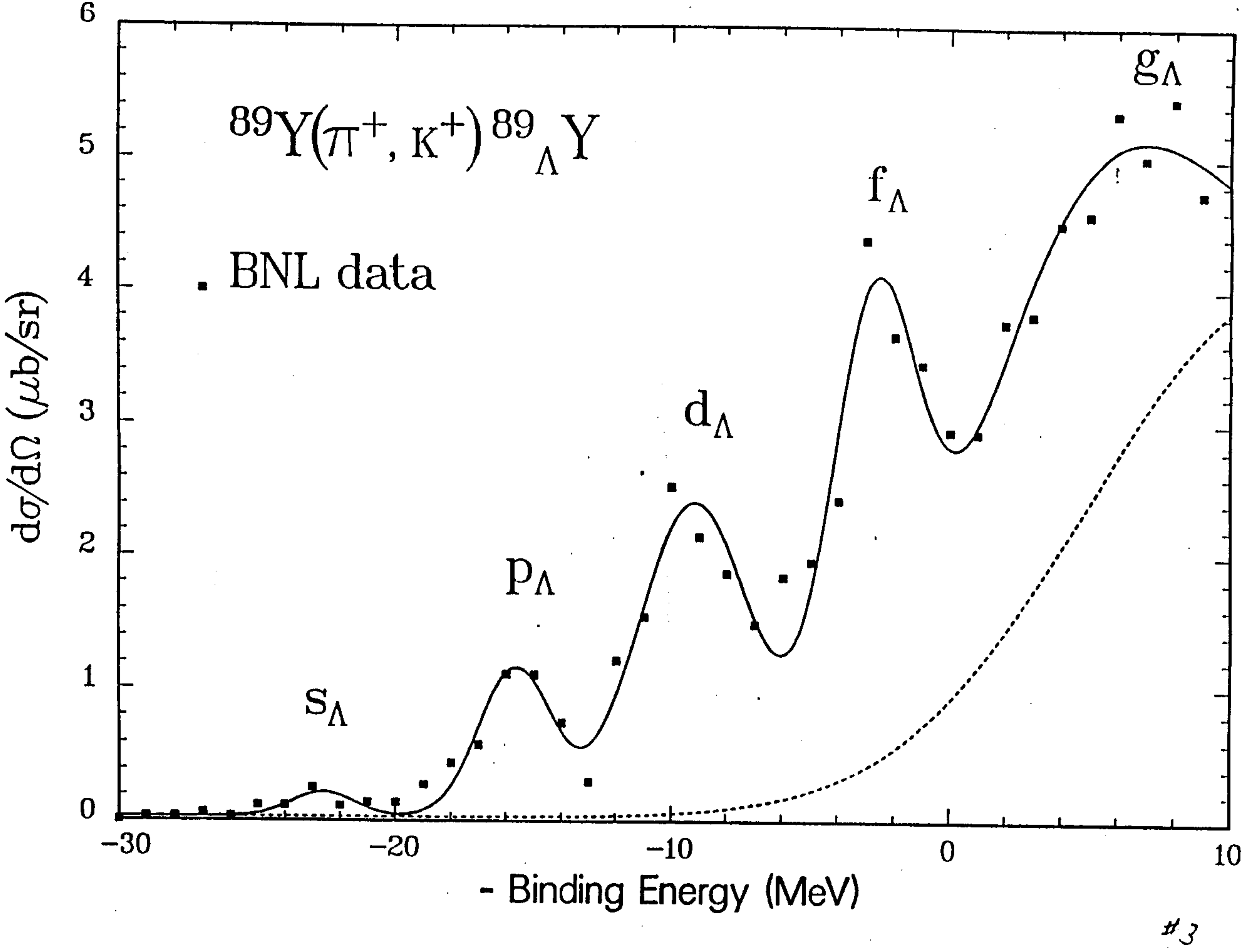
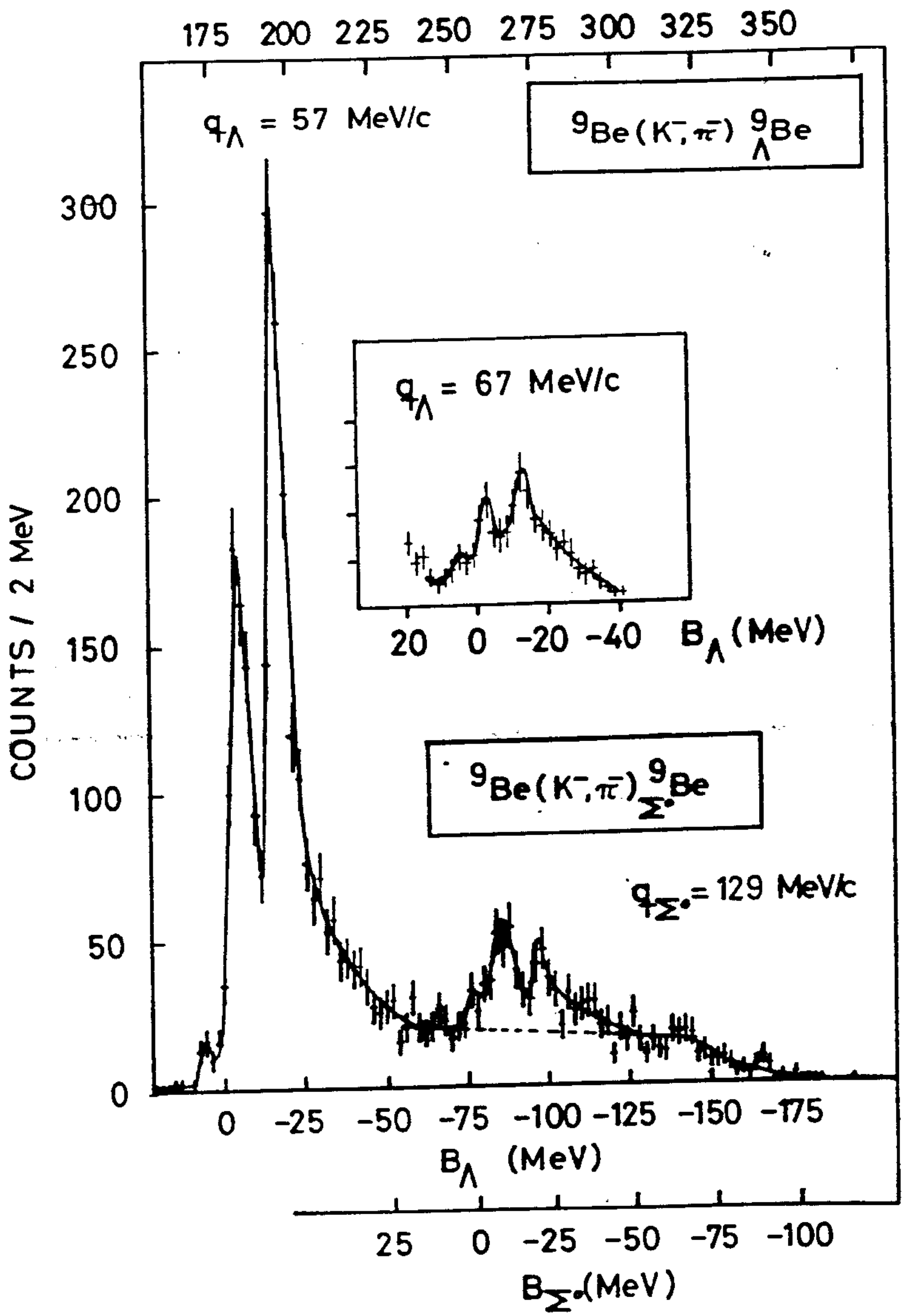


Fig. 1. Separation energy (on the left scale) and intensity ratio (on the right scale) as functions of the spin–orbit difference. The solid line corresponds to the gaussian interaction with a range $\mu = 1.04$ fm. The experimental and theoretical uncertainties on ΔE ($5.5 < \Delta E < 7$) and on N ($2.5 < N < 4.5$) impose constraints on $\Delta\zeta$ (indicated by slashes). The overlap (if any) gives the value of the spin–orbit difference. A value $\epsilon' = 0.25$ has been taken for the exchange mixture parameter.

A. Bouyssy P.L. 91 B (1980) 15


$^{89}Y(\pi^+, K^+)\,^{89}_{\Lambda}Y$
BNL data
s_Λ
p_Λ
d_Λ
f_Λ
g_Λ
$d\sigma/d\Omega$ (μb/sr)
0
1
2
3
4
5
6
−30
−20
−10
0
10
- Binding Energy (MeV)
#3

$p_K = 720$ MeV/c $M_{HY} - M_A$ (MeV)



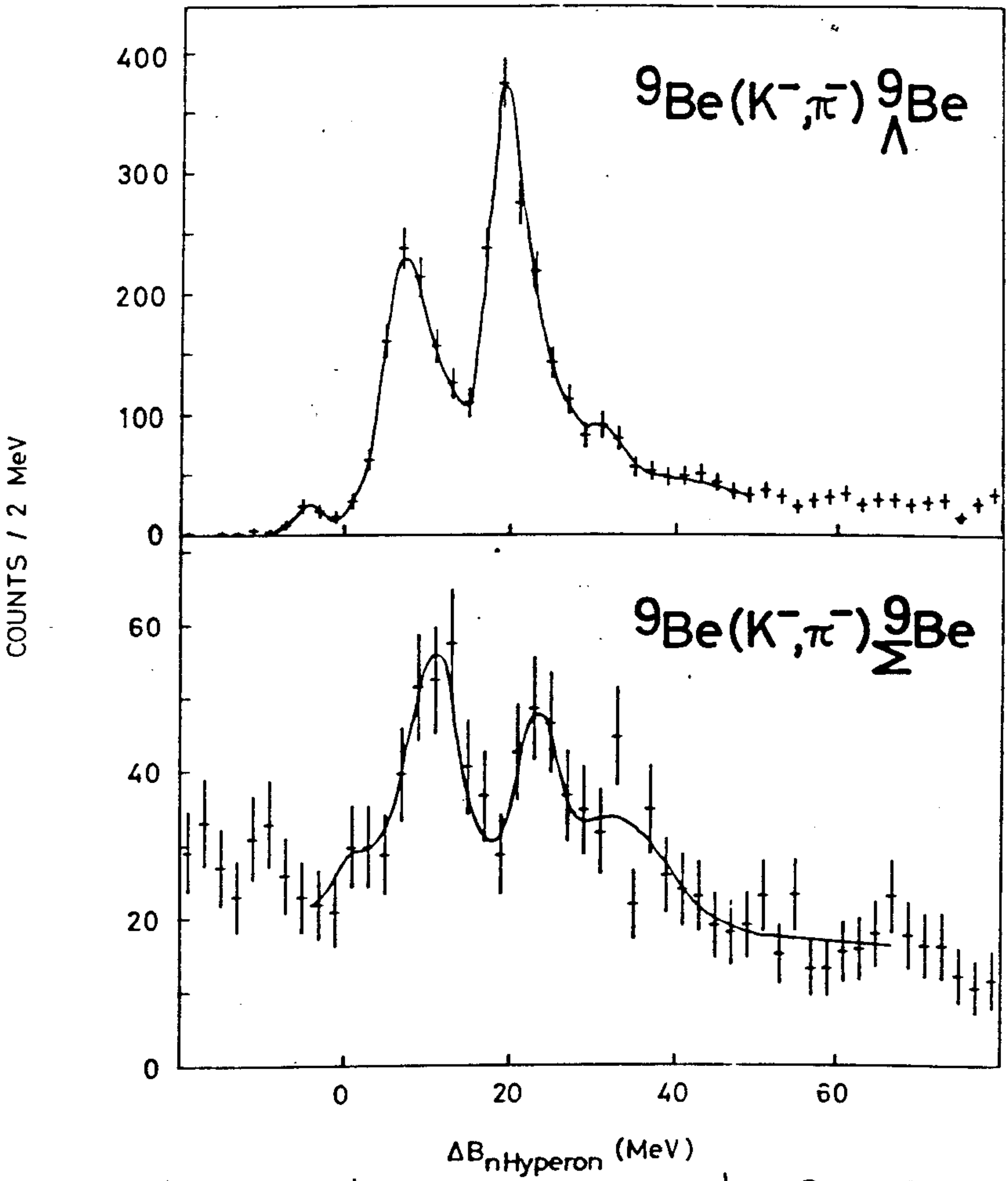
R. Bertini et al.
Phys Lett 90B (1980) 375

Hyp ($S=-1$)	Mass (MeV)	I	J^P	τ (sec.) / Γ (meV)	Mode	%
Λ	1115.6	0	$1/2^+$	$2.6\cdot10^{-10}$ $4.1\cdot10^{-12}$	$p\pi^-$ $n\pi^0$	64. 36.
Σ^+	1189.4	1	$1/2^+$	$.8\cdot10^{-10}$ $8.2\cdot10^{-12}$	$p\pi^0$ $n\pi^+$	52. 48.
Σ^0	1192.5	1	$1/2^+$	$7.4\cdot10^{-20}$ $8.9\cdot10^{-3}$	$\Lambda\gamma$	100.
Σ^-	1197.4	1	$1/2^+$	$1.5\cdot10^{-10}$ $4.4\cdot10^{-12}$	$n\pi^-$	100.

but in the nuclear matter

$\Lambda + N \rightarrow N + N$ weak int.

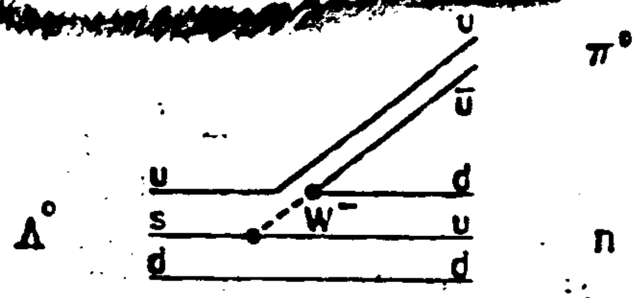
$\Sigma + N \rightarrow \Lambda + N$ strong int.



$$\Delta B_{NY} = M_{YA} - M_{A} - (M_Y - M_N) = B_N - B_Y$$

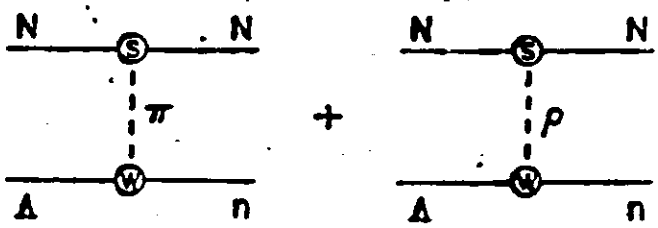
NONLEPTONIC WEAK INTERACTIONS

MESONIC $\Lambda^0 \longrightarrow n + \pi^0$

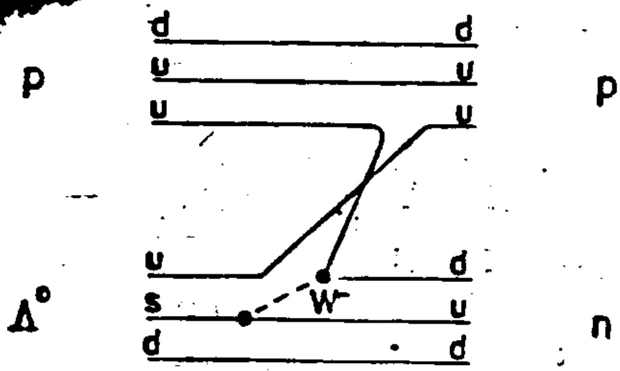


(a)

MESON Exchange Calculations



NONMESONIC $\Lambda + p \longrightarrow n + p$

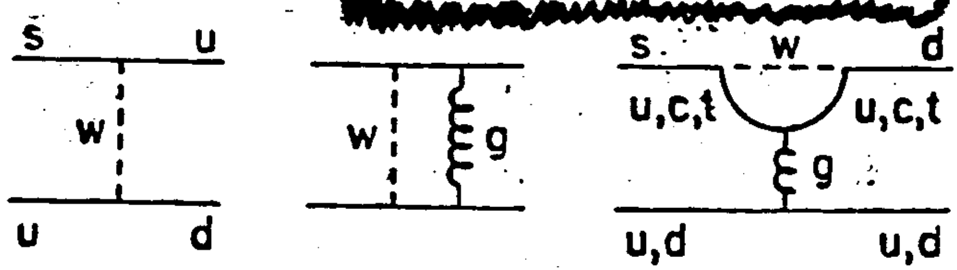


(b)

$$H_{VA} = \frac{G_F}{\sqrt{2}} \sin\vartheta_c \cos\vartheta_c \, Q_{VA} + c.c.$$

"$\Delta I = \frac{1}{2}$ rule"

Strong interaction corrections



V–A interaction

gluon radiative correction

Penguin diagram

Non leptonic decay rates

Mesonic decay $\qquad\qquad\qquad\qquad$ Energy release

Γ_{π^0} [illegible] $\Lambda \to n + \pi^0$ $\qquad$ [illegible]

Γ_{π^-} $\Lambda \to p + \pi^-$

Non mesonic decay

Γ_n $\qquad \Lambda + n \to n + n$ $\qquad +176\ \text{MeV} - (B_\Lambda + B_N$

Γ_p $\qquad \Lambda + p \to n + p$

$\Gamma_p = .49^{+.3}_{-.2}\ )\ \Gamma_\Lambda$

$\Gamma_n = .65^{+.2}_{-.3}\ )\ \Gamma_\Lambda$ $\qquad$ Γ_Λ = free Λ decay rate

$\Gamma_{\pi^-} = .05^{+.06}_{-.03}\ )\ \Gamma_\Lambda$

$\Gamma_{\pi^0} = .06^{+.08}_{-.05}\ )\ \Gamma_\Lambda$ $\qquad$ [illegible] $\pm .02$

$^{12}C_\Lambda$ $\qquad \tau = 211 \pm 31$ ps $\qquad \Gamma / \Gamma_\Lambda = 1.25 \pm .18$

$$1/\tau = \Gamma = \Gamma_{\pi^0} + \Gamma_{\pi^-} + \Gamma_n + \Gamma_p$$

R. Grace et al $\quad$ P. R. L. 55 (1985) 1055

${}^{10}_{\Lambda\Lambda}Be$ $\quad B_{\Lambda\Lambda} = 17.7 \pm .4$ MeV

${}^{6}_{\Lambda\Lambda}He$ $\quad B_{\Lambda\Lambda} = 10.9 \pm .6$ MeV

⇓

H particle

K^-, K^+ reaction

S = 0 Resonances

$I = 1/2$ nucleon resonances N^*

$I = 3/2$ Δ resonances

$\Gamma \simeq 100 - 200$ MeV

S = -1 Resonances

$I = 0$ Λ resonances

$I = 1$ Σ resonances

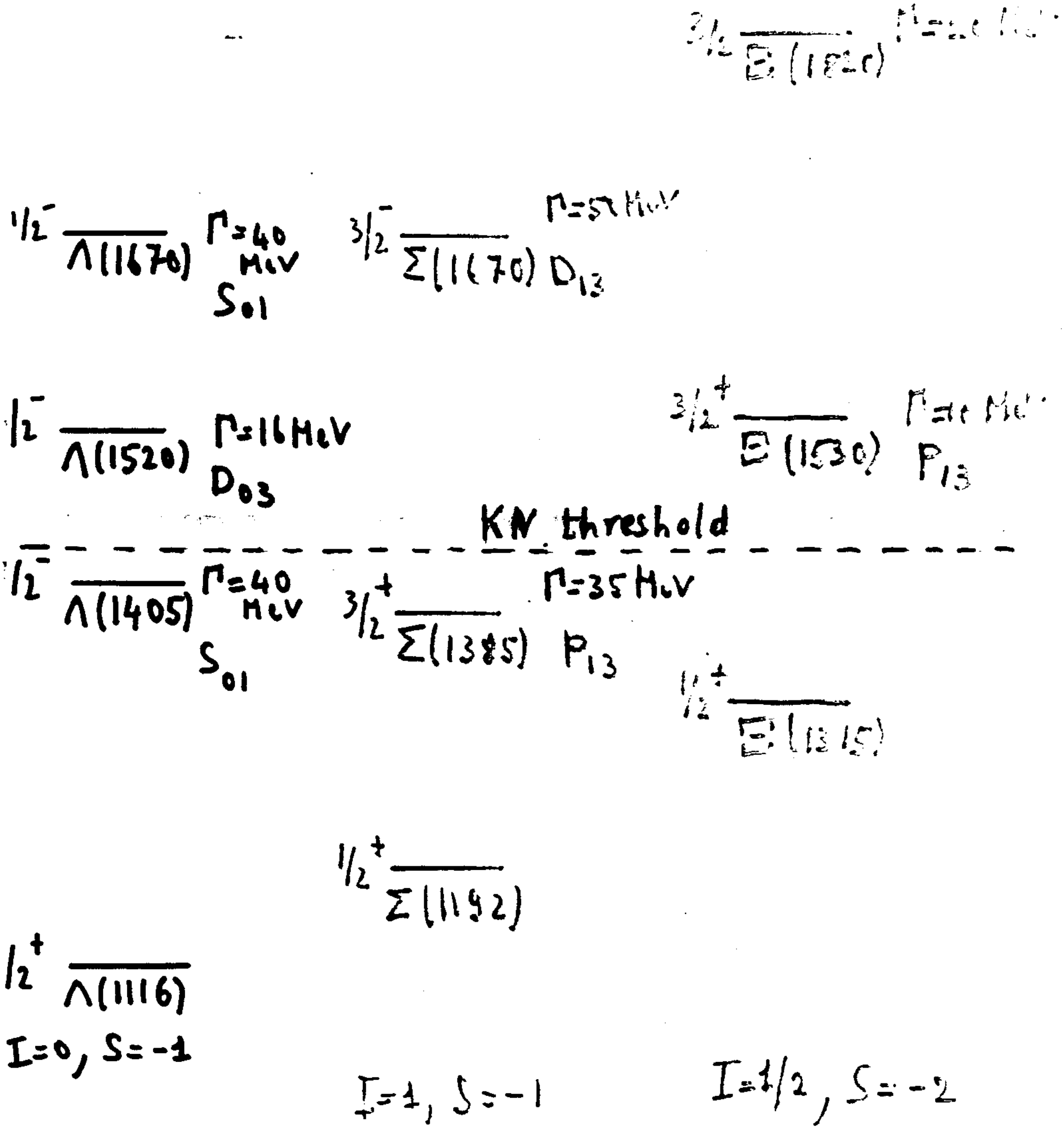
$\Gamma \simeq 15 - 60$ MeV

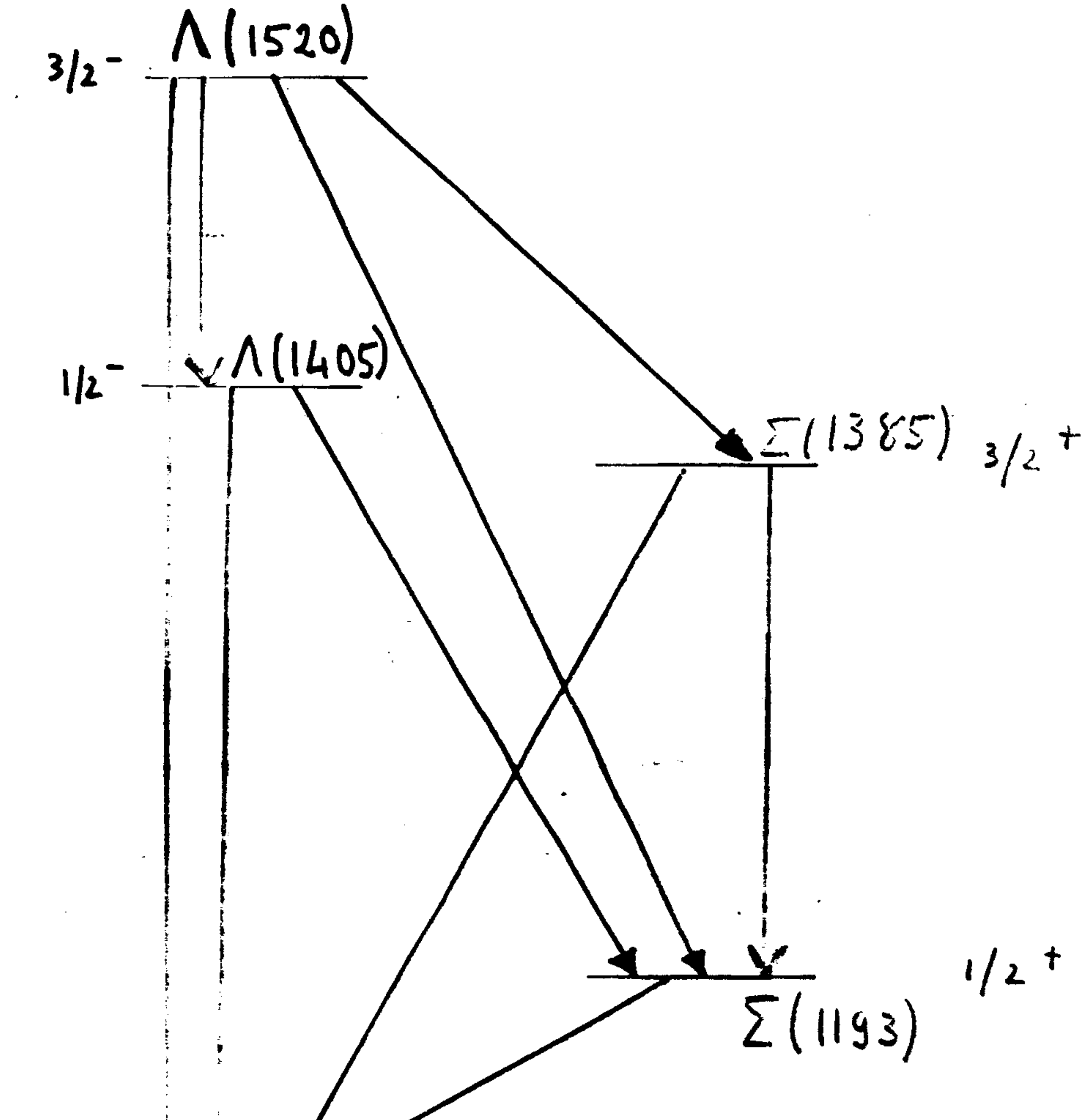
S = -2 Resonances

$I = 1/2$ Ξ resonances

$\Gamma \simeq 10 - 20$ MeV

Hyperon Level Scheme

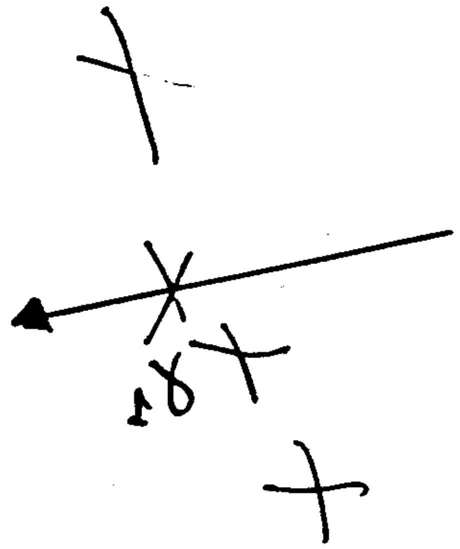




3/2⁻ Λ(1520)
1/2⁻ Λ(1405)
Σ(1385) 3/2⁺
1/2⁺
Σ(1193)
1/2⁺
Λ(1116)

↑ μ
↑ l
↑ s

$[(\uparrow\uparrow)\downarrow_{s=0,I=0}] = s^2p_{3/2}$



$[(\downarrow\downarrow)\downarrow_{s=1,I=1}] = s^3$

$[(\uparrow\uparrow)\downarrow_{s=0,I=0}] = s^2p_{1/2}$

γ_1

$(E_\gamma + M_\gamma) = 1314 \pm 30$ keV

E1

$\sqrt{\tfrac{1}{2}}[(\uparrow\uparrow)\downarrow_{s=0,I=1}] + \sqrt{\tfrac{2}{3}}[(\downarrow\uparrow)\uparrow_{s=1,I=1}] = s$

M1 $E_\gamma = 11.3$ keV ± 2.6

$([(\uparrow\uparrow)]\downarrow_{s=0,I=0}) = s^3$

E. Kaxiras et al Phys. Rev. D 32 (1985) 695

$$.86\,\Lambda\left\{1,\tfrac{3}{2}^-\right\} + .35\,\Lambda\left\{8,\tfrac{3}{2}^-\right\}_{S=0} - .35\,\Lambda\left\{8,\tfrac{3}{2}^-\right\}_{S=1} - .14\,\Lambda\left\{1,\tfrac{1}{2}^-\right\}$$

$$-\,.91\,\Lambda_1\,{}^2P_M + .40\,\Lambda_8\,{}^2P_M + .01\,\Lambda_8\,{}^4P_M$$

γ_0 27 KeV γ_1 102 KeV

48 KeV 17 KeV

96 KeV 74 KeV

$$.97\,\Sigma_8\,{}^2S_S - .18\,\Sigma_8\,{}^2S_S - .10\,\Sigma_8\,{}^2S_S - .02\,\Sigma_M\,{}^2S_M$$

$$.93\,\Lambda_8\,{}^2S_S - .30\,\Lambda_8\,{}^2S_S - .20\,\Lambda_8\,{}^2S_M - .05\,\Lambda_1\,{}^2S_M$$

J.W. Darewych et al.
Phys. Rev. D 28 (83) 1125

$$X_{m}\,{}^{2S+1}L_{\sigma}$$

$$\sigma_{tot} = 4\pi \lambda^2 \left(J + 1/2\right) x_e \qquad x_e = \frac{\Gamma_{el}}{\Gamma} = .45$$

$$\sigma_\gamma = 4\pi\lambda^2 \cdot x_e \cdot \left(J + \frac{1}{2}\right) \frac{\Gamma_\gamma}{\Gamma} = 74 \cdot \frac{\Gamma_\gamma}{\Gamma}$$

F. W. correction = .5 $\rightarrow \sigma_{eff} = 37$ mb.

$$\frac{d\sigma}{d\Omega}_{eff} = \frac{37}{4\pi} = 2.94 \text{ mb/sr}$$

$$N_\gamma^c = N_k \times D_{Time} \times \Delta\Omega_\gamma \times \varepsilon_{NaI} \times \sigma_{eff} \times \frac{\Gamma_\gamma}{\Gamma} \times N_{Targ.} \times \varepsilon_{Rec} \times \Delta\Omega_{Rec}$$

$$= 3.5 \cdot 10^8 \times .9 \times 5.8 \cdot 10^{-2} \times .70 \times 2.9 \cdot 10^{-27} \times \frac{\Gamma_\gamma}{\Gamma} \times 7.7 \cdot 10^{23} \times 1 \times 1$$

$$= 3.0 \cdot 10^4 \frac{\Gamma_\gamma}{\Gamma}$$

$N_{\gamma_0}^c = 63 \pm 20$ $\qquad$ $N_{\gamma_1}^c = 90 \pm 32$

$\downarrow$ $\qquad$ $\downarrow$

$\Gamma_{\gamma_0} = 33 \pm 11$ KeV $\qquad$ $\Gamma_{\gamma_1} = 47 \pm 17$ keV

$$\boxed{\frac{\Gamma_{\gamma_1}}{\Gamma_{\gamma_0}} = 1.4 \pm .7} \longleftrightarrow \frac{\Gamma_{\gamma_1}}{\Gamma_{\gamma_0}} = 3.8$$

$$\frac{\Gamma_{\gamma_1}}{\Gamma_{\gamma_0}} = .37$$

↑ exp. Value

$$\Gamma_{\gamma_1} = .8$$

Resonance propagation in nuclei

Free space no Fermi motion !

$$d_{\Delta} = vt \simeq \frac{p_{\pi}}{m_{\Delta}\,\Gamma_{\Delta}} \simeq .5\ \mathrm{fm}$$

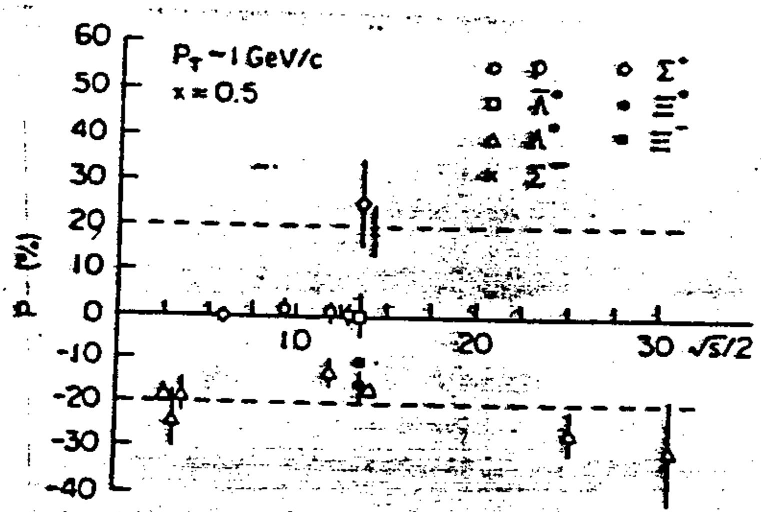
$$d_{\Lambda(1520)} = vt \simeq \frac{p_K}{m_{\Lambda^*}\,\Gamma_{\Lambda^*}} \sim 6\ \mathrm{fm.}$$

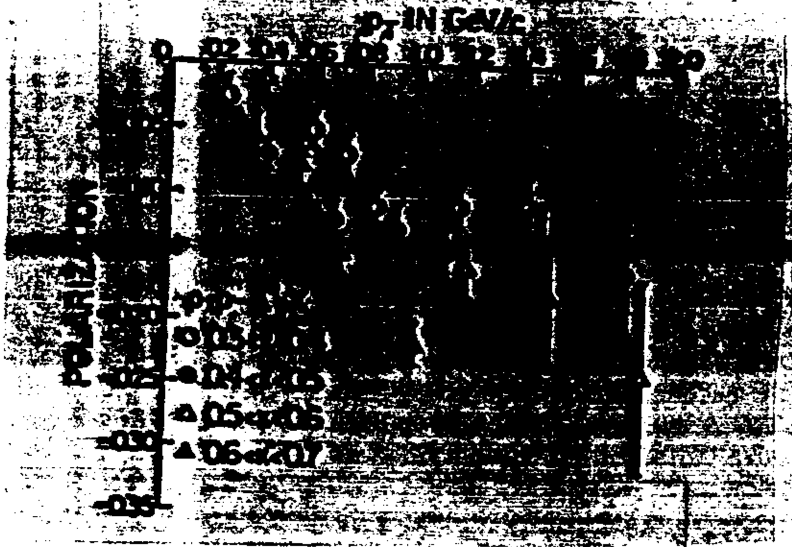
Decay modes :

$$\Lambda(1520) \rightarrow \begin{cases} \bar{K}N & 45\% \pm 1 \\ \pi\Sigma & 42\% \pm 1 \\ \Lambda\pi\pi & 10\% \pm 1 \\ \Sigma\pi\pi & .9\% \pm .1 \end{cases}$$

Hyperon Polarization

Reaction $p + A \to \vec{Y}$





Regularities:

a) Λ, Σ and Ξ are polarized for $p_T >$

b) P_Λ has opposite sign to P_Σ

c) $P_{\bar{\Lambda}}$ always = 0 but $P_{\bar{\Lambda}} \neq 0$ for the reaction $\bar{p} + A \to \vec{\bar{\Lambda}}$

⇓

When 1 or 2 squarks are picked up from the quark sea $P_Y \neq 0$ when 3 $P_Y = 0$

⇓

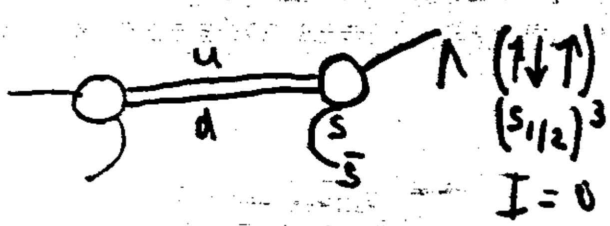
Question: why $P_Y \neq 0$ if squark picked up from sea

⇓

Models ad hoc: QFRC, VVS

Ex. $p \to \vec{\Lambda}$

uud → uds



For p_T large $p_T \simeq q_T + K_T$ (diquark, squark)

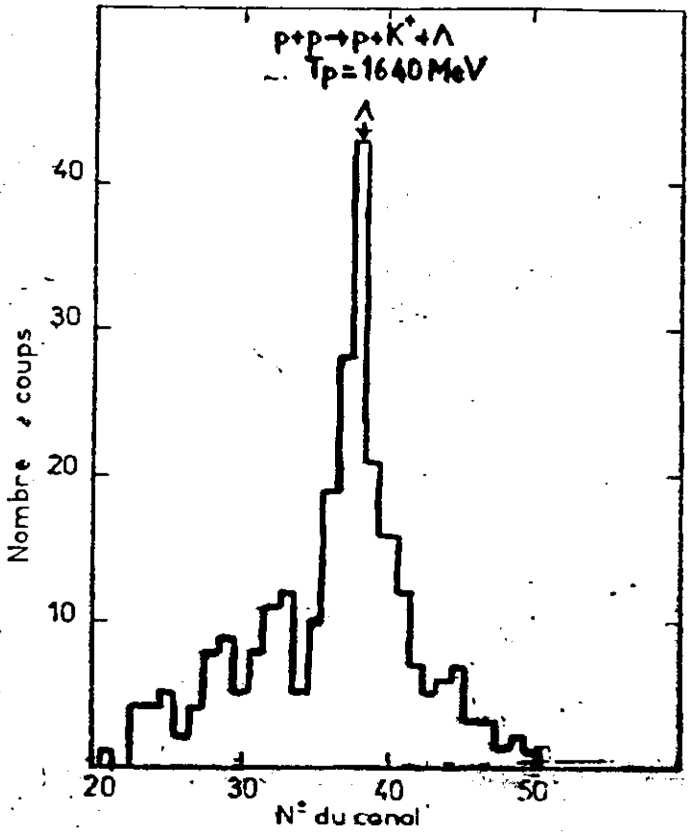
In this framework: there should not be a correlation between the spin direction of the incoming proton and the spin of the Λ

there should be a correlation between the spin direction of the incoming proton. and the spin of the

With the inclusive reaction $p + A \to \Lambda$ problems:

1) $p \to \vec{\Lambda}$ directly
but also
$p \to \Sigma \to \Lambda$

2) measurements performed at forward angles only
$\vartheta_\Lambda \leq 10°$ overall



At Saturne

$pp \to p K^+ \Lambda$ exclusive, $\Lambda \to p\pi^-$ $\alpha = .64$
choose the right angle ϑ_Λ for same p_T

Measurement of spin correlation parameters

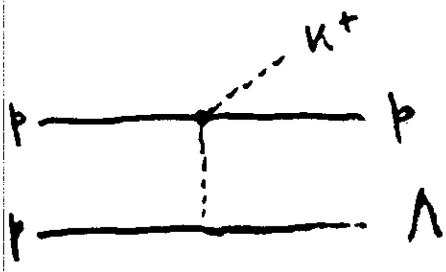
Also possible:

$pp \to p K^+ \Sigma^0$, $\Sigma^0 \to \gamma\Lambda$

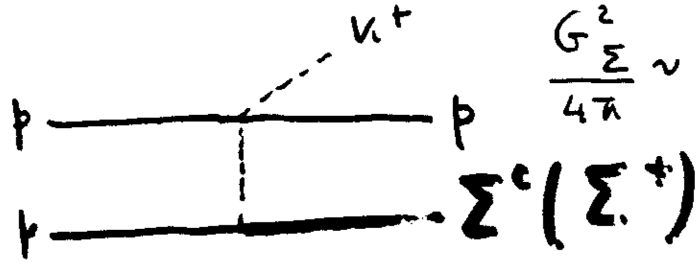
$pp \to K^+ n \Sigma^+$ / $K^0 p \Sigma^+$, $\Sigma^+ \to p\pi^0$ $\alpha = -.98$

$pn \to p K^+ \Sigma^-$, $\Sigma^- \to n\pi^-$ $\alpha = -.07$

Comparison with OBEM



$\frac{G_\Lambda^2}{4\pi} \sim 15$

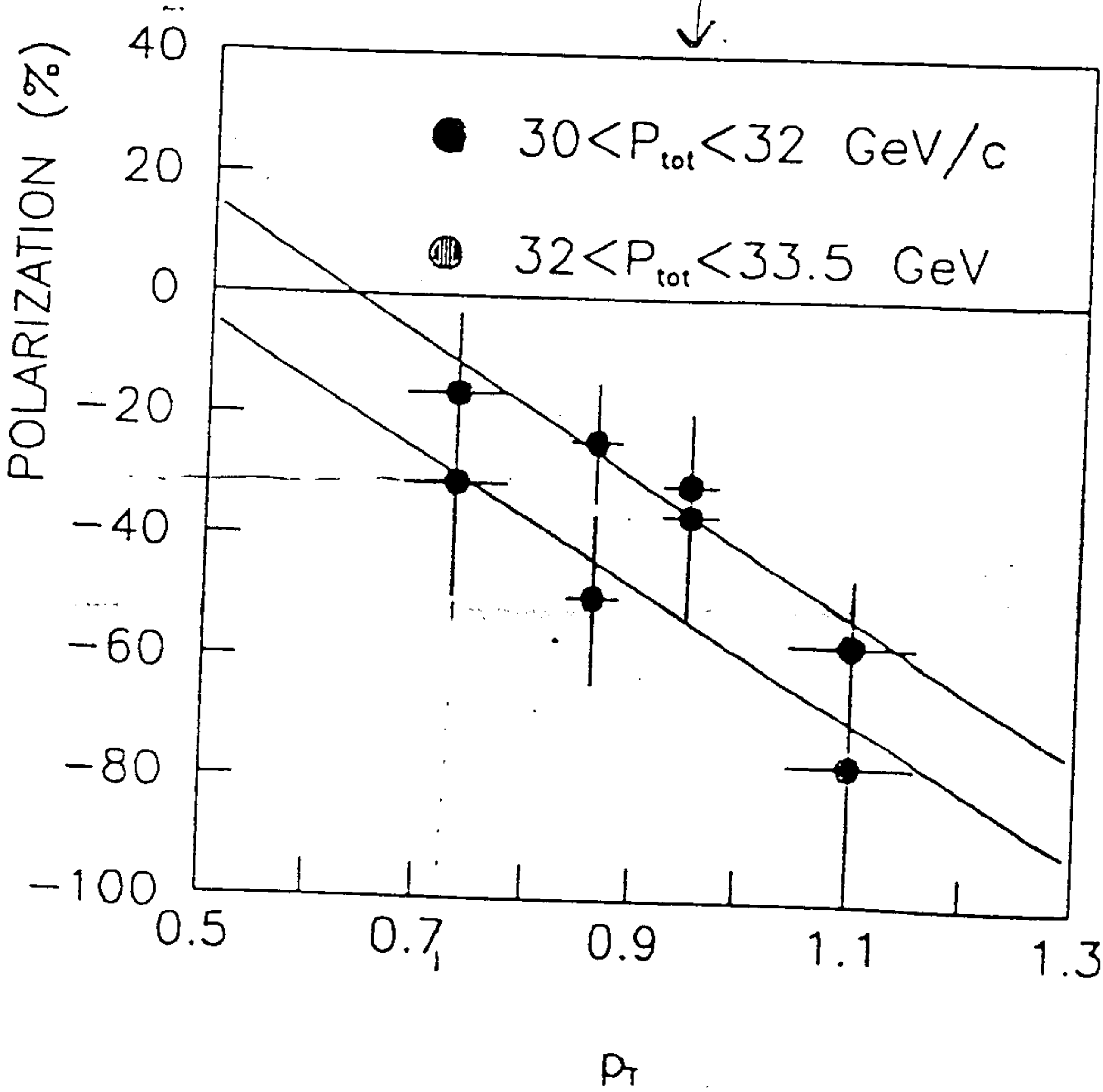


$\frac{G_\Sigma^2}{4\pi} \sim 5$

Laget calculations

$pp \to p\ (\Lambda K^+)$

$2.1 \le M_{\Lambda K} \le$ [illegible]



[PRELIMINARY RESULTS]

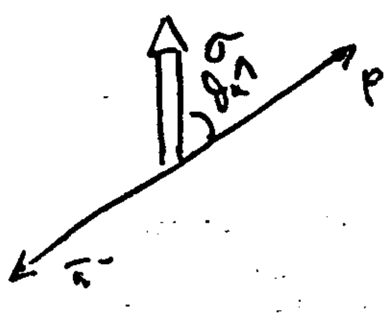
CERN ISR → $\sqrt{s} = 63$ GeV
(R608)

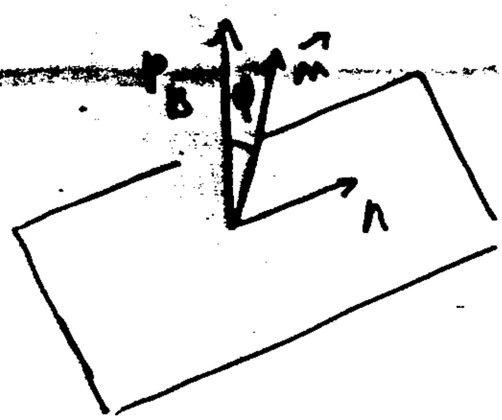
$pp \to p(\Lambda K^+)$

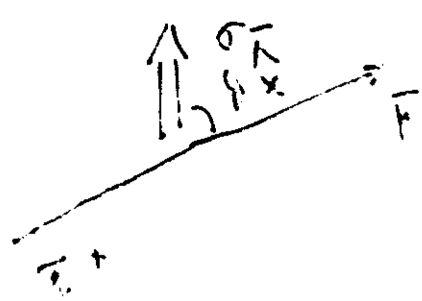
$$A_N = \frac{1}{P_B \cos\psi} \frac{N\uparrow(\psi) - N\downarrow(\psi)}{N\uparrow(\psi) + N\downarrow(\psi)}$$

$$D_{NN} = \frac{1}{P_B \cos\psi} \left[P_\Lambda^{\uparrow} - P_\Lambda^{\downarrow} \right]$$

$$\frac{dN}{d\cos\theta^*} = N_0 \left(1 + \alpha P_\Lambda \cos\theta^* \right)$$







$$pp \to p(K^+ \Lambda)^{N^*}$$
$$\quad \hookrightarrow \Lambda \to p\pi^-$$

$$pp \to p(K^+ \Sigma^0)^{N^*}$$
$$\quad \hookrightarrow \Sigma^0 \to \gamma \Lambda, \quad \Lambda \to p\pi^-$$

$$pp \to p K^+ \Lambda^*$$
$$pp \to p K^+ \Sigma^*$$

$$pp \to p K^+ \Lambda^*$$
$$\quad \hookrightarrow \gamma \Lambda$$
$$\quad \hookrightarrow \gamma \Sigma$$

Nuclei

$$pA \to p K^+ \Lambda^* X$$
$$\quad \hookrightarrow p K^-$$
$$\quad \hookrightarrow \gamma \Lambda$$
$$\quad \hookrightarrow \gamma \Sigma$$

$$pA \to p K^+ \Sigma^0 X$$

$$V(r) = V_0(r) + \text{s.o.} + \text{L.T.} + \text{r.i}$$

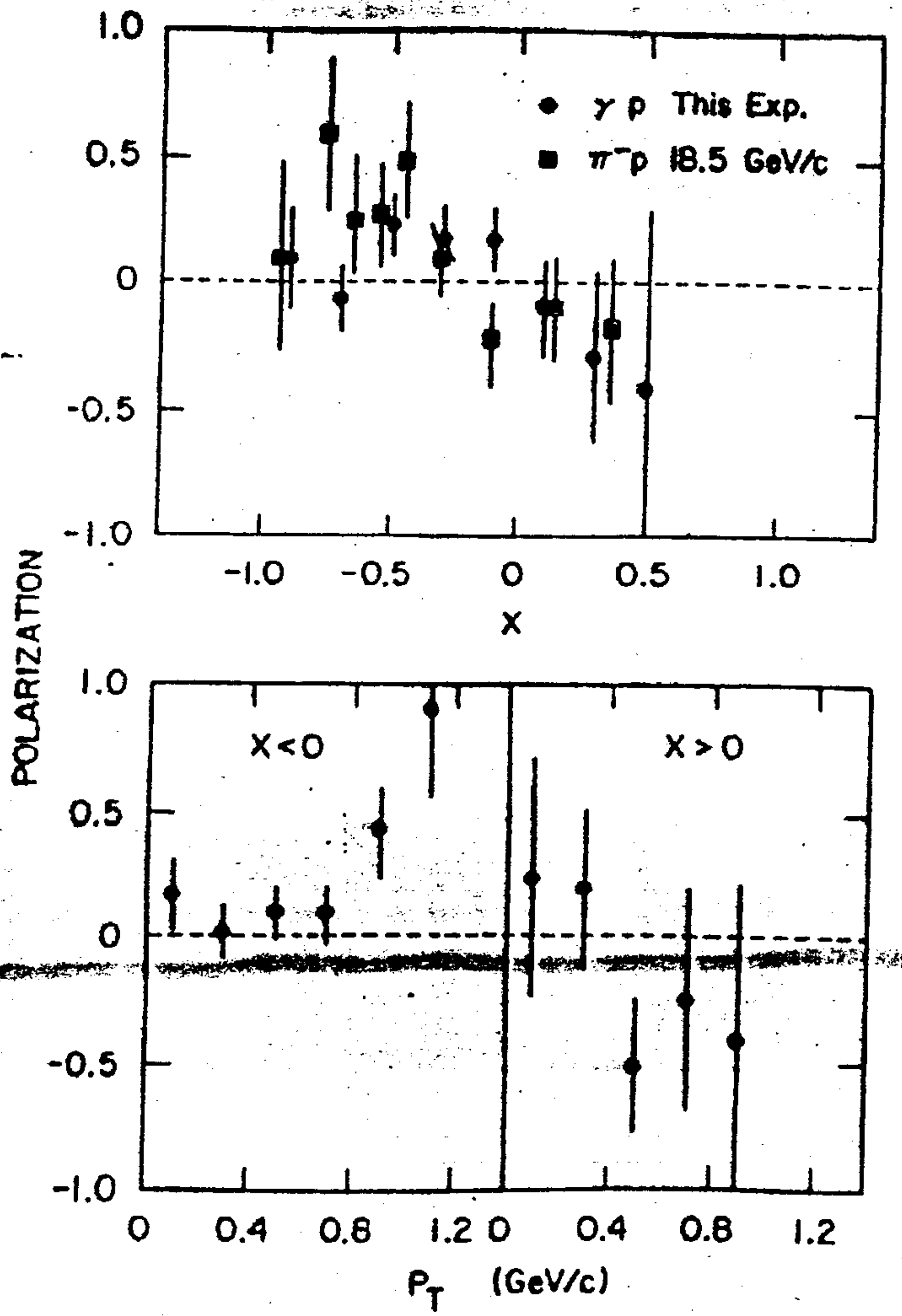
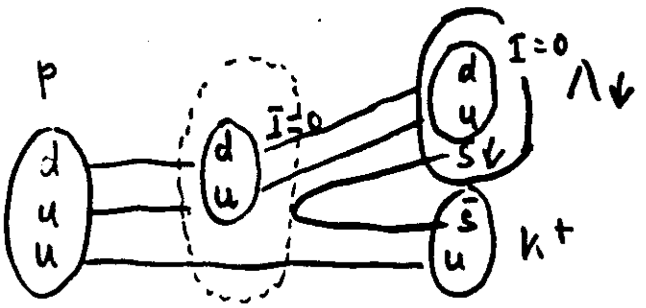


FIG. 8. Average polarization of Λ's as a function of x and p_T. The open square points are from Ref. 1.

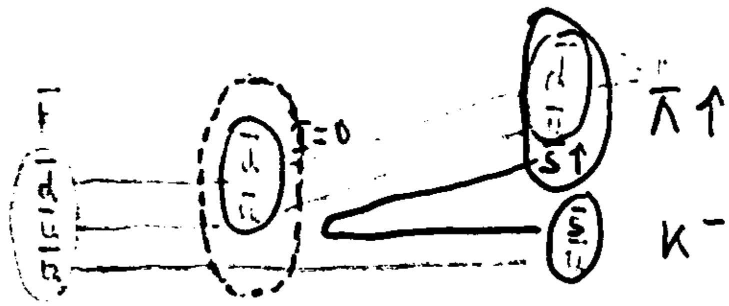
K. Abe et al.
Phys. Rev. D 29 (1984) 1877

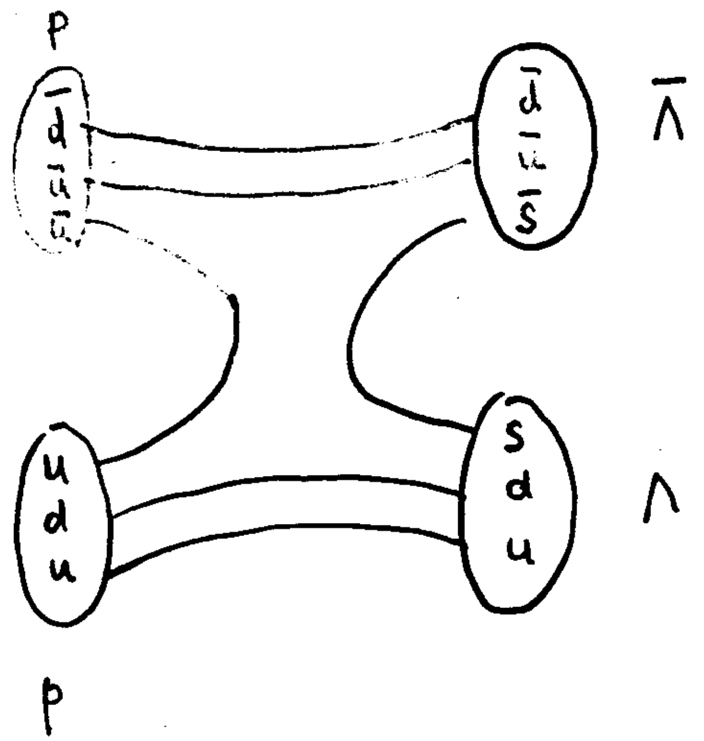
Strangeness

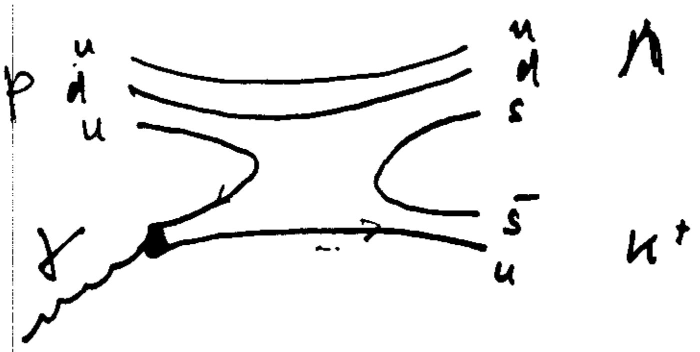
N N



N̄ N



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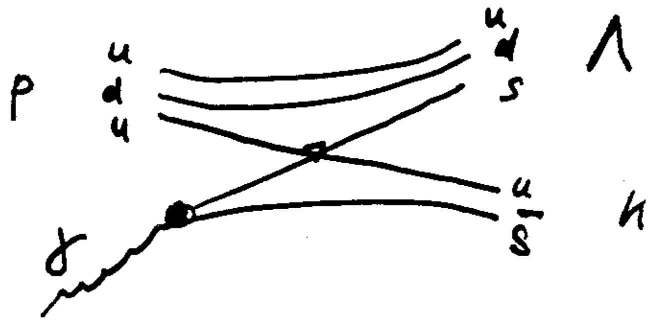
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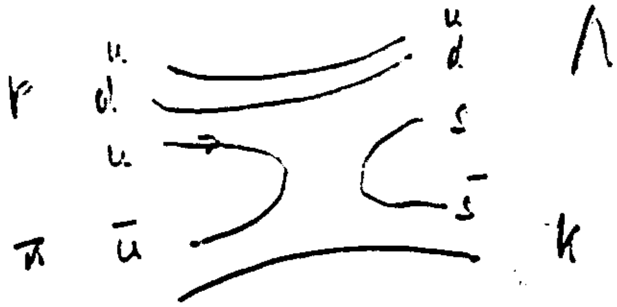
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