IC/76/79
INTERNAL REPORT
(Limited distribution)

International Atomic Energy Agency

and

United Nations Educational Scientific and Cultural Organization

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

TOPICAL MEETING

ON LEPTON INTERACTIONS AND NEW PARTICLES

6 - 9 July 1976

PART II

(Contributions)

MIRAMARE - TRIESTE
July 1976

THEORETICAL ANALYSIS OF HIGH-ENERGY NEUTRINO SCATTERING

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PROGRAM

- MODELS OF WEAK INTERACTIONS
  (FRACTIONALLY CHARGED, CONFINED QUARKS)

- NEUTRAL CURRENT EXPTS.

  SIGNATURES FOR CHARM

  THE NEW PUZZLES:

$$\langle y \rangle^{\bar{\nu}}$$

$$\sigma^{\bar{\nu}} / \sigma^{\nu}$$

$G = SU(3)_c \otimes [SU(2) \otimes U(1)]_W$

ELEMENTARY FERMIONS ← BEFORE THE HEAVY LEPTON

$$\begin{matrix} p' & p' & p' & \nu_\mu \\ p & p & p & \nu_e \\ n & n & n & e^- \\ \lambda & \lambda & \lambda & \mu^- \end{matrix}$$

WEAK (AND E.M.) CURRENTS COLOR SINGLET:

$\begin{pmatrix} p \\ n_c \end{pmatrix}_L \begin{pmatrix} p' \\ \lambda_c \end{pmatrix}_L$ ALL q_R SINGLETS

$\begin{pmatrix} \nu_e \\ e^- \end{pmatrix}_L \begin{pmatrix} \nu_\mu \\ \mu^- \end{pmatrix}_L$ e_R, μ_R SINGLETS

QUALITIES:

- RENORM. - NO ANOMALIES $\sum_q Q = 2 = -\sum_\ell Q$

- NO $\Delta S = 1$ NEUTRAL CURRENTS:

GIM:

$$J^+ = (\bar{p}\ \bar{p}')\, C \begin{pmatrix} n \\ \lambda \end{pmatrix}$$

$$J^- = (\bar{n}\ \bar{\lambda})\, C^+ \begin{pmatrix} p \\ p' \end{pmatrix}$$

$$C = \begin{pmatrix} \cos\theta_c & \sin\theta_c \\ -\sin\theta_c & \cos\theta_c \end{pmatrix} \Rightarrow CC^+ = C^+C = 1$$

- THE MODEL IS NATURAL

MOST GENERAL C : $2 \times 2 = 4$ PARAMETERS

BUT $n_Q - 1 = 3$ PHASES ARBITRARY

- LEPTON QUARK SYMMETRY

A NEW LEPTON $\rightarrow \begin{cases} \text{ANOMALIES} \\ \text{LEPTON-QUARK SYMM. LOST} \end{cases}$

GENERALIZED GIM (HARARI)

NEW DOUBLETS (V−A) $\begin{pmatrix} L^0 \\ L^- \end{pmatrix}_L$ $\begin{pmatrix} t \\ b \end{pmatrix}_L$ 3 col. CHARGE 2/3, −1/3

$$J^+ = (\bar{p}\ \bar{p}'\ \bar{t})\, C \begin{pmatrix} n \\ \lambda \\ b \end{pmatrix} \qquad CC^+ = C^+C = 1$$

NOW C is 3×3 $\Rightarrow 3\times3 - (6-1) = 4$ PARAM.
(3 MIXING ANGLES AND ONE PHASE)

BUT $\cos^2\theta_c + \sin^2\theta_c \overset{\text{EXP.}}{\simeq} 1$

THUS: $\begin{pmatrix} p \\ \cos\delta\, n_c + \underline{\underline{\sin}}\,\delta\, b \end{pmatrix}_L \Longrightarrow \underline{\underline{\sin}}^2\delta \lesssim 1\%$

APPROX.

$$\begin{pmatrix} p \\ n_c \end{pmatrix}_L \begin{pmatrix} p' \\ \cos\alpha\,\lambda_c + \sin\alpha\, b \end{pmatrix}_L \begin{pmatrix} t \\ -\sin\alpha\,\lambda_c + \cos\alpha\, b \end{pmatrix}_L$$

(PLUS A PHASE)

- NO ANOMALIES $\sum_q Q = 3 = -\sum_\ell Q$
- NO $\Delta S = 1$ NEUTRAL CURRENTS
- LEPTON-QUARK SYMM. $\begin{pmatrix} \nu_e \\ e^- \end{pmatrix}_L \begin{pmatrix} \nu_\mu \\ \mu^- \end{pmatrix}_L \begin{pmatrix} L^0 \\ L^- \end{pmatrix}_L$
- SLIGHTLY LESS NATURAL $\sin^2\delta \lesssim 1\%$
- POSSIBILITY OF INCLUDING CP VIOL.

VECTORLIKE THEORIES

GFM
DGG
KTWZ

$$J^+_\mu = \bar{\Psi}\gamma_\mu\left[(1-\gamma_5)A + (1+\gamma_5)B\right]\Psi$$

IF $B = A$ TRIVIAL VECTOR CASE

IF $B = UAU^+$ VECTOR IN ZERO MASS LIMIT - (PARITY BROKEN SPONTANEOUSLY)

$(UU^+ = U^+U = 1)$

WITH 4 QUARKS : POSSIBLE BUT FALSE

$$\begin{pmatrix} p \\ n_c \end{pmatrix}_L \begin{pmatrix} p' \\ \lambda_c \end{pmatrix}_L \leftarrow \text{V-A} \;\Big\|\; \text{V+A} \rightarrow \begin{pmatrix} p \\ ? \end{pmatrix}_R \begin{pmatrix} p' \\ ? \end{pmatrix}_R$$

n OR λ
BOTH FALSE

WITH 6 QUARKS : EXAMPLE (SMALL MIXINGS $\lesssim \theta_c$ NEGLECTED)

$$\begin{pmatrix} p \\ n_c \end{pmatrix}_L \begin{pmatrix} p' \\ \lambda_c \end{pmatrix}_L \begin{pmatrix} t \\ b \end{pmatrix}_L \leftarrow \text{V-A} \;\Big\|\; \text{V+A} \rightarrow \begin{pmatrix} p \\ \underline{\underline{b}} \end{pmatrix}_R \begin{pmatrix} p' \\ \lambda \end{pmatrix}_R \begin{pmatrix} t \\ n \end{pmatrix}_R$$

EXP. SIGNATURE : THE NEUTRAL CURRENT IS PURE <u>VECTOR</u>

- NO ANOMALIES
- NO $\Delta S = 1$ NEUTRAL CURRENTS
- CP VIOLATION CAN BE INCLUDED

SOMEWHAT UNNATURAL { MANY SMALL ANGLES; $p' \rightarrow \lambda$ ACCIDENTAL

MODELS A LA BARNETT

OLD QUARKS $\begin{pmatrix} p \\ n \\ \lambda \end{pmatrix}$ NEW QUARKS $\begin{pmatrix} p' \\ b \\ b' \end{pmatrix} \begin{matrix} 2/3 \\ -1/3 \\ -1/3 \end{matrix}$

WEAK CURRENT:

$$\begin{pmatrix} p \\ n_c \end{pmatrix}_L \quad \begin{pmatrix} p' \\ \lambda_c \end{pmatrix}_L \leftarrow V-A \Big\| V+A \rightarrow \begin{pmatrix} p \\ b(\varphi) \end{pmatrix}_R \quad \begin{pmatrix} p' \\ \cos\alpha\, \lambda + \sin\alpha\, b'(\varphi) \end{pmatrix}_R$$

NOT NATURAL:

$$J = (\bar{p}\ \bar{p}')\, C \begin{pmatrix} n \\ \lambda \\ b \\ b' \end{pmatrix}$$

C IS NOW 2×4

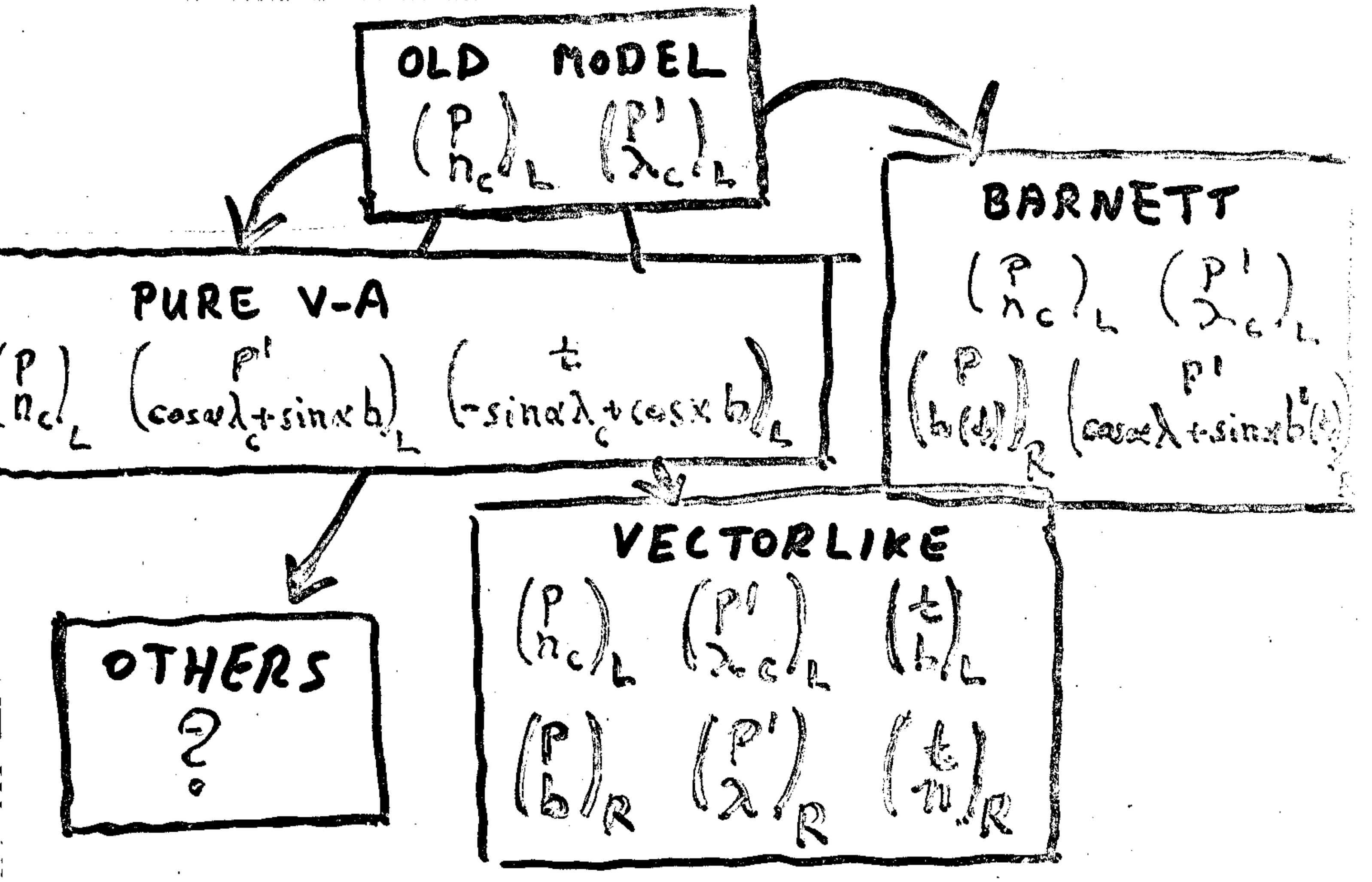
THUS $CC^+ = 1$ BUT IN GENERAL C^+C NOT DIAGONAL.

GIM CANCELLATION IMPOSED BY HAND

$p' \rightarrow \lambda$ IMPOSED BY HAND

GURSEY - SIKIVIE

ACHIMAN - KOLLER - WALSH


OLD MODEL
$\begin{pmatrix} p \\ n_c \end{pmatrix}_L \begin{pmatrix} p' \\ \lambda_c \end{pmatrix}_L$
BARNETT
$\begin{pmatrix} p \\ n_c \end{pmatrix}_L \begin{pmatrix} p' \\ \lambda_c \end{pmatrix}_L$
$\begin{pmatrix} p \\ b(d) \end{pmatrix}_R \begin{pmatrix} p' \\ \cos\alpha\lambda + \sin\alpha b \end{pmatrix}$
PURE V-A
$\begin{pmatrix} p \\ n_c \end{pmatrix}_L \begin{pmatrix} p' \\ \cos\alpha\lambda_c + \sin\alpha b \end{pmatrix}_L \begin{pmatrix} t \\ -\sin\alpha\lambda_c + \cos\alpha b \end{pmatrix}_L$
VECTORLIKE
$\begin{pmatrix} p \\ n_c \end{pmatrix}_L \begin{pmatrix} p' \\ \lambda_c \end{pmatrix}_L \begin{pmatrix} t \\ b \end{pmatrix}_L$
$\begin{pmatrix} p \\ b \end{pmatrix}_R \begin{pmatrix} p' \\ \lambda \end{pmatrix}_R \begin{pmatrix} t \\ n \end{pmatrix}_R$
OTHERS
?

NEW RESULTS ON NEUTRAL CURRENTS

INCREASING EVIDENCE AGAINST PURE VECTOR (OR PURE AXIAL) NEUTRAL CURRENT

[VECTORLIKE MODELS IN TROUBLE]

- INCLUSIVE $\nu\ (\bar{\nu})$ NEUTRAL CURRENT CROSS SECTIONS
- ELASTIC $\nu\ (\bar{\nu})$ - P SCATTERING
- PA[illegible] VIOLATIONS IN ATOMS (?)

CONCLUSION

NEUTRAL CURRENTS O.K. FOR:

a) STANDARD WEINBERG-SALAM
(ONLY V-A CHARGED WEAK CURRENTS)

$$\sin^2\theta_W = 0.3 \div 0.4$$

b) MODELS À LA BARNETT

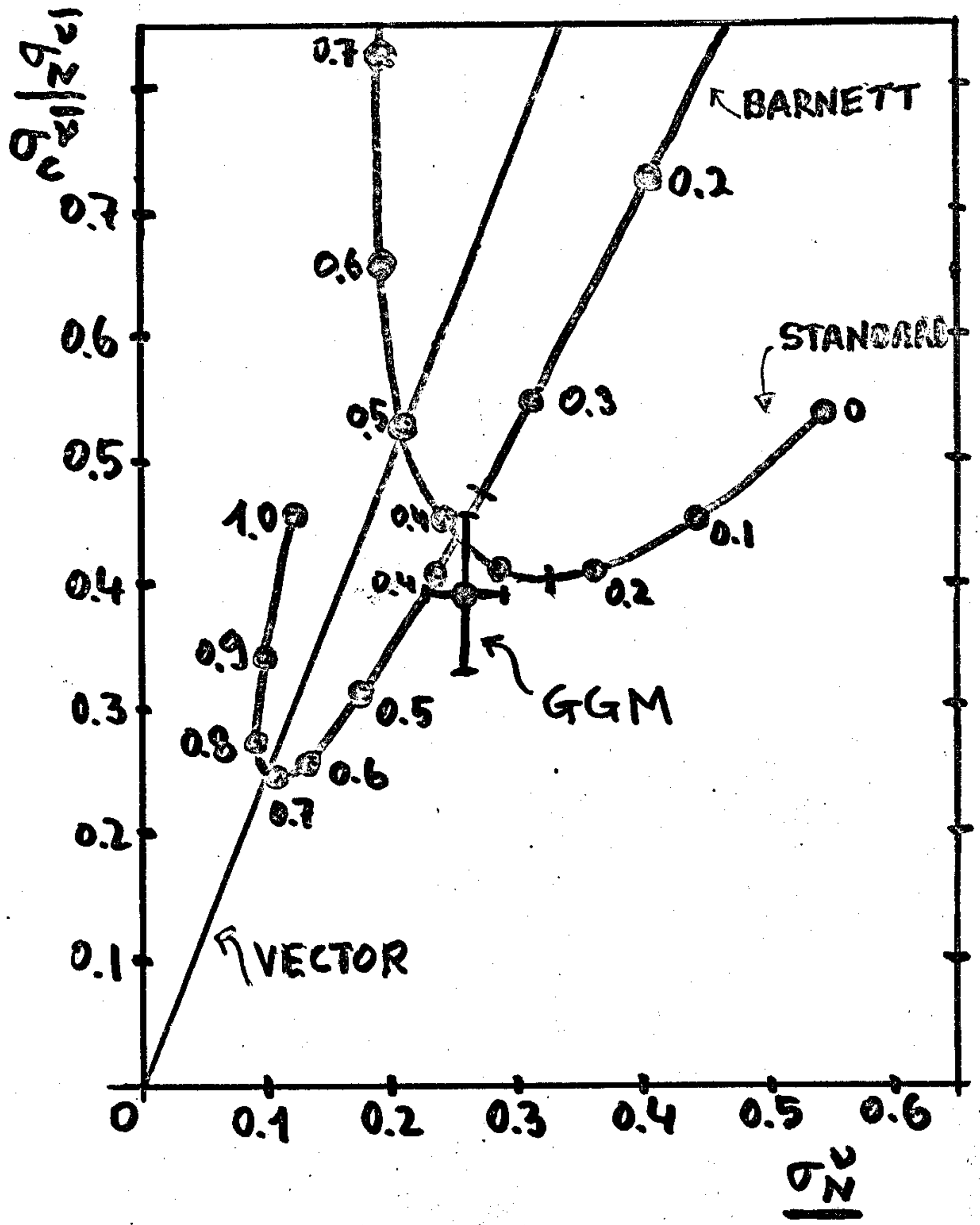
$$\sin^2\theta_W \simeq 0.4$$

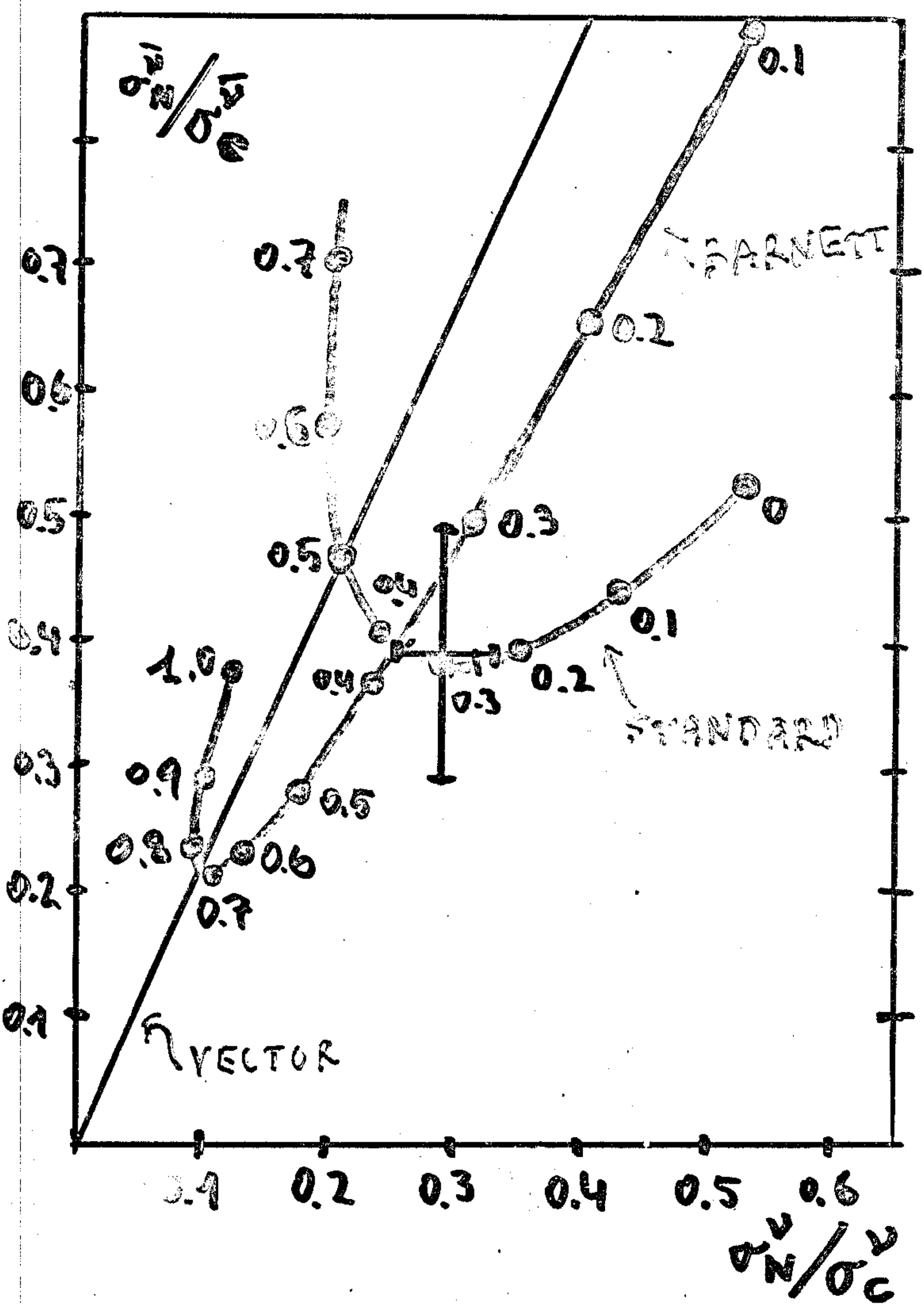
ATOMIC PHYSICS MAY DECIDE THE ISSUE

PURE VECTOR (PURE AXIAL) NEUTRAL C. EXCLUD

IN WEINBERG-SALAM: NEUTRAL CURRENT

$$Z_\mu \cong \bar{\psi}\gamma_\mu\left[(1-\gamma_5)\underset{\substack{\uparrow \\ \text{WEAK ISOSPIN} \\ \text{(LEFT)}}}{C_3^L} + (1+\gamma_5)C_3^R - 2\sin^2\theta_W \underset{\substack{\uparrow \\ \text{CHARGE}}}{Q}\right]\psi$$





CERN

$R_\nu = 0.26 \pm 0.04$

$R_{\bar\nu} = 0.39 \pm 0.06$

HPWF

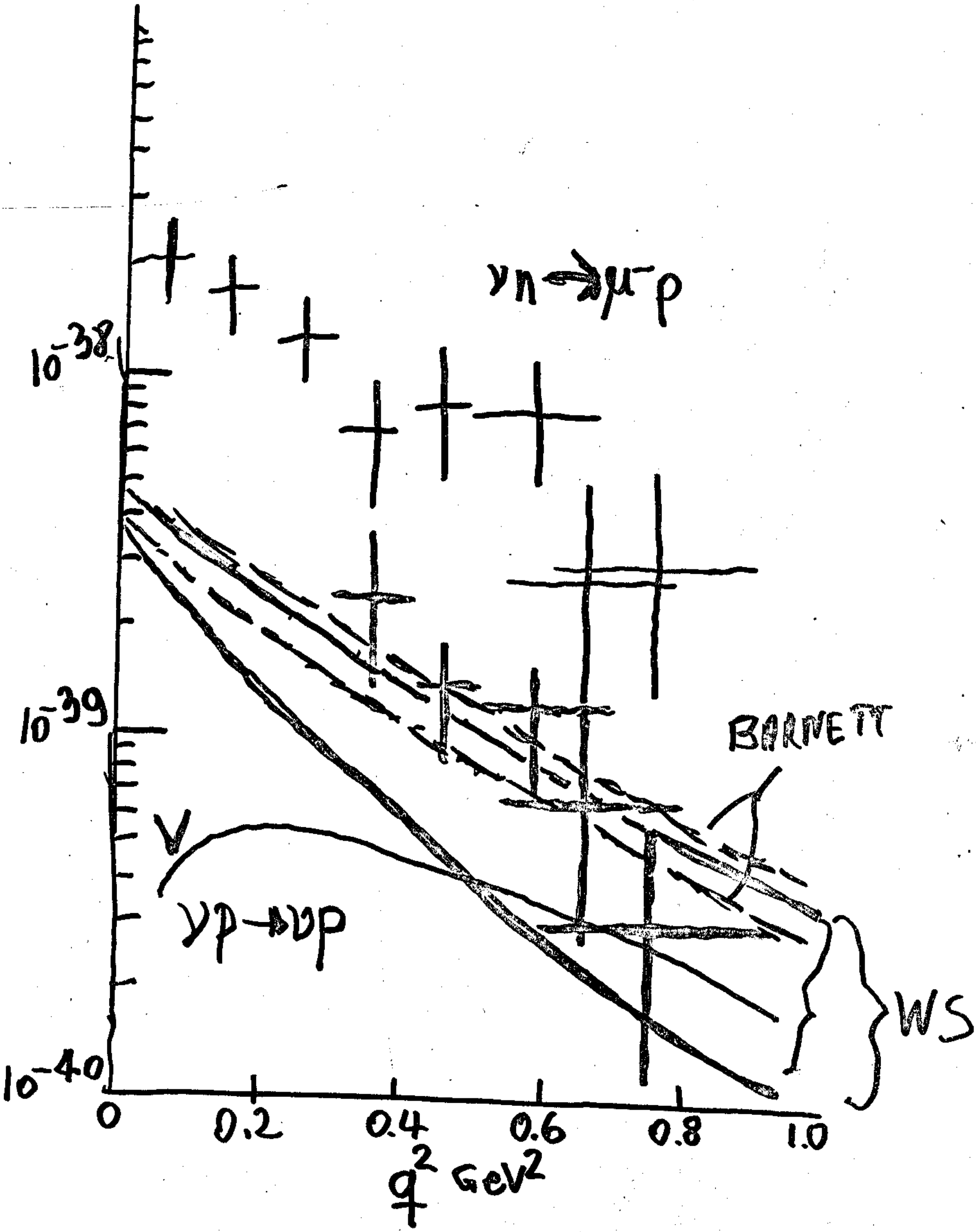
$R_\nu = 0.29 \pm 0.06$

$R_{\bar\nu} = 0.39 \pm 0.10$

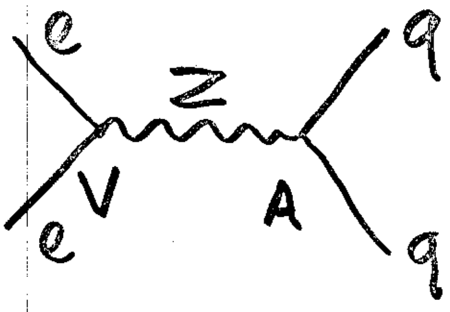
CALTECH

$R_\nu = 0.25 \pm 0.04$

$R_{\bar\nu} = 0.36 \pm 0.11$

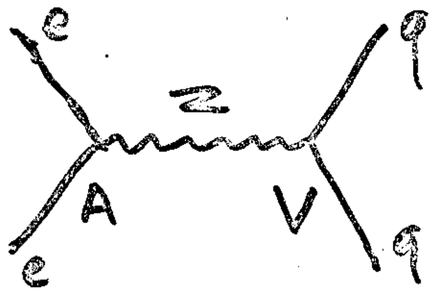

$\nu n \rightarrow \mu^- p$
10^{-38}
10^{-39}
10^{-40}
V
$\nu p \rightarrow \nu p$
BARNETT
WS
0
0.2
0.4
0.6
0.8
1.0
q^2 GeV^2

PARITY VIOLATION IN ATOMS



SMALL

$\sim$ SPIN OF NUCLEUS



LARGE

QUARK CONTRIBUTIONS ADDITIVE

$$\sim e_{AC}\left[u_{VC}(2Z+N)+d_{VC}(2N+Z)\right]$$

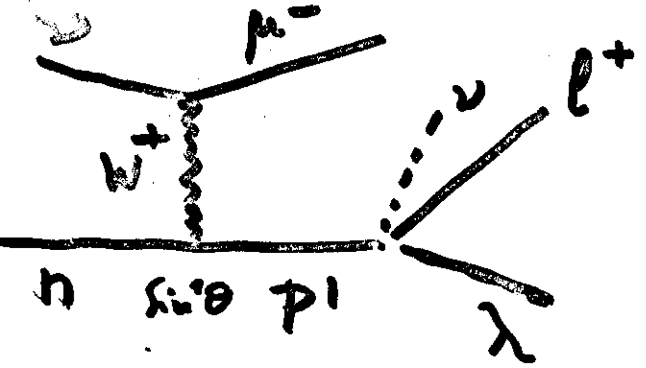
ELECTRON AXIAL COUPLING

VECTOR COUPLING OF UP and DOWN QUARKS

(JARLSKOG-BERNABEU)

SIGNATURES FOR CHARM (CHARGED C.)

a) DILEPTONS



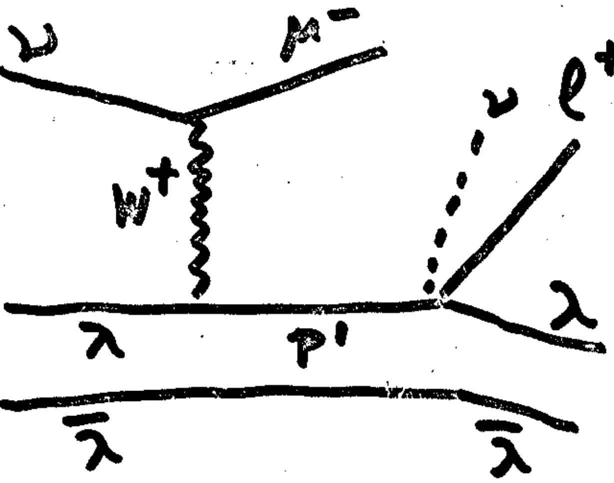
ALL X

$\nu \mathcal{N} \to \mu^- \ell^+ \nu + \left(\underline{1}\ \text{STRANGE PRTCLS}\right)$

TYPICALLY:

$\nu \mathcal{N} \to \mu^- B_c + \ldots$

$\quad \hookrightarrow \ell^+ \nu \begin{cases} N \bar{K} \pi\text{'s} \\ \Sigma, \Lambda\, \pi\text{'s} \end{cases}$



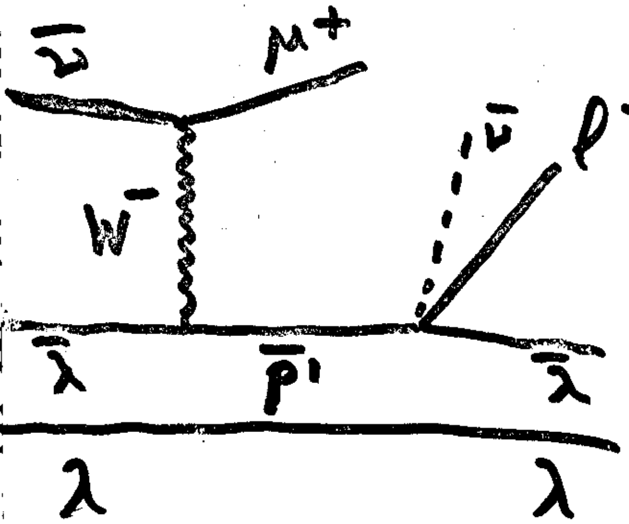
SMALL X

$\nu \mathcal{N} \to \mu^- \ell^+ \nu + \left(\underline{2}\ \text{STRANGE PRTICLS}\right)$

TYPICALLY:

$\nu \mathcal{N} \to \mu^- B_c K + \ldots$

$\quad \hookrightarrow \ell^+ \nu \begin{cases} N \bar{K} \pi\text{'s} \\ \Sigma, \Lambda\, \pi\text{'s} \end{cases}$



SMALL X

$\bar{\nu} \mathcal{N} \to \mu^+ \ell^- \bar{\nu} + \left(\underline{2}\ \text{STRANGE PRTCLS}\right)$

TYPICALLY:

$\bar{\nu} \mathcal{N} \to \mu^+ \mathcal{N} M_c \bar{K} + \ldots$

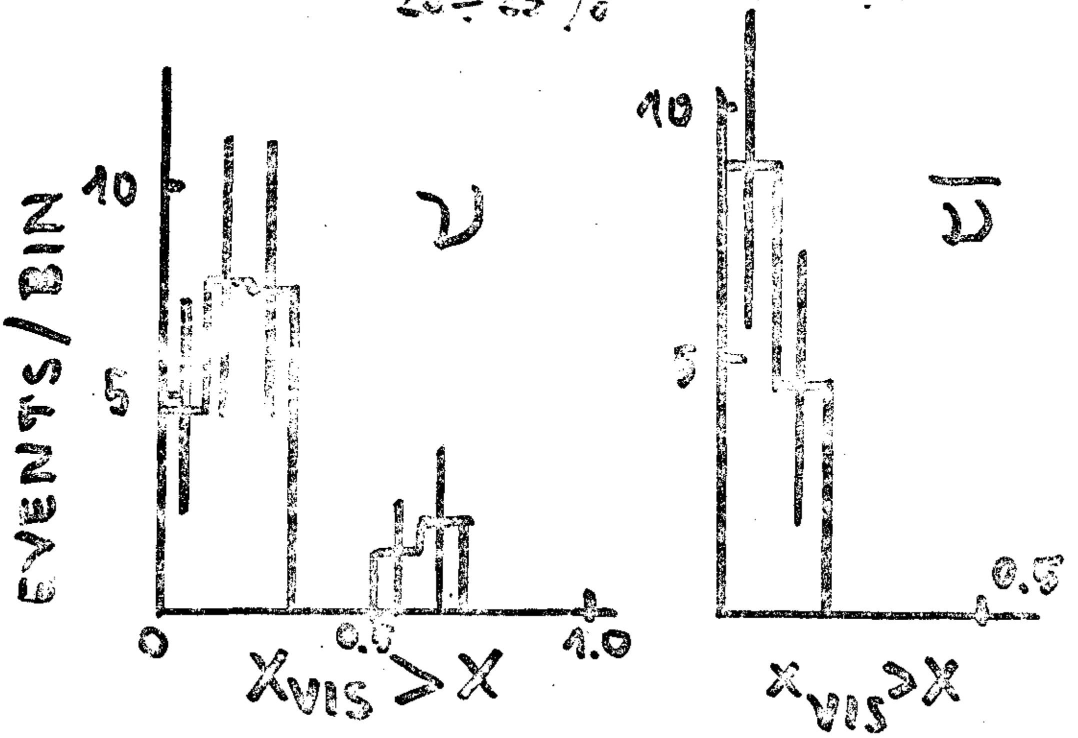
$\quad \hookrightarrow K \pi\text{'s}$

SEVERAL DILEPTONS WITH ASSOCIATED STRANGE PARTICLES OBSERVED IN BUBBLE CHAM. (CERN, FNAL)

RATES OF DILEPTONS: (HPWF)

$$\nu: \quad \frac{R(\mu^-\mu^+)}{R(\mu^-)} \simeq \underbrace{\left(\frac{\Delta\sigma}{\sigma}\right)_\nu}_{10\div15\%} \underbrace{B(c\to\mu^+\dots)_{AVE}}_{5\div10\%} \simeq \overset{EXP}{0.8\,\%}$$

$$\bar\nu: \quad \frac{R(\mu^+\mu^-)}{R(\mu^+)} \simeq \underbrace{\left(\frac{\Delta\sigma}{\sigma}\right)_{\bar\nu}}_{20\div25\%} \underbrace{B(c\to\mu^-\dots)_{AVE}}_{7\div10\%} \simeq \overset{EXP}{2\,\%}$$



BUBBLE CHAMBER (FINAL)

$\langle N_{K^0} \rangle \sim 2 \pm 0.8$ (FOR $\mu^- e^+$ EVENTS)

[NON μe EVENTS $\langle K_s(\pi^+\pi^-) \rangle = 4.7\,10^{-2}$]

$B(c \to e + \dots) \sim 10 \div 20\,\%$

DIMUONS OF EQUAL CHARGES

HPWF: $$\frac{R(\mu^-\mu^-)}{R(\mu^-\mu^+)} \sim \frac{1}{10}$$ [ALSO OBSERVED $\mu^+\mu^+$]

MOST LIKELY:

$c\bar{c}$ PRODUCTION (IN $\Delta C = 0$ TRANSITIONS)

NEEDED $$\frac{\sigma(c\bar{c})}{\sigma_{TOT}} \sim \frac{1}{100}$$

COMPARISON: V^0 PRODUCTION (CORRECTED INCLUDING $K_S, K_L, \Lambda^0, \Sigma^0$; EXCLUDING $K^+, K^-, \Sigma^+, \Sigma^-$):

$$\frac{\sigma(V^0 + \dots)}{\sigma_{TOT}} = 0.16 \pm 0.03$$

(FNAL BUBBLE CH.)

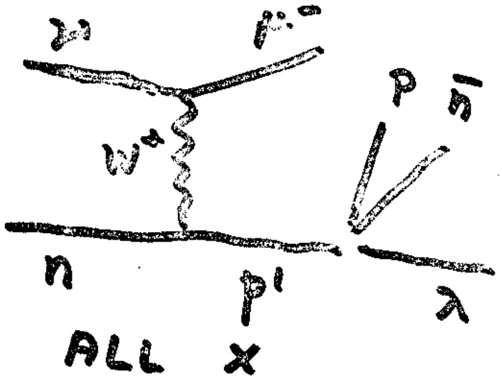
THUS PROBABLY:

$$\frac{\sigma(s\bar{s})}{\sigma(TOT)} \gtrsim \frac{1}{10}$$

TRIMUONS PREDICTED ($\mu^-\mu^-\mu^+$ in ν)

$$\frac{R(3\mu)}{R(\mu^-\mu^-)} \sim \frac{1}{10}$$

b) $\Delta S = -\Delta Q$ EVENTS IN ν:



I) $n + W^{+} \longrightarrow p'$

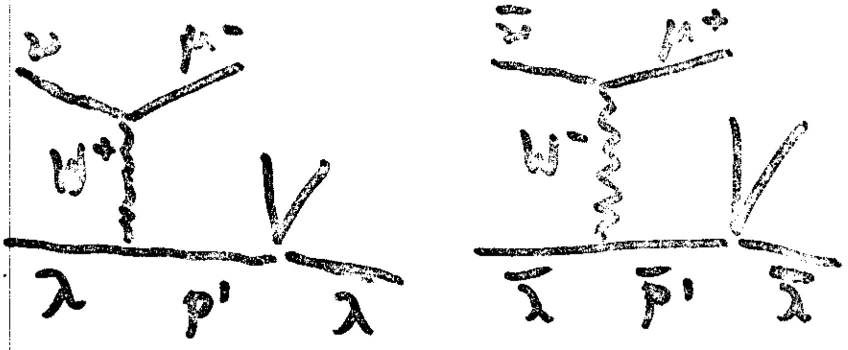
INITIAL	INTERMEDIATE
Q	$Q+1$
$C=0$	$C=+1$
$S=0$	$S=0$

II) NON LEPTONIC DECAY $p' \to \lambda\, p \bar{\pi}$

INTERMEDIATE	FINAL
$Q+1$	$Q+1$
$C=+1$	$C=0$
$S=0$	$S=-1$

TOTAL: $\Delta C = 0$; $\Delta S = -\Delta Q$

[NOT IN $\bar{\nu}$ OR IN ν AT SMALL x]



DIFFICULT TO OBSERVE.

1 EVENT FNL.

$\nu \bar{P} \to \mu^{-} \Lambda \pi \pi^{+} \pi^{+} \pi^{-}$

AT FNAL $E_{\nu} > 10$ GeV

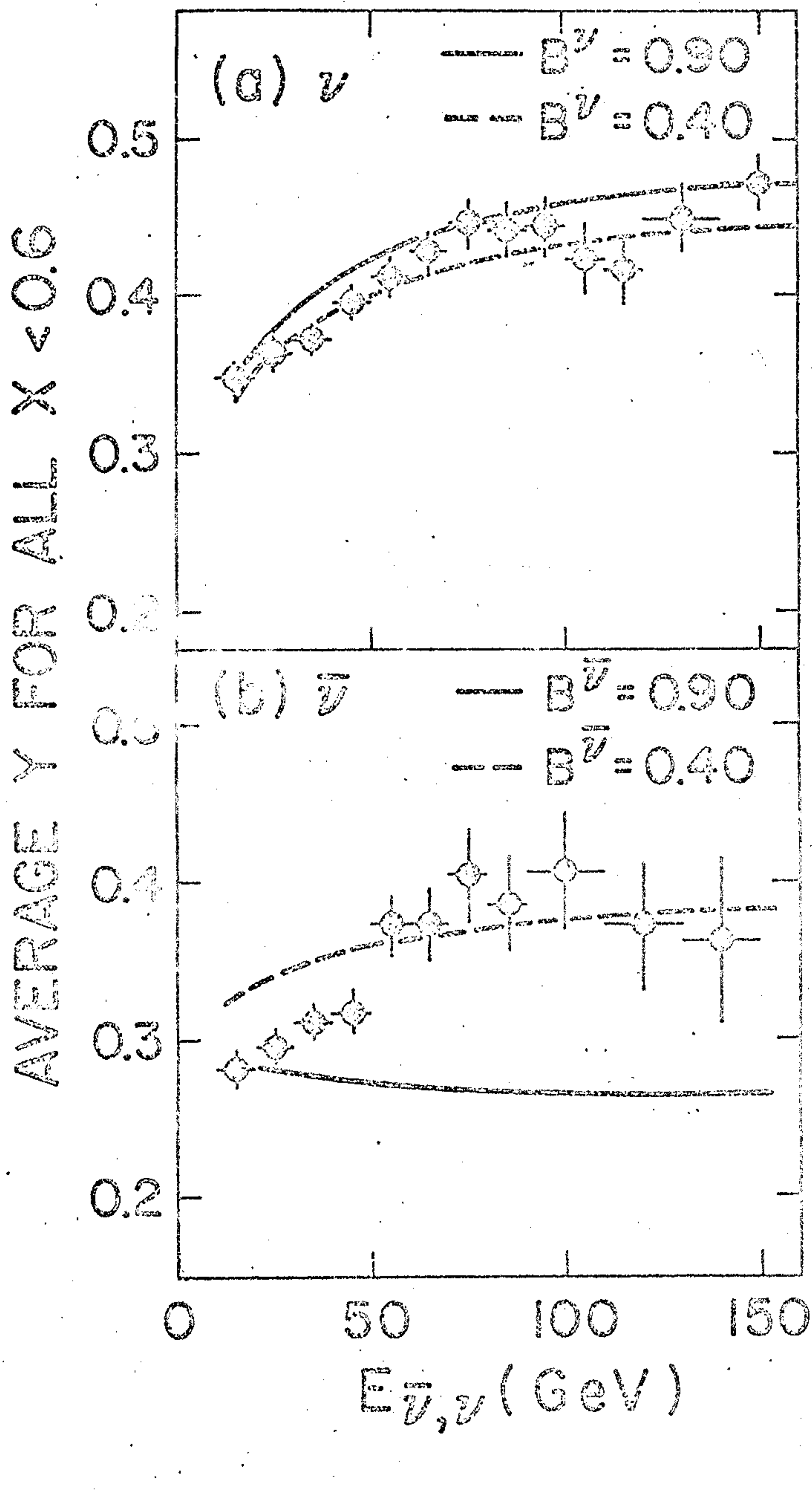
$$\frac{N_{\nu}(\Delta S = -\Delta Q)}{N_{TOT}(\text{ch. cur})} \simeq 3.6\,\% \longleftarrow \text{NOT VERY IMPRESSIVE}$$

SERIOUS PROBLEMS FOR SCALING 4 FLAVOR PARTON MODEL:

- y DISTR. IN $\bar{\nu}$; $\langle y \rangle^{\bar{\nu}}$ $\quad y = \frac{E_h}{E_\nu}$
- $\sigma^{\bar{\nu}} / \sigma^{\nu}$

POSSIBLE EXPLANATIONS:

- NEW HEAVY QUARKS ($M \sim 5$ GeV) WITH V+A COUPLINGS (BARNETT, ...)
- NO V+A COUPLINGS - BREAKING OF SCALING FROM ASYMPTOTIC FREEDOM (G.A., G. PARISI, R. PETRONZIO)
- BOTH
- COLOUR EXCITATION (PATI-SALAM)

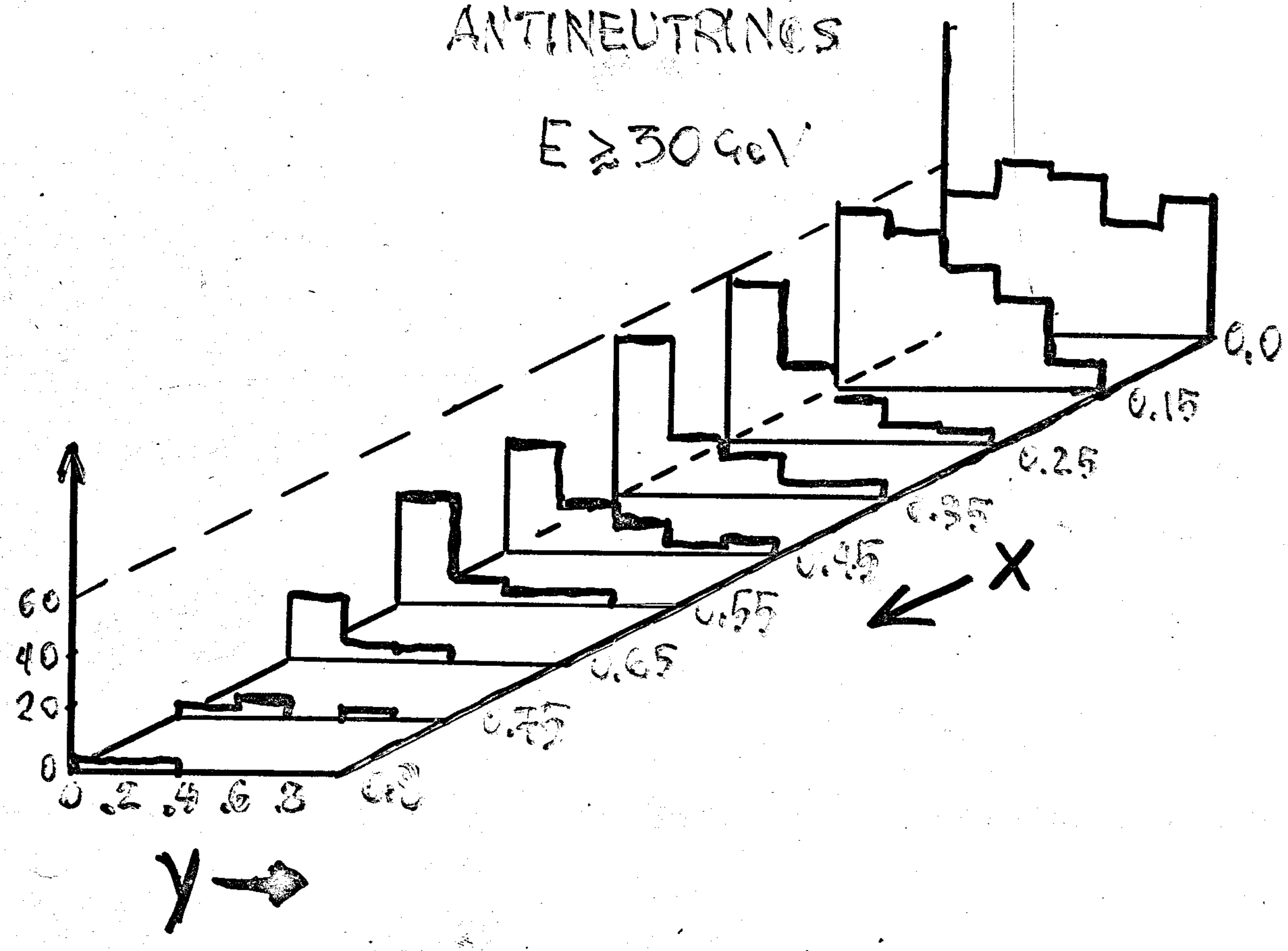


$y = \frac{E_h}{E_\nu}$

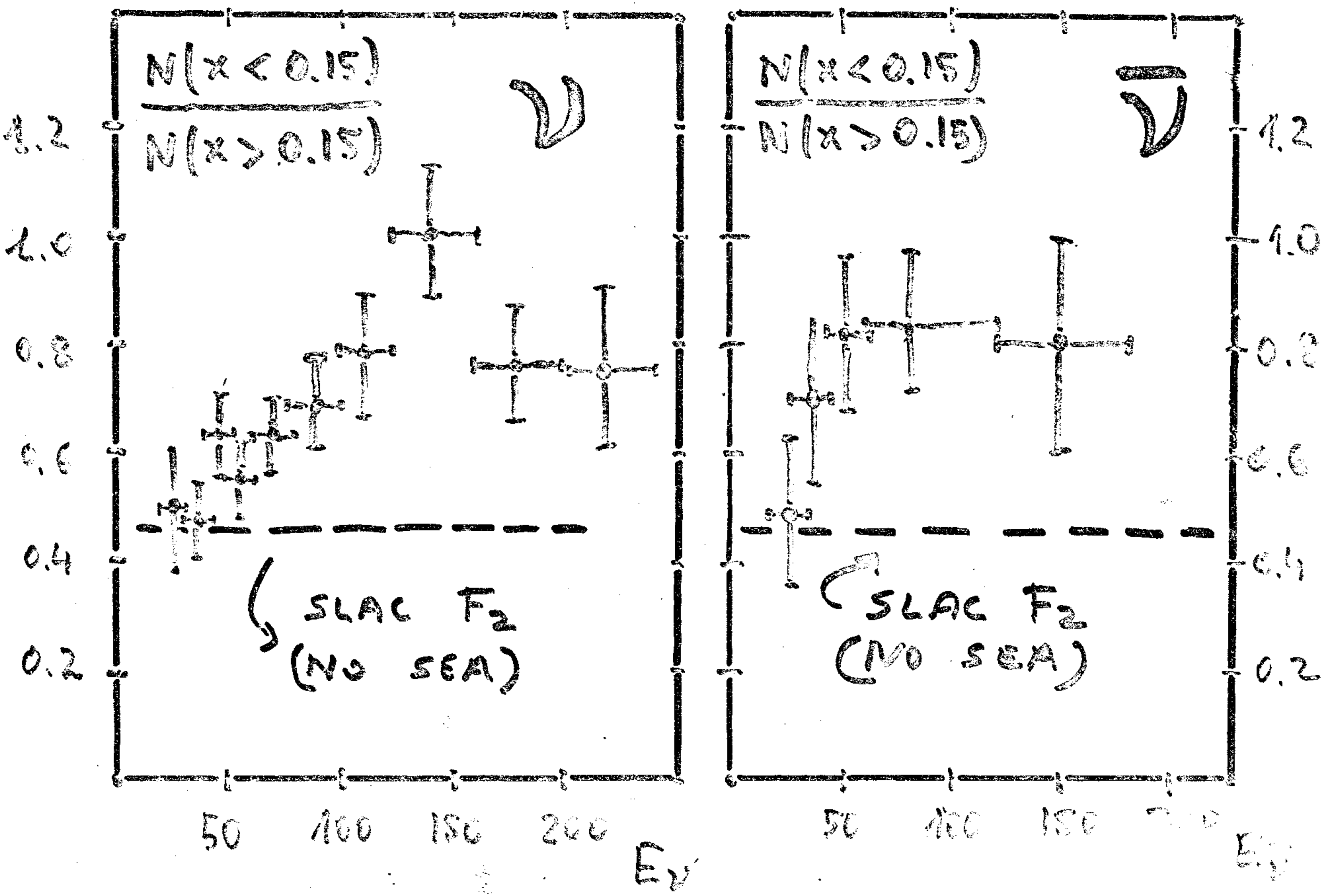
0,390

0,284

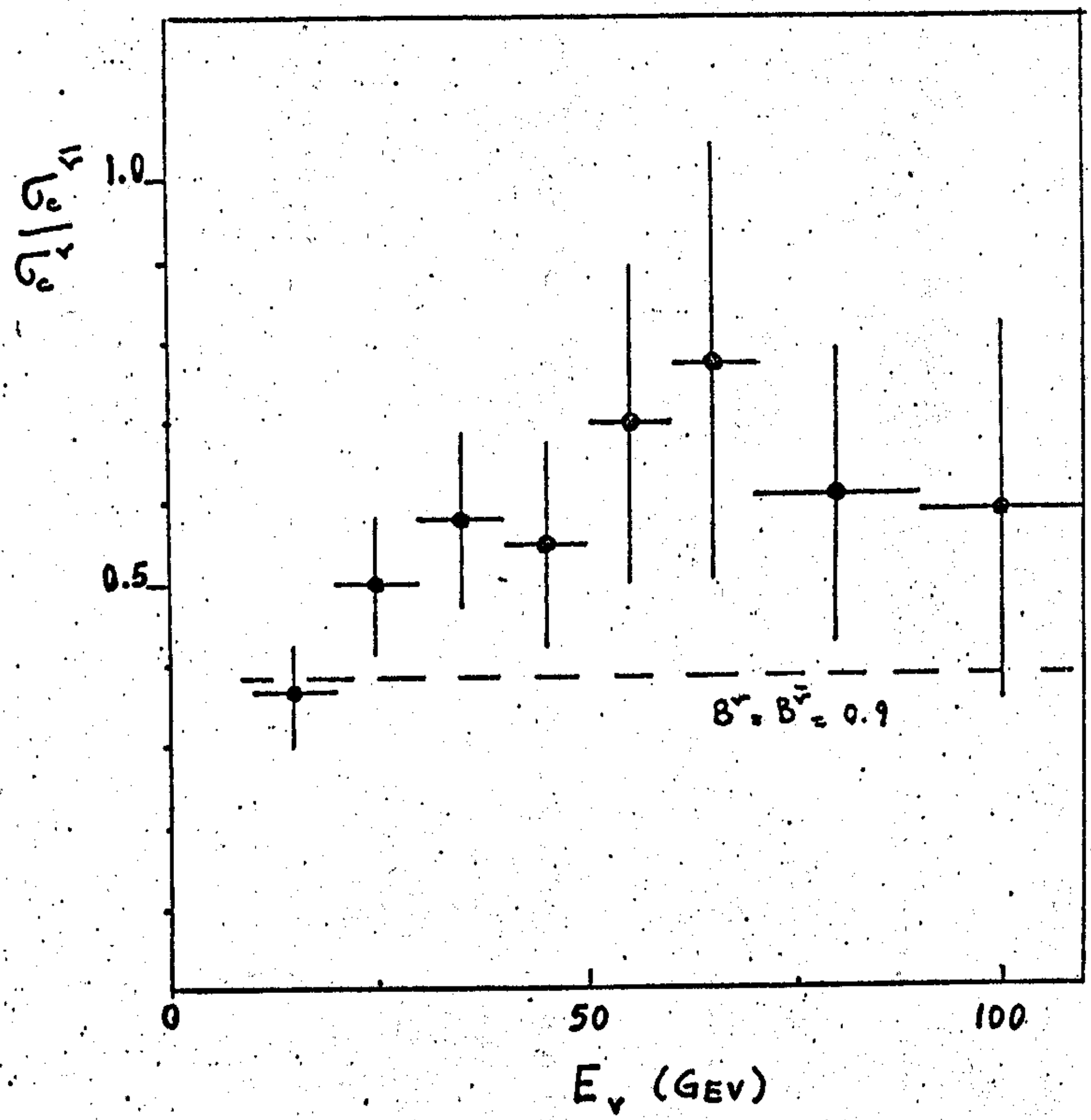
Fig. 4


ANTINEUTRINOS
E ≳ 30 GeV
60
40
20
0
0
.2
.4
.6
.8
y
0.0
0.15
0.25
0.35
0.45
0.55
0.65
0.75
x

DATA FROM HPWF



FLUX INDEPENDENT METHOD (ALL DATA)

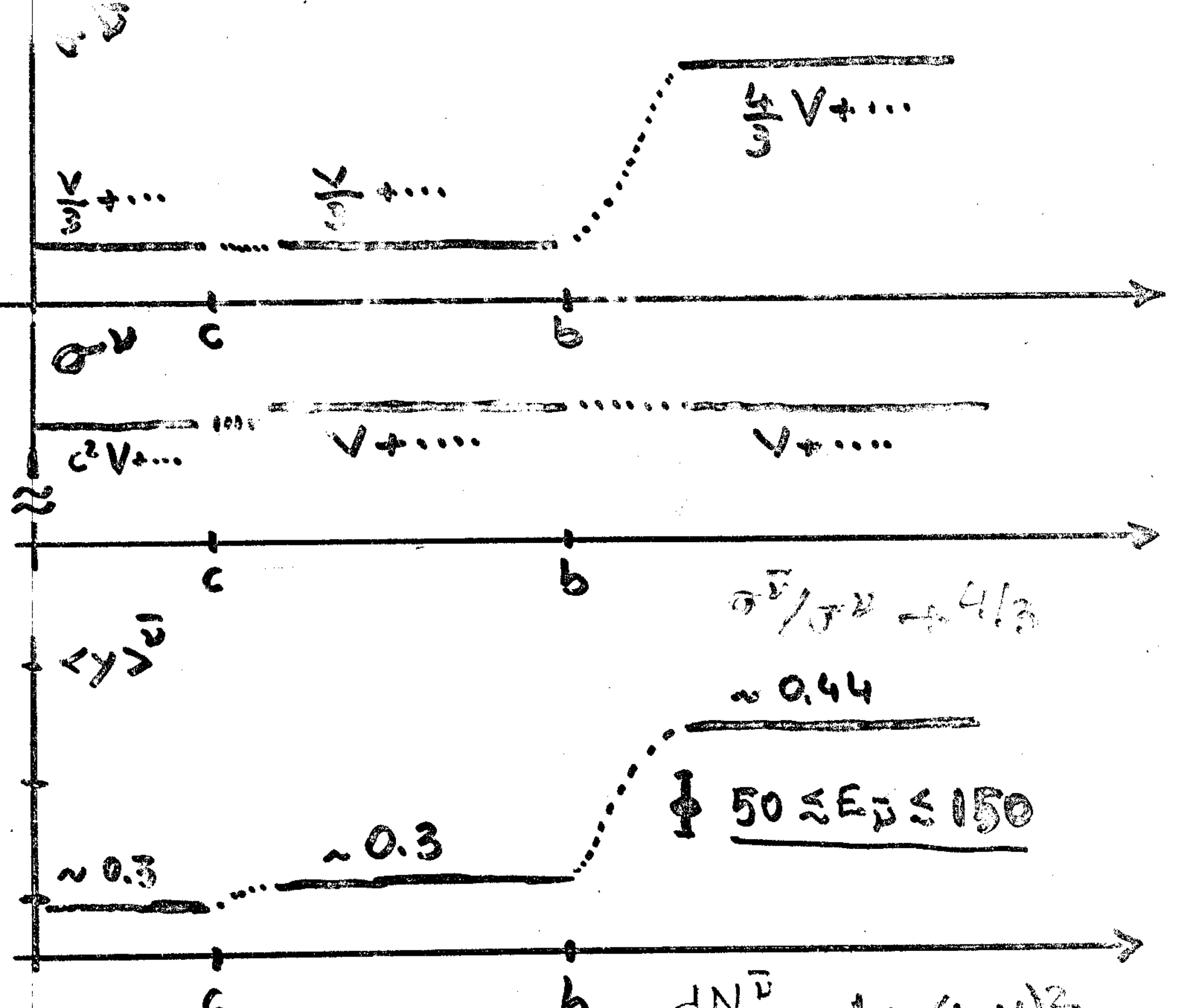


IF $\begin{pmatrix} p \\ b \end{pmatrix}_R$ EXISTS:

ν : $\bar{p} + W^+ \to \bar{b}$ ~ SEA SMALL

$\bar{\nu}$: $p + W^- \to b$ ~ VALENCE VERY LARGE

[WELL ABOVE b THRESHOLD]



$$\frac{dN^{\bar{\nu}}}{dy} \sim 1 + (1-y)^2$$

REQUIREMENTS:

- JUSTIFY THE VERY SLOW ONSETTING OF b THRESHOLD

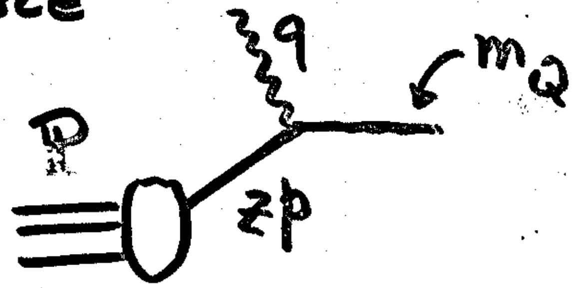
[$m_b \sim 5$ GeV $\Rightarrow \Upsilon_{b\bar{b}} \sim 8-10$ GeV]
outside SPEAR

- EXPLAIN CONCENTRATION OF EVENTS AT SMALL y.

[FOR EXAMPLE: IF $\mathbb{P} \Rightarrow b$ IMPORTANT IN $\bar{\nu}$, X DISTRIB. OF VALENCE SHOULD APPEAR IN $\bar{\nu}$ ETC.]

PROPOSED SOLUTION: $\left\{ \begin{array}{l} \text{BARNETT} \\ \text{GEORGI - PULITZER} \end{array} \right.$

MODIFIED SCALING VARIABLE



$$(zP+q)^2 = m_Q^2$$

$$\hookrightarrow \approx -Q^2 + 2M\nu z = m_Q^2$$

$$z = \frac{Q^2 + m_Q^2}{2M\nu} = x\left(1 + \frac{m_Q^2}{Q^2}\right) = x + \frac{m_Q^2}{2ME_\nu y}$$

FOR EXAMPLE: $\langle x \rangle = \langle z \rangle - \dfrac{m_Q^2}{2ME_\nu y}$

ALSO $z > \dfrac{m_Q^2}{2ME_\nu y} \Rightarrow E_\nu > \dfrac{m_Q^2}{2My} \dfrac{1}{z}$

FROM:
BARGER-PHILLIPS
② WETCUTZ

SLOW RESCALING

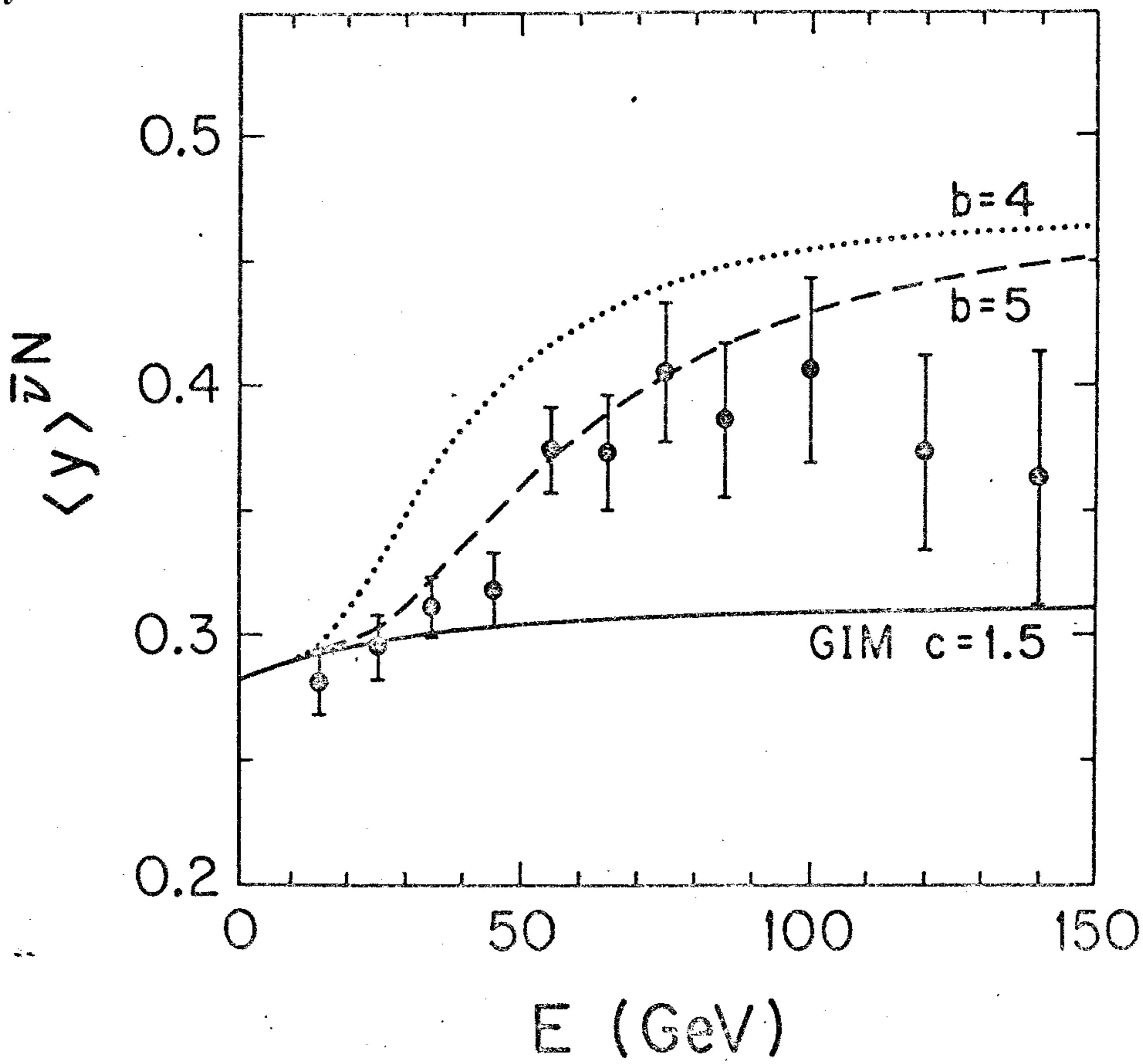


Fig. 4

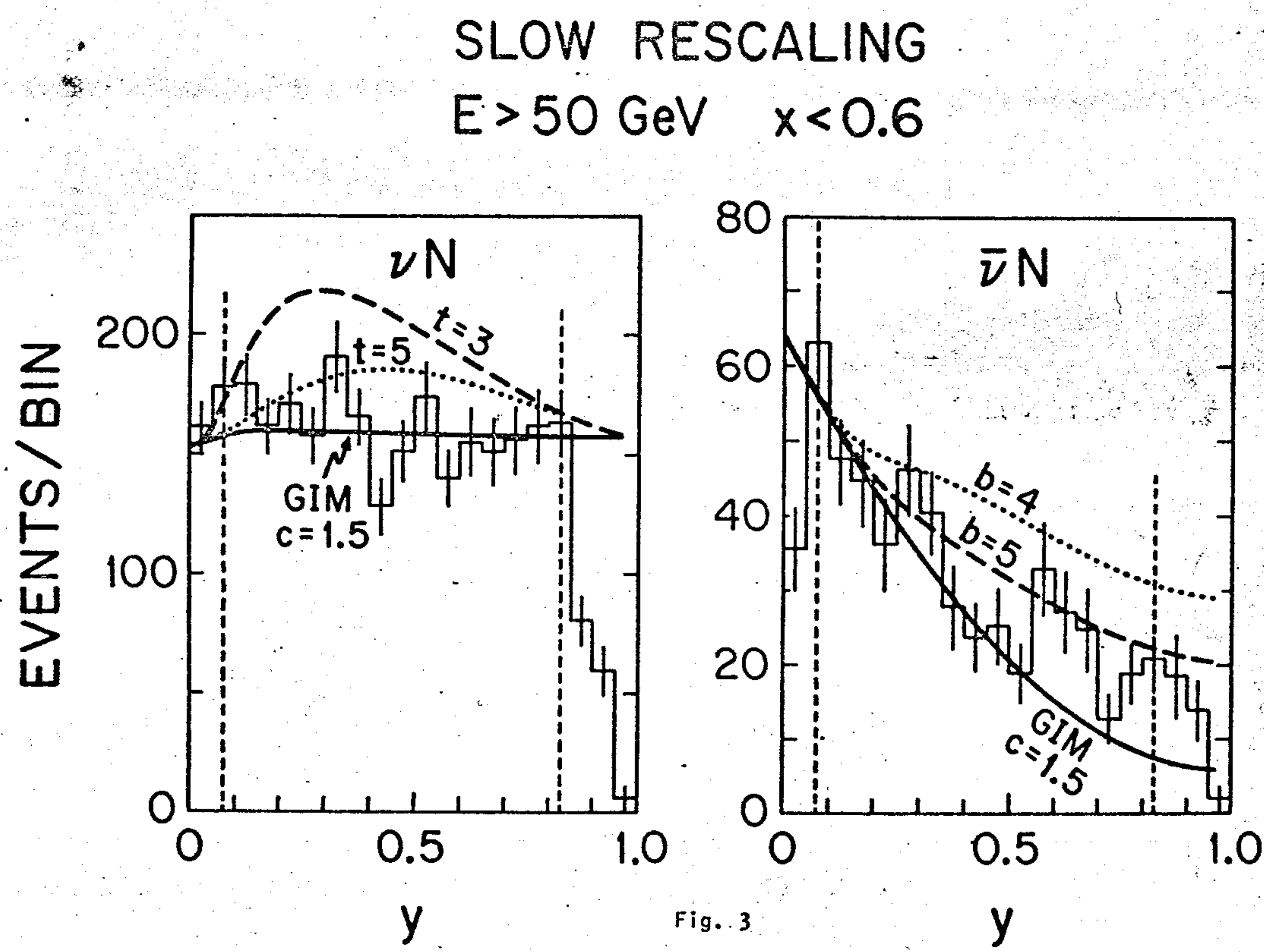

SLOW RESCALING
E > 50 GeV x < 0.6
EVENTS/BIN
νN
t=3
t=5
GIM
c=1.5
ν̄N
b=4
b=5
GIM
c=1.5
0
100
200
20
40
60
80
0.5
1.0
y
y

Fig. 3

1

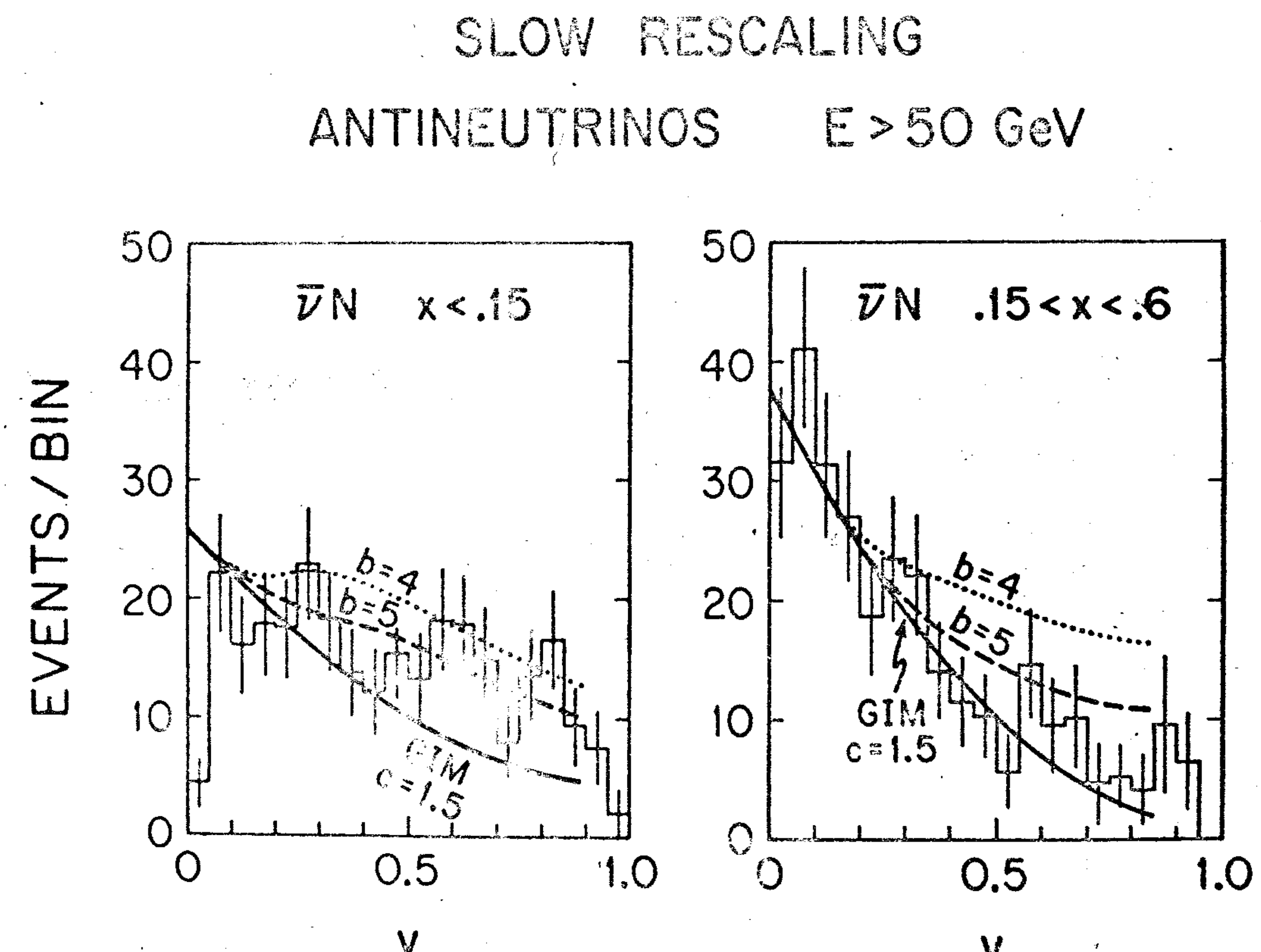

SLOW RESCALING
ANTINEUTRINOS E > 50 GeV
EVENTS / BIN
$\bar{\nu}N$ x < .15
$\bar{\nu}N$ .15 < x < .6
b=4
b=5
GIM
c=1.5
0
10
20
30
40
50
0
0.5
1.0
y

Fig. 2

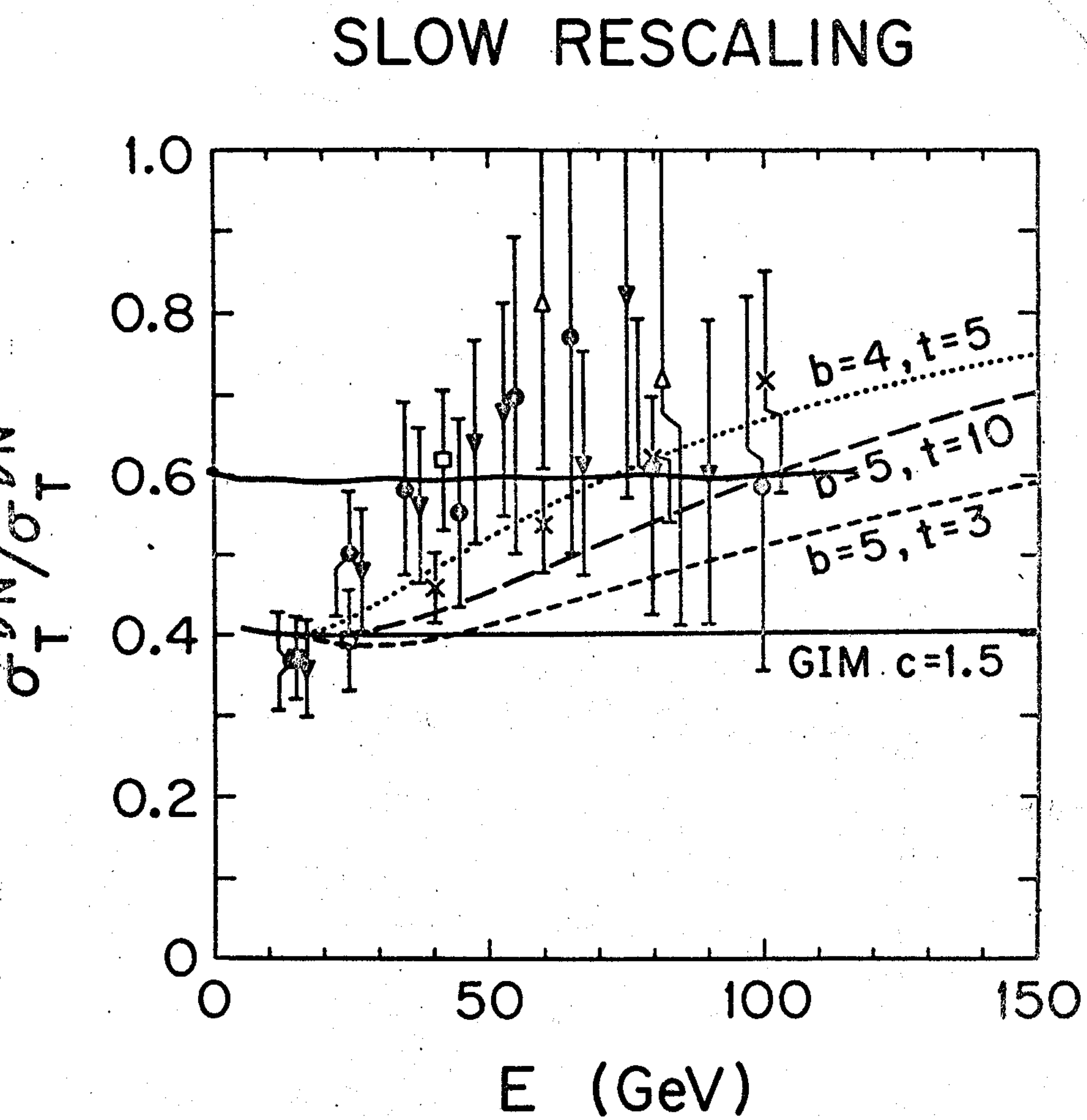

SLOW RESCALING
$\sigma_T^{\bar{\nu}N}/\sigma_T^{\nu N}$
1.0
0.8
0.6
0.4
0.2
0
0
50
100
150
E (GeV)
b=4, t=5
b=5, t=10
b=5, t=3
GIM c=1.5

Fig. 6

IN V-A MODELS NEW HEAVY QUARKS t and/or b MAKE ALMOST NO DIFFERENCE

$$\begin{pmatrix} p' \\ \cos\alpha\,\lambda_c + \sin\alpha\, b \end{pmatrix}_L \qquad \begin{pmatrix} t \\ -\sin\alpha\,\lambda_c + \cos\alpha\, b \end{pmatrix}_L$$

SAME AS:

$$\begin{pmatrix} \cos\alpha\, p' - \sin\alpha\, t \\ \lambda_c \end{pmatrix}_L \qquad \begin{pmatrix} \sin\alpha\, p' + \cos\alpha\, t \\ b \end{pmatrix}_L$$

NEGLECTING p', b AND t QUARKS IN THE NUCLEON

b DECOUPLED

t ONLY FROM λ_c

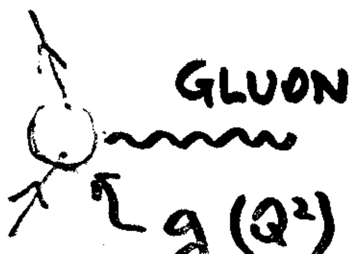
$$\frac{d\sigma^{\nu}}{dy} = 1 + \epsilon(1-y)^2 \qquad \langle y\rangle^{\nu} = \frac{\frac{1}{2} + \epsilon\frac{1}{12}}{1+\epsilon/3} = \frac{1}{2}\left[\frac{1+\epsilon/6}{1+\epsilon/3}\right]$$

$$\frac{d\sigma^{\bar\nu}}{dy} = \bar\epsilon + (1-y)^2 \qquad \langle y\rangle^{\bar\nu} = \frac{\frac{1}{12} + \bar\epsilon\frac{1}{2}}{\frac{1}{3}+\bar\epsilon} = \frac{1}{4}\left[\frac{1+6\bar\epsilon}{1+3\bar\epsilon}\right]$$

$$\frac{\sigma^{\bar\nu}}{\sigma^{\nu}} = \frac{\frac{1}{3}+\bar\epsilon}{1+\frac{1}{3}\epsilon} = \frac{1}{3}\left[\frac{1+3\bar\epsilon}{1+\epsilon/3}\right]$$

BOTH $\langle y\rangle^{\bar\nu}$ AND $\sigma^{\bar\nu}/\sigma^{\nu}$ ARE VERY SENSITIVE TO THE AMOUNT OF "SEA" QUARKS

ASYMPTOTIC FREEDOM EFFECTS IN ν-SCATT.



$$\alpha_s = \frac{g^2}{4\pi}$$

$$\frac{\alpha_s(\mu^2)}{\alpha_s(Q^2)} \simeq \left[1+\frac{25}{12\pi}\alpha_s(\mu^2)\ln\frac{Q^2}{\mu^2}\right] \equiv L$$

$\mu^2 \sim 1$ GeV

$\alpha_s(\mu^2) \sim 1/2$

PARTON DENSITIES:

$$p+n = V+2S \leftarrow \text{VALENCE}$$

$$\bar{n} = \bar{p} = \lambda = \bar{\lambda} = S \leftarrow \text{SEA}$$

$$p' = \bar{p}' = C \leftarrow \text{CHARM}$$

MOMENTS: $\int x^N q(x)\,dx = \langle q\rangle_N$

FIRST MOMENTS $\left[\sigma, \frac{d\sigma}{dy}, \langle y\rangle ..\right]$

$$\langle V\rangle_1 = A_8 L^{-32/75}$$

$$\langle S\rangle_1 = \frac{1}{8}\left[\frac{3}{7}+\frac{4}{7}A_5 L^{-56/75}\right] + \frac{1}{6}\left[\frac{1}{4}A_{15} - A_8\right] L^{-32/75}$$

$$\langle C\rangle_1 = \frac{1}{8}\left[\frac{3}{7}+\frac{4}{7}A_5 L^{-56/75} - A_{15} L^{-32/75}\right]$$

$$L \equiv \left[1+\frac{25}{12\pi}\alpha_s(\mu^2)\ln\frac{Q^2}{\mu^2}\right]$$

RELATION BETWEEN Q^2 AND E_ν:

EXACT RELATION	APPROXIMATE:
$Q^2 = 2ME_\nu\, x \cdot y$	$\langle Q^2 \rangle = 2ME_\nu \langle xy \rangle$

THRESHOLD CONDITION FOR CHARM

EXACT	APPROXIMATE
$y > \dfrac{W_T^2 - M^2}{2ME_\nu(1-x)}$	$y > \dfrac{W_T^2 - M^2}{2ME_\nu(1-\underbrace{x_0}_{0.2})}$
$(y < 1)$	

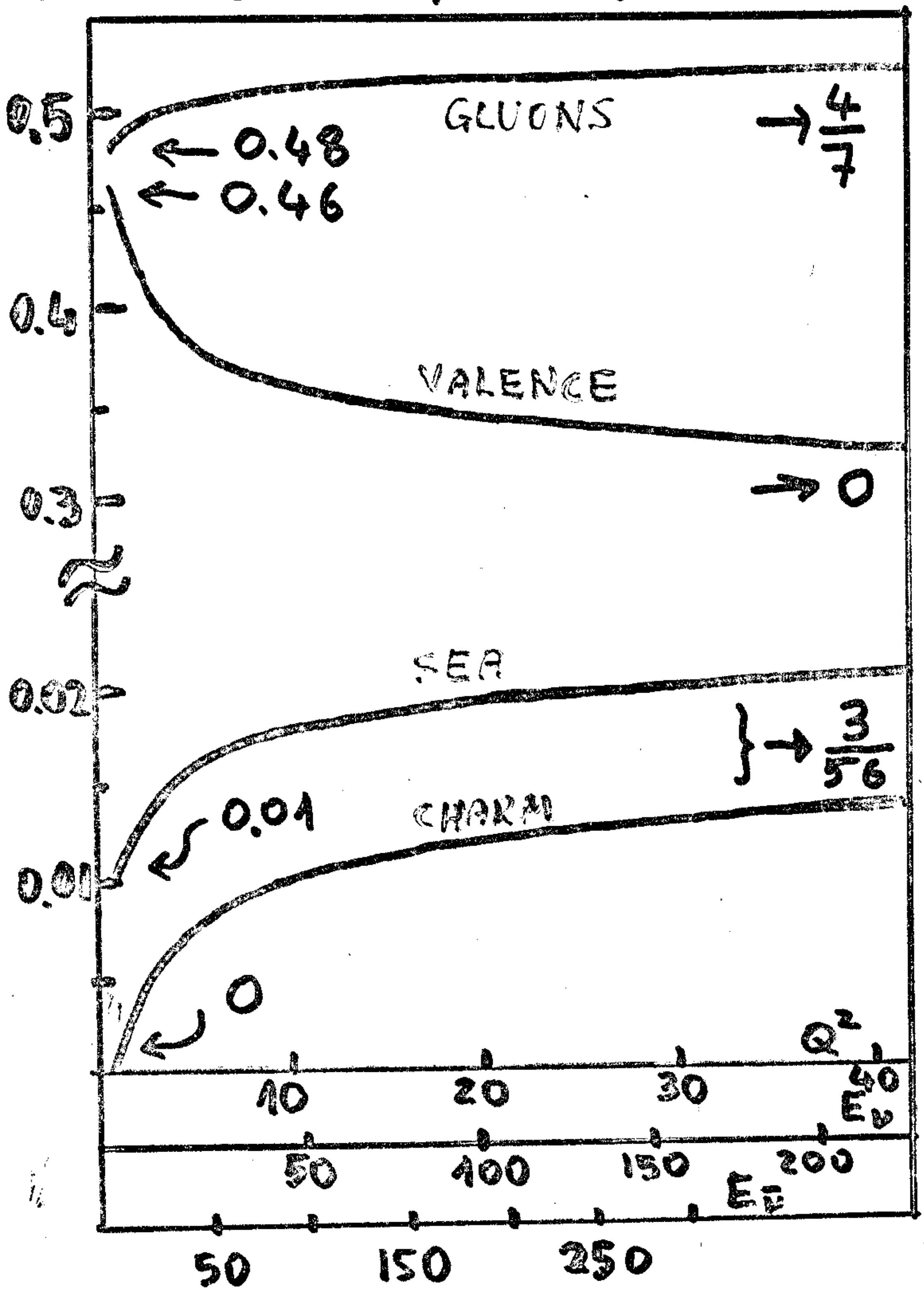
W_T EFFECTIVE THRESH. INV. MASS:

$$W_T \sim 5 \div 7 \text{ GeV}$$

FIRST MOMENTS $\int_0^1 x\,q(x)\,dx$

VALENCE → $p+n-\bar{p}-\bar{n}$

SEA → $\lambda \sim \bar{\lambda} \sim \bar{p} \sim \bar{n}$; CHARM → $p' \sim \bar{p}'$

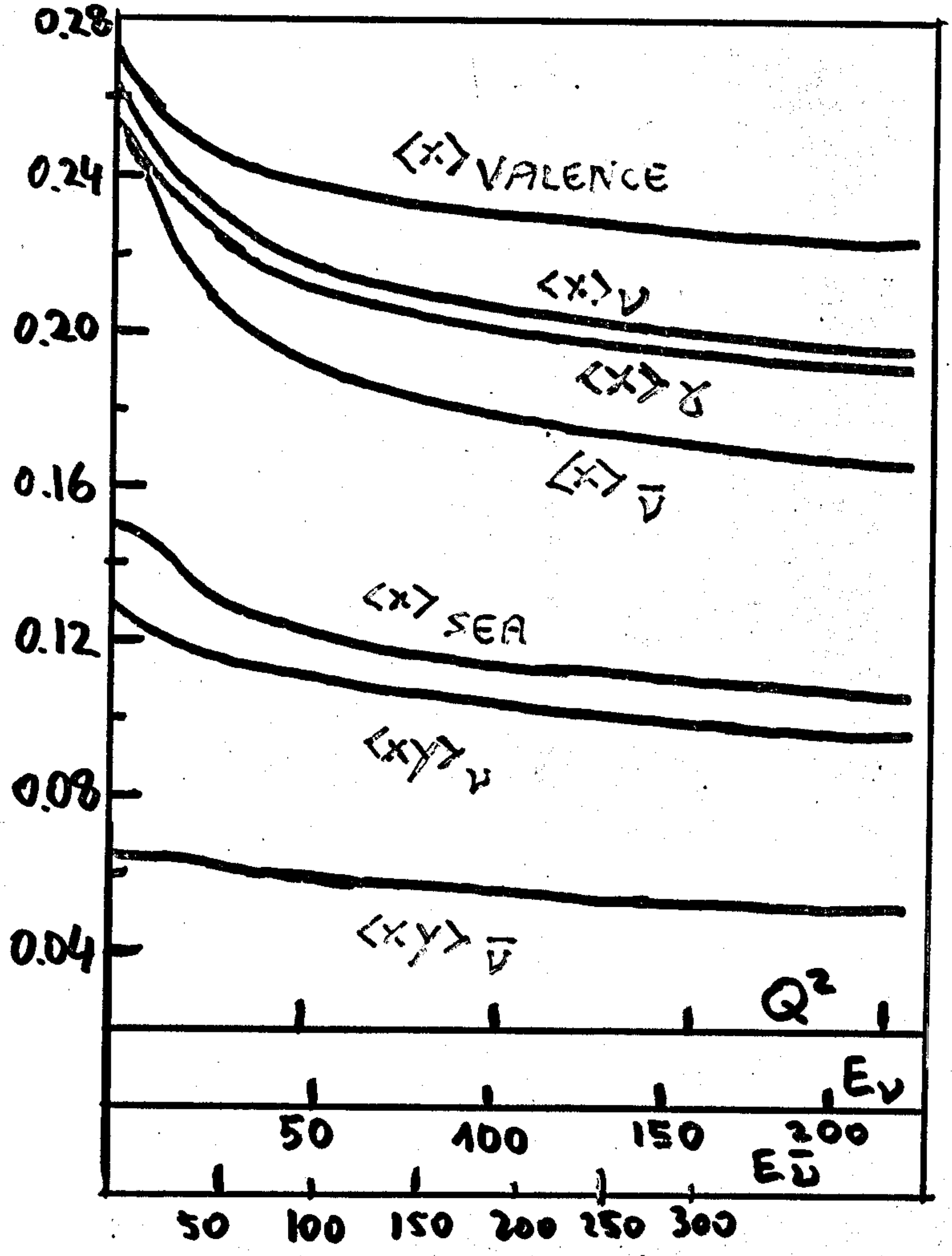


$2ME_\nu \langle xy \rangle =$
$= \langle Q^2 \rangle$

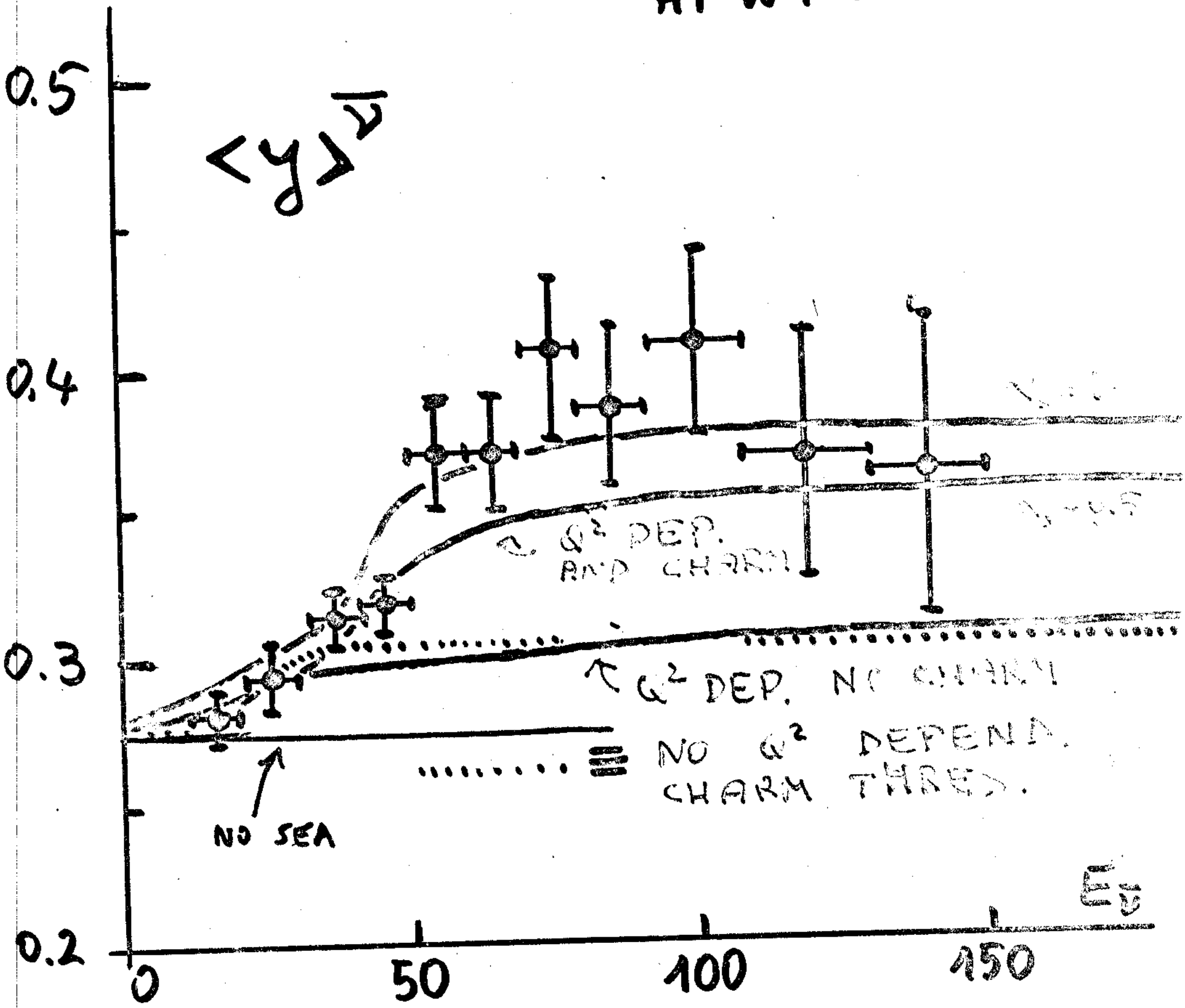
$\alpha_s(1\,\mathrm{GeV}^2) \simeq 1/2$

SECOND MOMENTS.

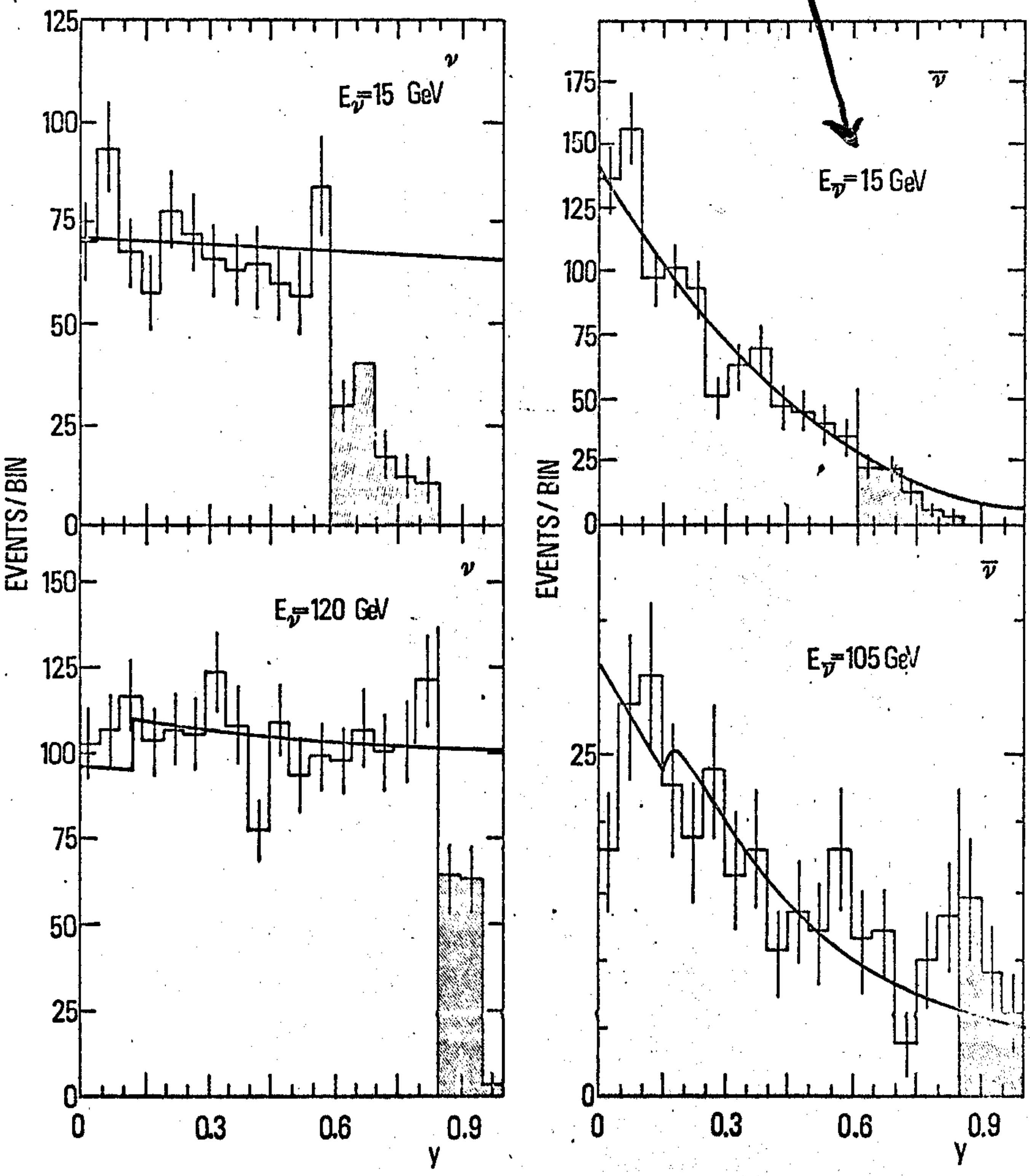
$$\langle x \rangle = \int_0^1 x^2 q(x)\,dx \Big/ \int_0^1 x\, q(x)\,dx$$



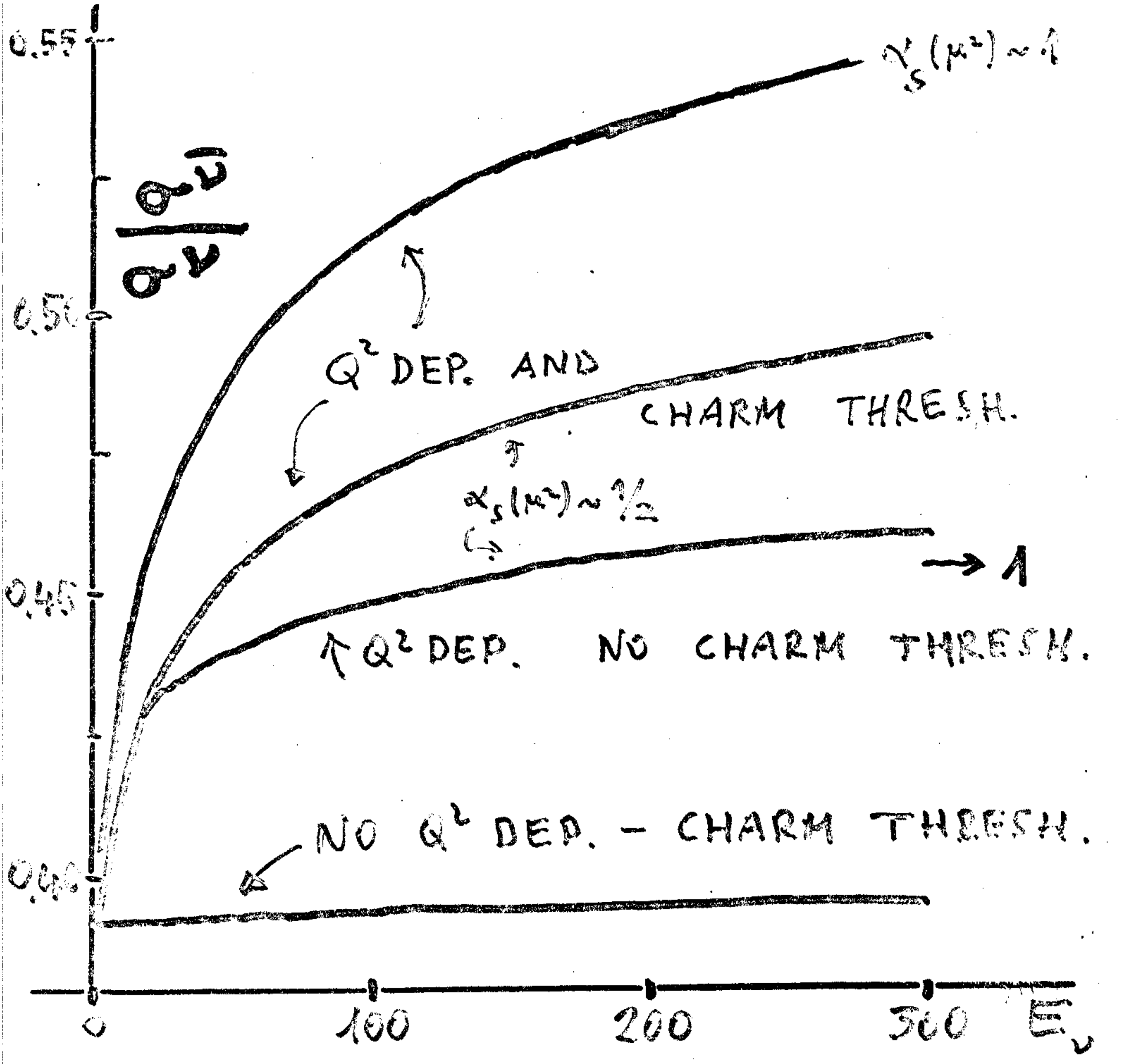
DATA FROM HPWF.



AVERAGE ENERGY OF SAMPLE

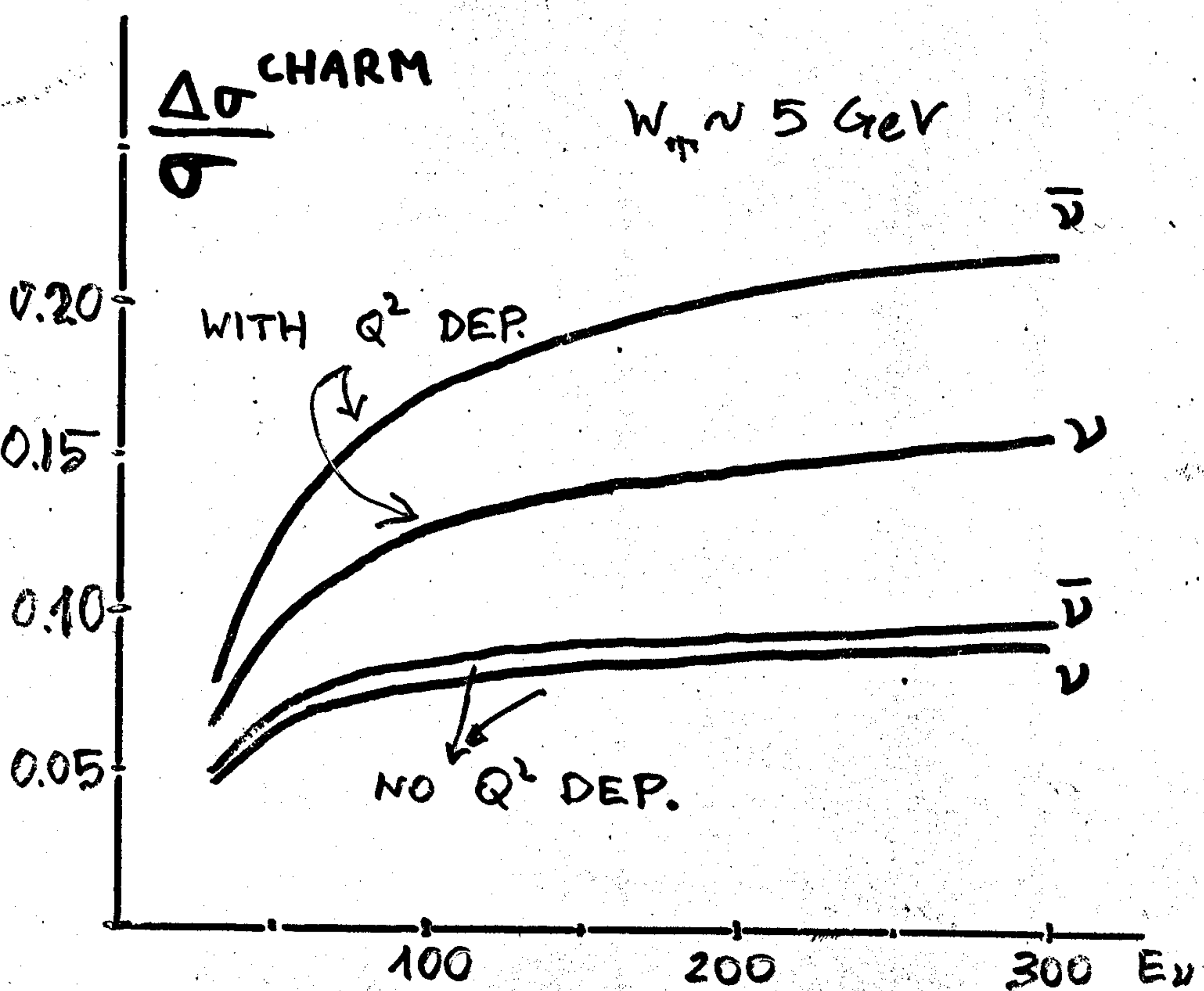


$\alpha_s(1\,GeV^2) = 1/2$



NOTE : $\sigma^{\bar\nu}/\sigma^\nu$ AND $\langle y\rangle^{\bar\nu}$ BOTH MEASURE SEA/VALENCE AND ARE THUS RELATED:

$$\sigma^{\bar\nu}/\sigma^\nu \simeq \frac{3}{16-28\langle y\rangle_{\bar\nu}}$$



$\frac{\Delta\sigma^{CHARM}}{\sigma}$
$W_{\pi} \sim 5$ GeV
0.20
0.15
0.10
0.05
WITH Q^2 DEP.
NO Q^2 DEP.
$\bar{\nu}$
ν
$\bar{\nu}$
ν
100
200
300
E_ν

CONCLUSION

- ALLEGED EVIDENCE FOR $\binom{p}{b}_R$ AT THE MOMENT IS NOT CONVINCING.

- EFFECTS FROM ASYMPT. FREEDOM HAVE CORRECT SIGN AND MAY BE OF ADEQUATE MAGNITUDE (PURE V-A THEORY)

HOWEVER IF :

a) $\sigma^{\bar{\nu}}/\sigma^{\nu} > 0.55 \quad (E_\nu \sim 150\,\mathrm{GeV})$

b) COPIOUS PRODUCTION OF DIMUONS AT LARGE x IS FOUND (in $\bar{\nu}$)
(**NOT** IN ASSOSIATION WITH STRANGE PARTICLES)

ASYMPT. FREEDOM ALONE CANNOT EXPLAIN THAT.

- VECTOR (AXIAL) NEUTRAL CURRENTS EXCLUDED

- SELECTION RULE CHARM $\rightarrow$ STRANGENESS CLEARLY EMERGING