Predictive Power!

STRIKING RESULTS OF SZ66

$$177\ \text{MeV} = M_\Lambda - M_N = \frac{3(M_{K^*} - M_K) + (M_K - M_\pi)}{4} = 180\ \text{MeV}$$

Baryons — Mesons

$$\frac{M_\Delta - M_N}{M_{\Sigma^*} - M_\Sigma} = 1.53 \qquad \frac{M_\rho - M_\pi}{M_{K^*} - M_K} = 1.61$$

Extension by DGG-HJL et al

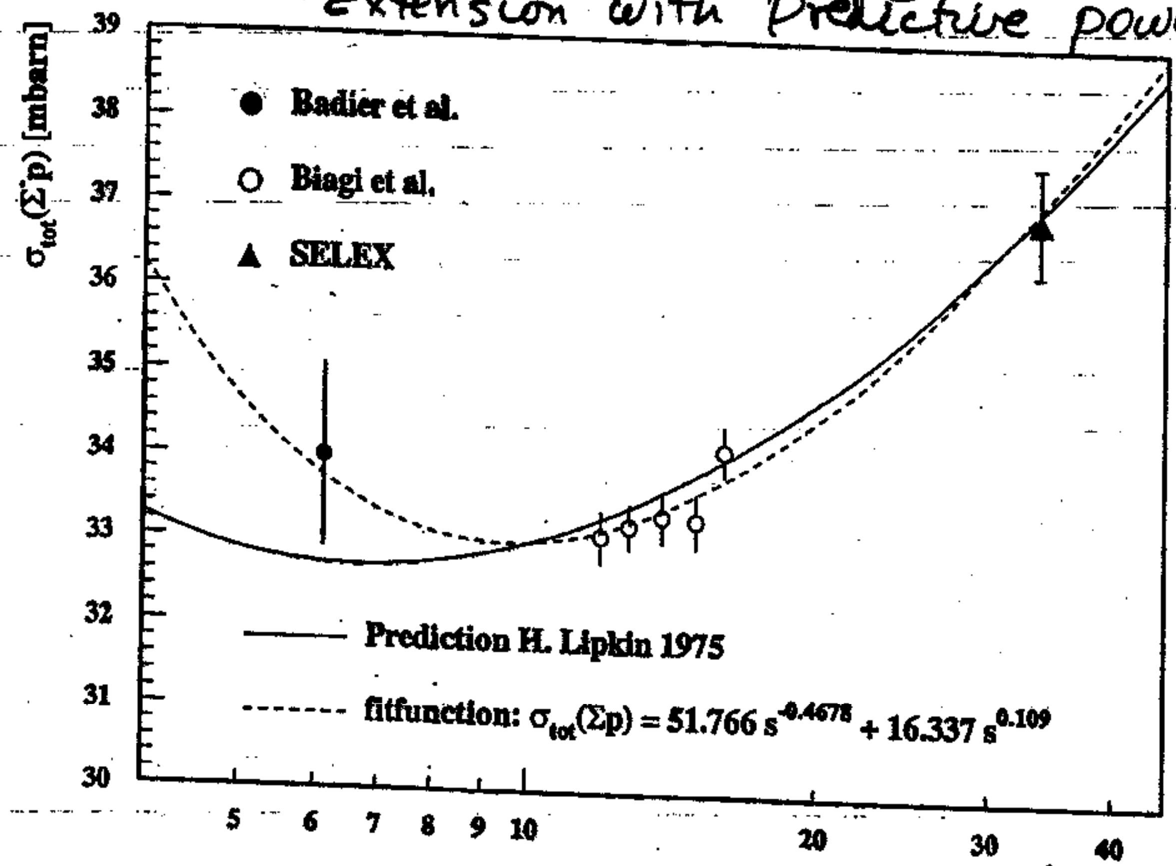
— Hyperfine Interaction —

$$0.88\ \text{n.m.} = \mu_p + \mu_n = \frac{2M_p}{M_N + M_\Delta} = 0.865$$

$$-0.61\ \text{n.m.} = \mu_\Lambda = -\frac{\mu_p}{3} \cdot \frac{M_{\Sigma^*} - M_\Sigma}{M_\Delta - M_N} = -0.61$$

Levin-Frankfurt $\sigma_{tot}(\pi p) \approx \frac{2}{3}\sigma_{tot}(pp)$

Extension with predictive power



Hyperon Decays and SU(3)

Where is the physics? Not in D & F

Bjorken Sum Rule

$$\frac{G_A}{G_V}(n \to p) = (\Delta u - \Delta d)_p = (\Delta d - \Delta u)_n$$

SU(3) then gives

$$\frac{G_A}{G_V}(\Sigma^- \to n) = (\Delta s - \Delta u)_{\Sigma^-} = (\Delta d - \Delta s)_p$$

$$= \frac{1}{2}[(\Delta s - \Delta u)_{\Sigma^-} + (\Delta u - \Delta s)_n]$$

New Data!

$$\boxed{\frac{G_A}{G_V}(\Xi^0 \to \Sigma^+) = (\Delta s - \Delta u)_{\Xi^0} = (\Delta u - \Delta d)_p}$$

How is SU(3) broken?

Weak and Strong SU(3).

Weak SU(3) OK

Current algebra. Cabibbo theory

CKM Matrix. Current Algebra Sum Rule

Strong SU(3) broken $m_s > m_u \approx m_d$

$$M_K >> M_\pi$$

$$(\Delta s - \Delta u)_{\Xi^0} \neq (\Delta u - \Delta s)_p$$

New Interesting result

$$\frac{G_A}{G_V}(\Xi^0 \rightarrow \Sigma^+) = \frac{G_A}{G_V}(n \rightarrow p)$$

SU(3) says this means that

$$(\Delta s - \Delta u)_{\Xi^0} = (\Delta u - \Delta d)_p$$

If strange sea is suppressed this is clearly wrong!

But Current Algebra says that

$$\frac{1}{2}[(\Delta s - \Delta u)_{\Xi^0} + (\Delta u - \Delta s)_{\Sigma^+}] = \frac{1}{2}[(\Delta u - \Delta d)_p + (\Delta d - \Delta u)$$

This is immune to strange Sea Suppression in all baryons

Predictions and Experimental Values of G_A/G_V

Decay	*SU* (6)	*Constit.* *SU*(6)	*SU*(3)	*Experiment*
$n \to p$	$\frac{5}{3}$	*input*	*input*	$1.261 \pm .004$
$\Lambda \to p$	1	0.756	$0.727 \pm .007$	$0.718 \pm .015$
$\Xi^- \to \Lambda$	$\frac{1}{3}$	0.252	$0.193 \pm .012$	$0.25 \pm .05$
$\Sigma^- \to n$	$-\frac{1}{3}$	-0.252	*input*	$-0.340 \pm .017$
$\frac{\Sigma^- \to n}{\Lambda \to p}$	$-\frac{1}{3}$	$-\frac{1}{3}$	*none*	$-0.473 \pm .026$

SU(3) equal spacing rule

$$\frac{\left(\frac{G_A}{G_V}\right)_{\Lambda\to p}}{\left(\frac{G_A}{G_V}\right)_{\Sigma^-\to n}} \cdot \frac{\mu_{\Sigma^+} + 2\mu_{\Sigma^-}}{3\mu_\Lambda} = 0.12 \pm 0.04$$

$$\Delta s(\Lambda)_{SU(6)} = 1$$

$$\Delta s(\Sigma)_{SU(6)} = -1/3$$

$$\frac{\Delta s(\Sigma)_{SU(6)}}{\Delta s(\Lambda)_{SU(6)}} = \frac{\left(\frac{G_A}{G_V}\right)_{\Sigma^-\to n}}{\left(\frac{G_A}{G_V}\right)_{\Lambda\to p}} = \frac{\mu_{\Sigma^+} + 2\mu_{\Sigma^-}}{3\mu_\Lambda} = -1/3$$

whereas experimentally

$$\frac{\left(\frac{G_A}{G_V}\right)_{\Sigma^-\to n}}{\left(\frac{G_A}{G_V}\right)_{\Lambda\to p}} = -0.473 \pm 0.026$$

$$\frac{\mu_{\Sigma^+} + 2\mu_{\Sigma^-}}{3\mu_\Lambda} = -0.06 \pm 0.02$$

SU(3) symmetry gives the relations:

$$\Delta u(p) = \Delta d(n) = \Delta u(\Sigma^+) = \Delta d(\Sigma^-) = \Delta s(\Xi^o) = \Delta s(\Xi^-)$$

$$\Delta d(p) = \Delta u(n) = \Delta s(\Sigma^+) = \Delta s(\Sigma^-) = \Delta s(\Sigma^o) = \Delta u(\Xi^o) = \Delta d(\Xi^-)$$

$$\Delta s(p) = \Delta s(n) = \Delta d(\Sigma^+) = \Delta u(\Sigma^-) = \Delta d(\Xi^o) = \Delta u(\Xi^-)$$

$$\Delta u(\Sigma^o) = \Delta d(\Sigma^o) = (1/2) \cdot [\Delta u(\Sigma^+) + \Delta d(\Sigma^+)]$$

$$\Delta q(\Sigma^o) + \Delta q(\Lambda) = (2/3) \cdot [\Delta u(n) + \Delta d(n) + \Delta s(n)]$$

These relations allow all the baryon spin structures to be obtained fr values of $\Delta u(n)$, $\Delta d(n)$ and $\Delta s(n)$

Baryon Spin Structures

From Nucleon Data and SU(3) Symmetry

Baryon	Δu	Δd	Δs
p	0.83 ± 0.03	-0.43 ± 0.03	-0.10 ± 0.03
n	-0.43 ± 0.03	0.83 ± 0.03	-0.10 ± 0.03
Σ^+	0.83 ± 0.03	-0.10 ± 0.03	-0.43 ± 0.03
Σ^-	-0.10 ± 0.03	0.83 ± 0.03	-0.43 ± 0.03
Ξ^o	-0.43 ± 0.03	-0.10 ± 0.03	0.83 ± 0.03
Ξ^-	-0.10 ± 0.03	-0.43 ± 0.03	0.83 ± 0.03
Σ^o	0.365 ± 0.03	0.365 ± 0.03	-0.43 ± 0.03
Λ	-0.165 ± 0.03	-0.165 ± 0.03	0.63 ± 0.03

$$\frac{W(q\uparrow\to B\uparrow)}{W(q\uparrow\to B\downarrow)} = \frac{q\uparrow(B\uparrow)}{q\uparrow(B\downarrow)} = \frac{q\uparrow(B\uparrow)}{q\downarrow(B\uparrow)}$$

$$P(q\uparrow\to B) = \frac{W(q\uparrow\to B\uparrow) - W(q\uparrow\to B\downarrow)}{W(q\uparrow\to B\uparrow) + W(q\uparrow\to B\downarrow)} = \frac{q\uparrow(B\uparrow) - q\downarrow(B\uparrow)}{q\uparrow(B) + q\downarrow(B)}$$

$$P(q\uparrow\to B) = \frac{\Delta q(B)}{q\uparrow(B) + q\downarrow(B)}$$

Distribution	all quarks	valence quarks
Δu_p	0.88 ± 0.03	0.93 ± 0.03
Δd_p	-0.38 ± 0.03	-0.33 ± 0.03
Δs_p	-0.05 ± 0.03	0.0 ± 0.03
Δu_Λ	-0.115 ± 0.03	-0.065 ± 0.04
Δd_Λ	-0.115 ± 0.03	-0.065 ± 0.04
Δs_Λ	0.68 ± 0.03	0.73 ± 0.04
Δu_{Σ^0}	0.415 ± 0.03	0.465 ± 0.04
Δd_{Σ^0}	0.415 ± 0.03	0.465 ± 0.04
Δs_{Σ^0}	-0.38 ± 0.03	-0.33 ± 0.04
Δu_{Σ^*}		0.23 ± 0.02
Δd_{Σ^*}		0.23 ± 0.02
Δs_{Σ^*}		0.33 ± 0.04