# Polarized Strangeness in the Nucleon and $\Phi$ Production in COMPASS

Aram Kotzinian
YerPhI (Yerevan, Armenia)
& JINR (Dubna, Russia)

COMPASS Week in Dubna
October 9th-15th, 2000

- Introduction
- (Anti)Neutrino data on $\Lambda$ polarization in TFR & Models
- $\Delta s$ from $\Phi$ production asymmetry
  with A. Korzenev & M. Sapozhnikov
- Conclusions

# Introduction

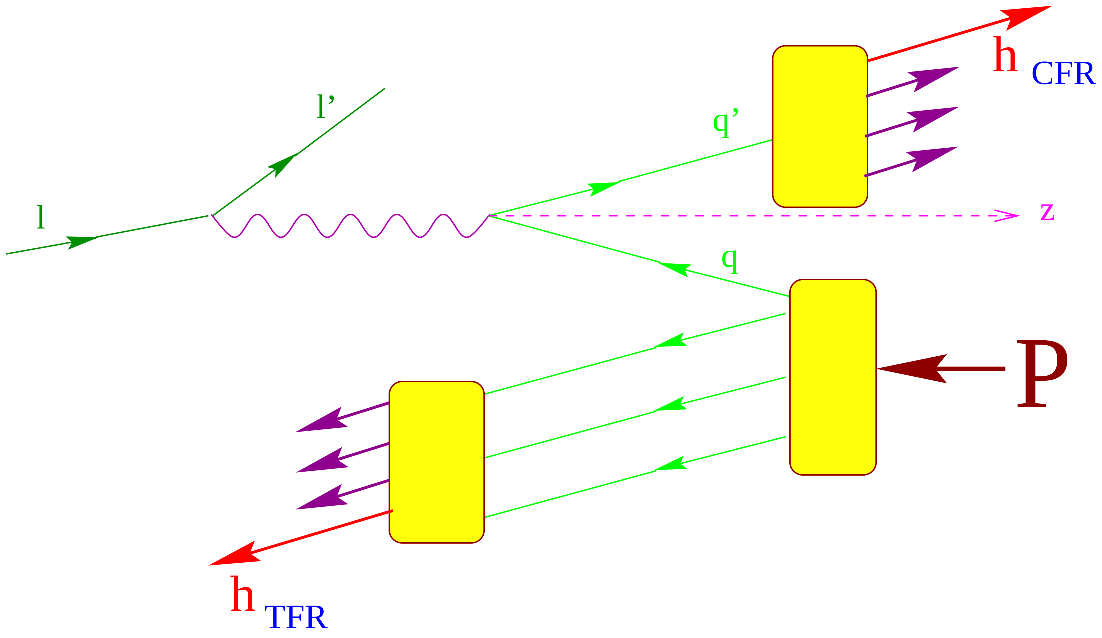



Figure 1: *DIS in quark-parton model.*

Virtual boson – nucleon CMS:

$x_F > 0$ – current fragmentation

$x_F < 0$ – target fragmentation

## $P_{Long}(\Lambda)$ in old neutrino experiments

| Exp. | $E_\nu$ | Cut | $N_\Lambda$ | $P_{Long}$ |
|---|---|---|---|---|
| $\nu_\mu - P$ | 51 | All | 289 | -0.10 $\pm$ 0.14 |
| WA21 | | $x_F < 0$ | 203 | -0.29 $\pm$ 0.18 |
| | | $x_F > 0$ | 86 | 0.53 $\pm$ 0.30 |
| $\bar{\nu}_\mu - P$ | 40 | Full sample | 267 | -0.24 $\pm$ 0.17 |
| WA21 | | $x_F < 0$ | 210 | -0.38 $\pm$ 0.18 |
| | | $x_F > 0$ | 75 | 0.32 $\pm$ 0.35 |
| $\bar{\nu}_\mu - Ne$ | 40 | Full sample | 469 | -0.56 $\pm$ 0.13 |
| WA59 | | $x_F < 0$ | 403 | -0.63 $\pm$ 0.13 |
| | | $x_F > 0$ | 66 | -0.11 $\pm$ 0.45 |
| $\nu_\mu - Ne$ | 150 | Full sample | 258 | -0.38 $\pm$ 0.16 |
| E632 | | $x_F < 0$ | 190 | -0.43 $\pm$ 0.20 |

## $P_{Long}(\Lambda)$ in the NOMAD experiment

| Cut | $N_\Lambda$ | $P_{Long}$ |
|---|---|---|
| All | 8087 | -0.15 $\pm$ 0.03 |
| $x_F < 0$ | 5608 | -0.21 $\pm$ 0.04 |
| $x_F > 0$ | 2479 | -0.09 $\pm$ 0.06 |
| "Proton" | 3472 | -0.26 $\pm$ 0.05 |
| $x_F < 0$ | 2407 | -0.29 $\pm$ 0.06 |
| $x_F > 0$ | 2479 | -0.23 $\pm$ 0.09 |
| "Neutron" | 4615 | -0.09 $\pm$ 0.04 |
| $x_F < 0$ | 3201 | -0.16 $\pm$ 0.05 |
| $x_F > 0$ | 1414 | 0.01 $\pm$ 0.08 |

# Formalism for TFR

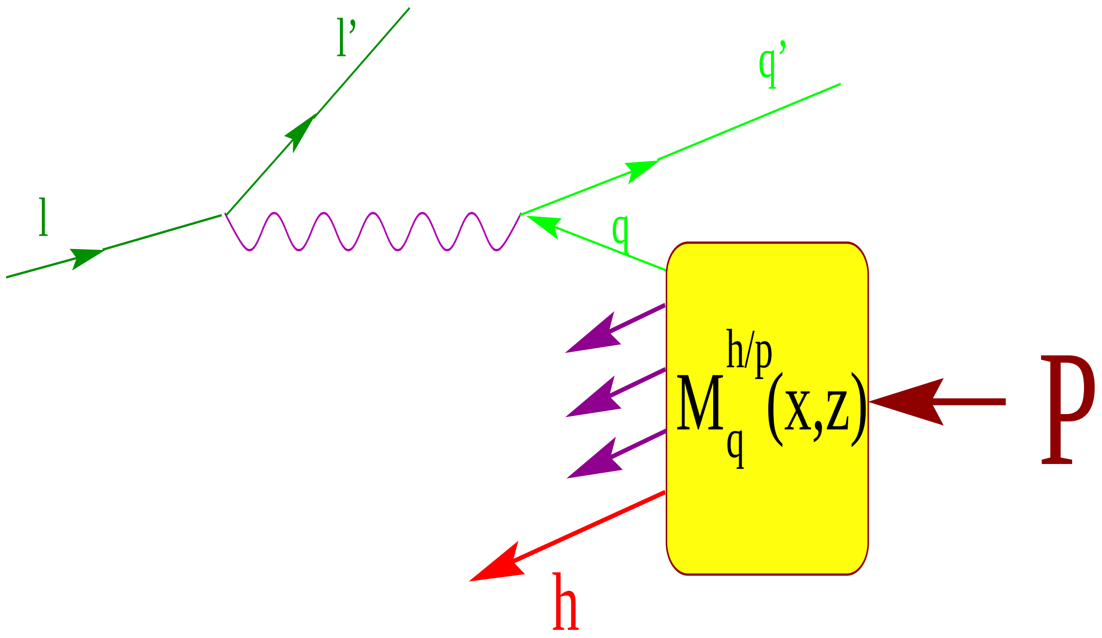



Figure 2: *Target fragmentation region of SIDIS.*

- Trentadue & Veneziano:
  fracture function $M_q^{h/p}(x,z)$ –
  probability of finding a parton $q$ with momentum fraction $x$ and a hadron $h$ with the CMS energy fraction $z = E_h/E_P$ in the proton.

- de Florian & Sassot:
  The NLO evolution equation for both unpolarized and polarized SIDIS (inhomogeneous term)

$$\frac{\partial M(Q^2)}{\partial ln\, Q^2} = \alpha_s(Q^2) P \otimes M(Q^2)$$
$$+\alpha_s(Q^2)\hat{P} \otimes f(Q^2) \otimes D(Q^2)$$

  Production of forward neutrons at ZEUS.
  At some input scale $Q_0^2$
  $M_q^{n/p}(x, z, Q_0^2) =$
  $\Phi_{n/p}(z) f_q^{\pi^+}(x/1 - z, Q_0^2),$
  $\Phi_{n/p}(z)$ – flux of neutrons in the proton.

## Models for Λ polarization in the TFR

- Bigi:
  in polarized SIDIS the remnant di-quark can transfer its polarization to hyperons.

- Melnitchouk & Thomas:

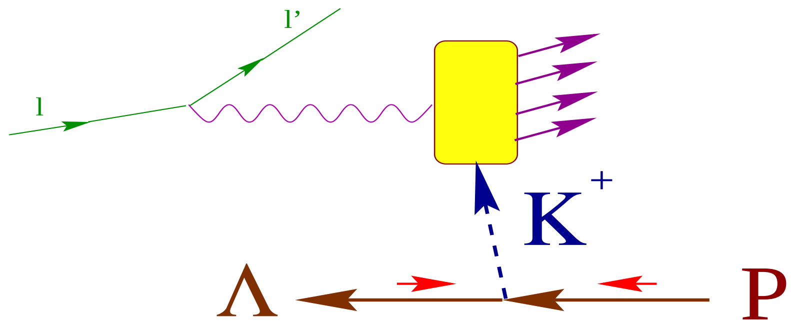



Figure 3: *DIS in the meson cloud model.*

- Ellis, Kharzeev & A.K.:
  polarized intrinsic strangeness model

## $\nu N$ DIS in the SU(6) quark-diquark model

$$
\begin{aligned}
N &= \frac{1}{2}(N^{\uparrow} + N^{\downarrow}) \\
p^{\uparrow} &= \frac{1}{\sqrt{18}}\{u^{\uparrow}[3(ud)_{00} + (ud)_{10}] - \sqrt{2}u^{\downarrow}(ud)_{11} \\
&\qquad -\sqrt{2}d^{\uparrow}(uu)_{10} + 2d^{\downarrow}(uu)_{11}\} \\
n^{\uparrow} &= \frac{1}{\sqrt{18}}\{d^{\uparrow}[3(ud)_{00} + (ud)_{10}] - \sqrt{2}d^{\downarrow}(ud)_{11} \\
&\qquad -\sqrt{2}u^{\uparrow}(dd)_{10} + 2u^{\downarrow}(dd)_{11}\}
\end{aligned}
$$

Remnant diquark:

$$
\begin{aligned}
\nu p: \; p \ominus d^{\uparrow} &\Rightarrow \frac{1}{36}[2(uu)_{10} + 4(uu)_{1-1}] \\
\nu n: \; n \ominus d^{\uparrow} &\Rightarrow \frac{1}{36}[9(ud)_{00} + (ud)_{10} + 2(ud)_{1-1}] \\
\bar{\nu} p: \; p \ominus u^{\uparrow} &\Rightarrow \frac{1}{36}[9(ud)_{00} + (ud)_{10} + 2(ud)_{1-1}] \\
\bar{\nu} n: \; n \ominus u^{\uparrow} &\Rightarrow \frac{1}{36}[2(dd)_{10} + 4(dd)_{1-1}]
\end{aligned}
$$

## Strange Baryons wave functions in the SU(6) quark-diquark model

### Octet

$$
\begin{aligned}
\Lambda^{\uparrow} \quad = \quad & \frac{1}{\sqrt{12}}\{2s^{\uparrow}(ud)_{00} \\
& +\sqrt{2}d^{\downarrow}(us)_{11} - d^{\uparrow}[(us)_{10} - (us)_{00}] \\
& -\sqrt{2}u^{\downarrow}(ds)_{11} + u^{\uparrow}[(ds)_{10} - (ds)_{00}]\}
\end{aligned}
$$

EM decay: $\Sigma^0 \longrightarrow \Lambda + \gamma$

$$
\begin{aligned}
\Sigma^{0\uparrow} \quad = \quad & \frac{1}{\sqrt{12}}\{\sqrt{2}s^{\uparrow}(ud)_{10} - 2s^{\downarrow}(ud)_{11} \\
& +d^{\downarrow}(us)_{11} - \frac{1}{\sqrt{2}}d^{\uparrow}[(us)_{10} + 3(us)_{00}] \\
& +u^{\downarrow}(us)_{11} - \frac{1}{\sqrt{2}}u^{\uparrow}[(ds)_{10} + 3(ds)_{00}]\}
\end{aligned}
$$

# Decuplet

## Strong decay: $\Sigma^* \longrightarrow \Lambda + \pi$

$$
\begin{aligned}
\Sigma^{*0\Uparrow} &= \frac{1}{\sqrt{3}}[s^{\uparrow}(ud)_{11} + u^{\uparrow}(ds)_{11} + d^{\uparrow}(us)_{11}] \\
\Sigma^{*0\uparrow} &= \frac{1}{\sqrt{18}}[2s^{\uparrow}(ud)_{10} + \sqrt{2}s^{\downarrow}(ud)_{11} \\
&\quad +2u^{\uparrow}(ds)_{10} + \sqrt{2}u^{\downarrow}(ds)_{11} + \\
&\quad +2d^{\uparrow}(us)_{10} + \sqrt{2}d^{\downarrow}(us)_{11}] \\
\Sigma^{*+\Uparrow} &= \frac{1}{\sqrt{3}}[s^{\uparrow}(uu)_{11} + \sqrt{2}u^{\uparrow}(us)_{11}] \\
\Sigma^{*+\uparrow} &= \frac{1}{\sqrt{9}}[\sqrt{2}s^{\uparrow}(uu)_{10} + s^{\downarrow}(uu)_{11} \\
&\quad +2u^{\uparrow}(us)_{10} + \sqrt{2}u^{\downarrow}(us)_{11}]
\end{aligned}
$$

$\Uparrow (\Downarrow) \Leftrightarrow m = \frac{3}{2}(m = -\frac{3}{2})$

Relative probabilities, $W(B)$ :

| Baryon | $\nu p$ | $\nu n$ | $\bar{\nu} p$ | $\bar{\nu} n$ |
|---|---|---|---|---|
| $\Lambda^{\uparrow}$ | 0 | 54 | 54 | 0 |
| $\Lambda^{\downarrow}$ | 0 | 54 | 54 | 0 |
| $\Sigma^{0\uparrow}$ | 0 | 3 | 3 | 0 |
| $\Sigma^{0\downarrow}$ | 0 | 15 | 15 | 0 |
| $\Sigma^{*0\Uparrow}$ | 0 | 0 | 0 | 0 |
| $\Sigma^{*0\Downarrow}$ | 0 | 12 | 12 | 0 |
| $\Sigma^{*0\uparrow}$ | 0 | 4 | 4 | 0 |
| $\Sigma^{*0\downarrow}$ | 0 | 8 | 8 | 0 |
| $\Sigma^{*+\Uparrow}$ | 0 | 0 | 0 | 0 |
| $\Sigma^{*+\Downarrow}$ | 24 | 0 | 0 | 0 |
| $\Sigma^{*+\uparrow}$ | 8 | 0 | 0 | 0 |
| $\Sigma^{*+\downarrow}$ | 16 | 0 | 0 | 0 |
| $\Sigma^{*-\Uparrow}$ | 0 | 0 | 0 | 0 |
| $\Sigma^{*-\Downarrow}$ | 0 | 0 | 0 | 24 |
| $\Sigma^{*-\uparrow}$ | 0 | 0 | 0 | 8 |
| $\Sigma^{*-\downarrow}$ | 0 | 0 | 0 | 16 |

## $\Lambda$ polarization in the SU(6) quark-diquark model

$$P(\Lambda) = \sum_B W(B) P_s(B) Br(B) / \sum_B W(B) Br(B)$$

In both $\Sigma^0 \rightarrow \Lambda + \gamma$ and $\Sigma^* \rightarrow \Lambda + \pi$

nonstrange diquark $J = 1 \rightarrow J = 0$

while the s-quark retains its polarization

$\Rightarrow P(\Lambda) = P_s(\Sigma)$

| B | $\Sigma^{0\uparrow}$ | $\Sigma^{0\downarrow}$ | $\Sigma^{*\Uparrow}$ | $\Sigma^{*\Downarrow}$ | $\Sigma^{*\uparrow}$ | $\Sigma^{*\downarrow}$ |
|---|---|---|---|---|---|---|
| $P_s(B)$ | -1/3 | 1/3 | 1 | -1 | 1/3 | -1/3 |
| $Br(B)$ | 1 | 1 | 0.88 | 0.88 | 0.88 | 0.88 |

$$P^{\nu p}_{TFR}(\Lambda) = P^{\bar{\nu} n}_{TFR}(\Lambda) = \simeq -0.55$$
$$P^{\nu n}_{TFR}(\Lambda) = P^{\bar{\nu} p}_{TFR}(\Lambda) = \simeq -0.05$$

Isoscalar target:

$$P^{\nu(p+n)}_{TFR}(\Lambda) = P^{\bar{\nu}(p+n)}_{TFR}(\Lambda) \simeq -0.30$$

## Nucleon Intrinsic strangeness

Alberg,Ellis, Karliner, Kharzeev & Sapozhnikov: nucleon wave function contains an admixture with $\bar{s}s$ component

$$|p\rangle = a\sum_{X=0}^{\infty}|uudX\rangle + b\sum_{X=0}^{\infty}|uud\bar{s}sX\rangle + ...$$

The simplest choice of $(\bar{s}s)$ wave function vacuum quantum numbers

$$J^{PC} = 0^{++} \Rightarrow {}^3P_0$$

Effective strong attraction in pseudoscalar $J^{PC} = 0^{-+}$ channel $\Rightarrow$ for the valence quark with $S_z(q) = 1/2$

$$S_z(\bar{s}s) = -1, \; L_z(\bar{s}s) = 1$$

From the phenomenology of strangeness production in $\bar{p}N$ annihilation

$$0.01 \leq |b|^2 \leq 0.19, \quad (\Delta s = -0.1)$$

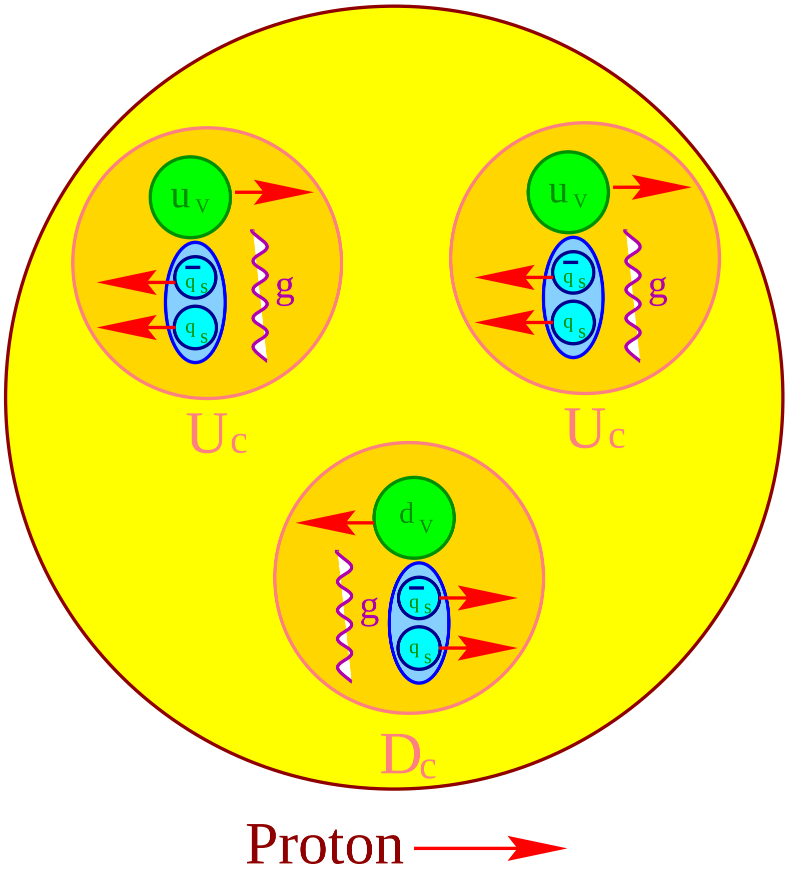



Figure 4: *Constituent quarks in the Polarized proton. Red arrow represent the polarization direction of the corresponding particle.*

Ellis, Kharzeev & A.K.:

TFR of SIDIS

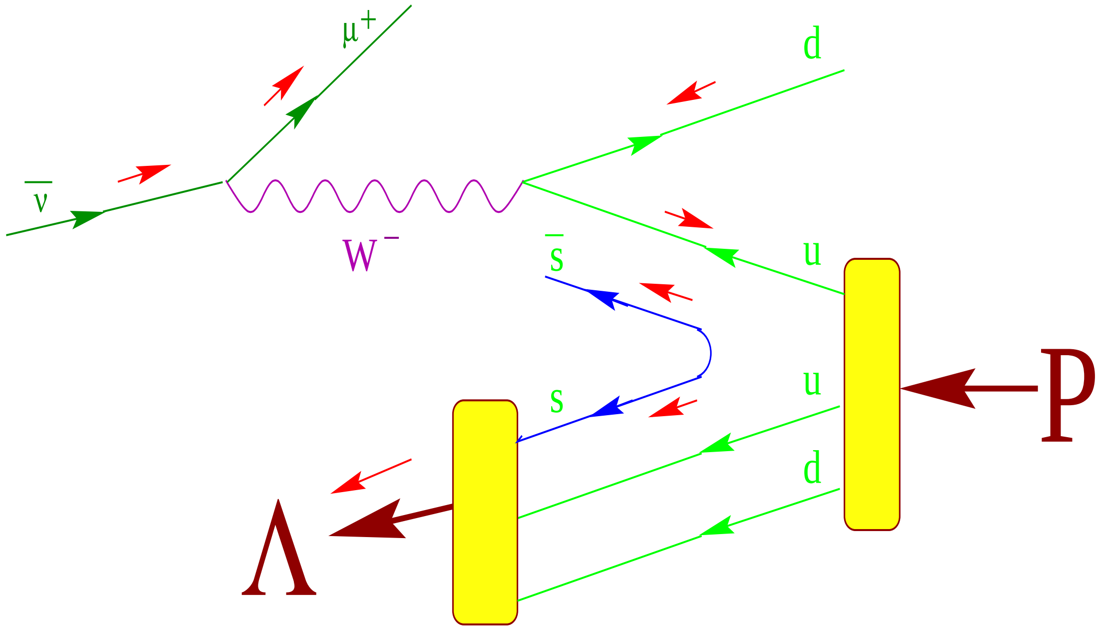



Figure 5: *Dominant diagram for $\Lambda$ production in the target fragmentation region due to scattering on a valence u-quark. Each red arrow represent the longitudinal polarization of the corresponding particle.*

## Spin-correlation coefficient $C_{sq}$

$$C_{sq} = \frac{W_{s^\uparrow q^\uparrow} - W_{s^\uparrow q^\downarrow}}{W_{s^\uparrow q^\uparrow} + W_{s^\uparrow q^\downarrow}}$$

## Remnant $s$-quark polarization $P_s$

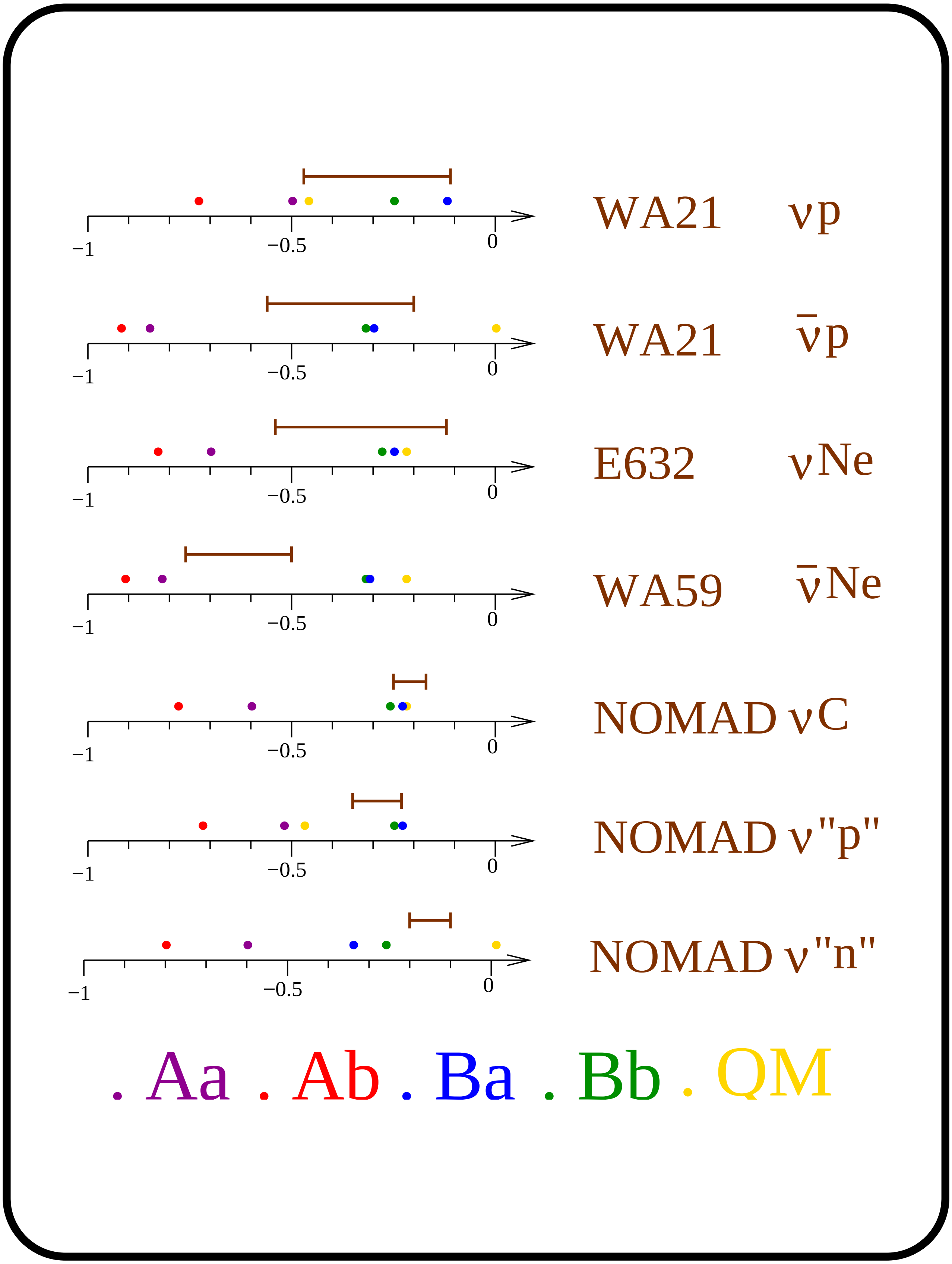
CC weak interacrions $\Rightarrow$ lefthanded quarks $q^\uparrow$ and righthanded antiquarks $\bar{q}^\downarrow$

$$P_s = \sum_q C_{sq} W_q - \sum_{\bar{q}} C_{s\bar{q}} W_{\bar{q}}$$

$$P_\Lambda = D_F \, P_s$$

| | | | |
|---|---|---|---|
| | $S_z$ | -1 | 0 |
| | $q_v$ | $\longrightarrow$ | $\longrightarrow$ |
| | $\bar{s}$ | $\longleftarrow$ | $\longleftarrow$ |
| | $s$ | $\longleftarrow$ | $\longrightarrow$ |
| A: | $W$ | 1 | 0 |
| B: | $W$ | 2/3 | 1/3 |

- A: Only $\bar{s}s$-pairs with $S_z = -1 \Rightarrow$
  $C_{sq_{val}} = -1, \quad C_{s\bar{s}} = 1$
- B: $\bar{s}s$-pairs with $S_z = -1$ and $S_z = 0$ with equal probabilities $\Rightarrow$
  $C_{sq_{val}} = -1/3, \quad C_{s\bar{s}} = 1/3$
- The $s$-quark which becames the constituent quark in $\Lambda$ and the struck $q_{sea} \neq \bar{s}$ are from the same parent constituent quark $\Rightarrow$
  Aa: $C_{sq_{sea}} = 1$
  Ba: $C_{sq_{sea}} = 1/9$
- $s$-quark and $q_{sea}$ are from different constituent quarks $\Rightarrow$
  b: $C_{sq_{sea}} = 0$
- LEPTO-JETSET (Lund fragmentation)



−1
−0.5
0
WA21 νp
WA21 ν̄p
E632 νNe
WA59 ν̄Ne
NOMAD νC
NOMAD ν"p"
NOMAD ν"n"
Aa
Ab
Ba
Bb
QM

# Conclusions 1

- In the Meson-Cloud model $P_\Lambda = 0$ for unpolarized target
- The NQ model fails to describe the $\nu``n''$ and $\bar{\nu}p$ data
- The Polarized Strangeness model describes correctly the sign and magnitude of $P_\Lambda$
  If B $\Leftrightarrow$ $L_z = 1$ and $L_z = 0$ are allowed:
  $\Delta s \approx 1/3 \Delta \bar{s} < 0$
  Ma & Brodsky: $\Delta \bar{s} \approx 0$, $\Delta s < 0$
- $$\begin{aligned} Ma\,\&\,Brodsky: &\quad \Rightarrow \quad P_{\bar{\Lambda}} \approx 0 \\ Pol.\,Str.\,model\ A: &\quad \Rightarrow \quad P_{\bar{\Lambda}} \approx P_\Lambda \\ Pol.\,Str.\,model\ B: &\quad \Rightarrow \quad P_{\bar{\Lambda}} \approx 3P_\Lambda \end{aligned}$$
- New measurements: $P_{\bar{\Lambda}}$, associatively-produced $\Lambda\,\&\,\bar{\Lambda}$

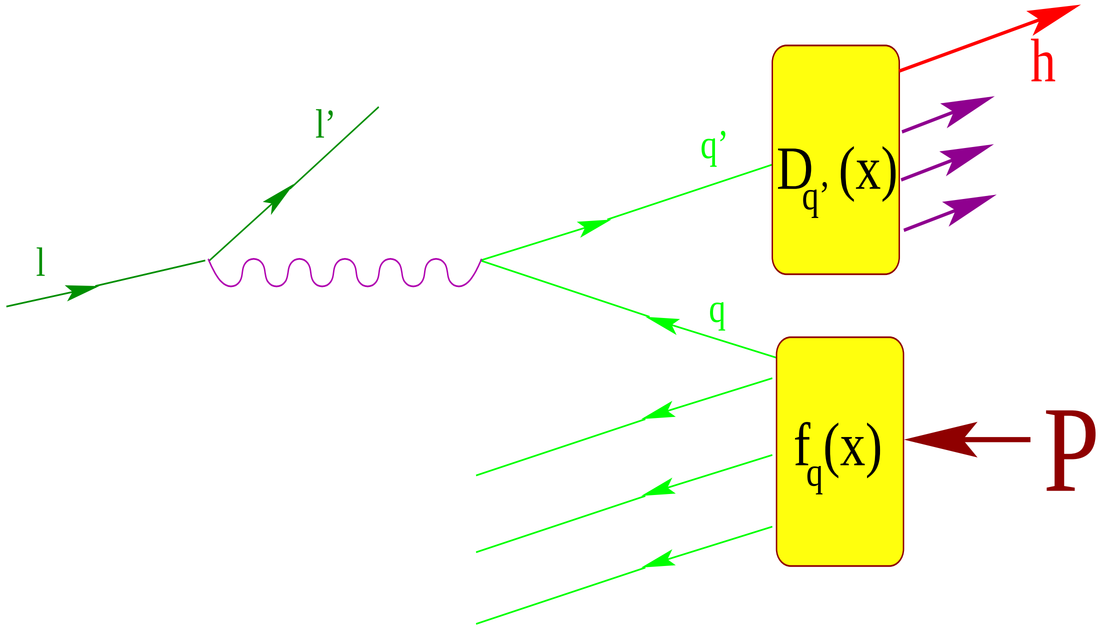



Figure 6: *Current fragmentation region of SIDIS.*

$f_q(x)$ – quark distribution function in nucleon.
$D_q^h(x)$ – quark fragmentation function into the hadron $h$.

$$h = \Phi$$

$$\sigma_p^h \propto (1+(1-y)^2)\sum_q e_q^2 q(x,Q^2)D_q^h(z,Q^2),$$

$$\Delta\sigma_p^h \propto (1-(1-y)^2)\sum_q e_q^2 \Delta q(x,Q^2)D_q^h(z,Q^2),$$

LEPTO 6.5.1: 160 GeV muons on $^6LiD$ target

$$0.2 < y < 0.9, \quad Q^2 > 1\ (GeV/c)^2$$

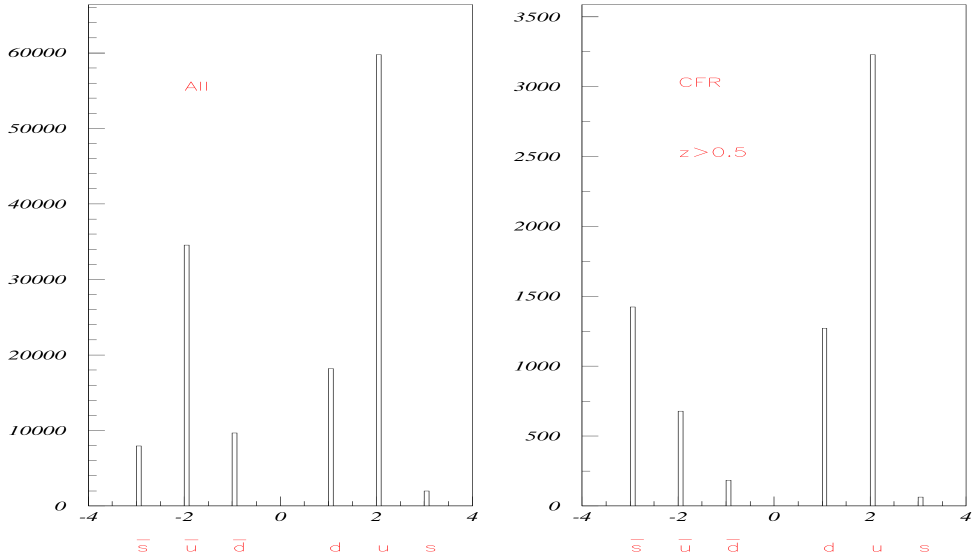



Figure 7: $K^+$ *yield dependence on struck quark flavor.*

$$|\Phi\rangle = |s\bar{s}\rangle$$

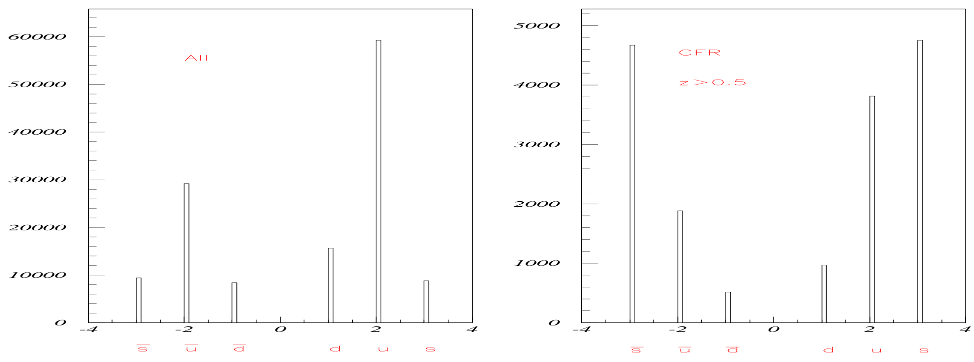



Figure 8: $\Phi$ *yield dependence on struck quark flavor. LEPTO, QCD off, LO*

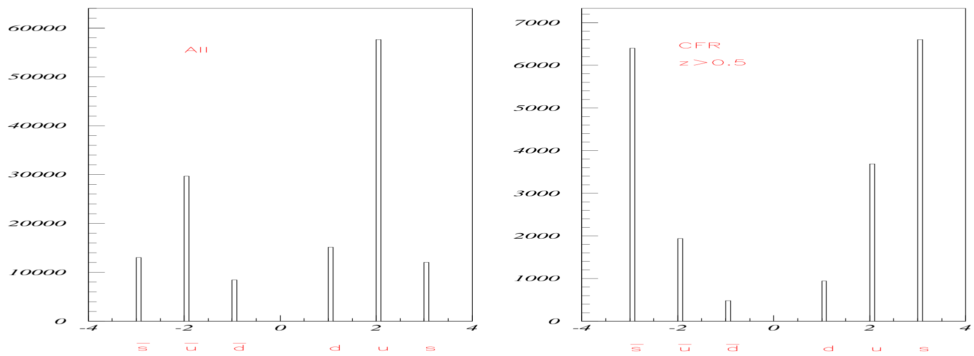



Figure 9: $\Phi$ *yield dependence on struck quark flavor. LEPTO, QCD on, NLO*

# Flavor separation

## Leader & Christova:

## A Strategy for the Analysis of SIDIS

Lot of equations including (un)polarized cross-sections and yields
$\frac{\Delta s}{s}$ from $\pi^+$ and $\pi^-$ production asymmetries on proton and neutron targets.
Or, from $\Phi$ production:

$$\frac{\Delta s + \Delta \bar{s}}{s + \bar{s}} = \frac{3\Delta q_3(\Delta\sigma_p^\Phi + \Delta\sigma_n^\Phi) - 5\Delta q_+(\Delta\sigma_p^\Phi - \Delta\sigma_n^\Phi)}{D(y)[3q_3(\sigma_p^\Phi + \sigma_n^\Phi) - 5q_+(\sigma_p^\Phi - \sigma_n^\Phi)]}$$

$$\Delta q_+ = \Delta u + \Delta\bar{u} + \Delta d + \Delta\bar{d}$$
$$\Delta q_3 = \Delta u + \Delta\bar{u} - \Delta d - \Delta\bar{d}$$

Different targets and selected hadrons:

Accuracy – ?

$$D_u^{\Phi}(z) = D_{\bar{u}}^{\Phi}(z) = D_d^{\Phi}(z) = D_{\bar{d}}^{\Phi}(z)$$

$$r(z) \equiv \frac{D_u^{\Phi}(z)}{D_s^{\Phi}(z)} \ll 1 \text{ at high } z$$

$$A_{1,p}^{\Phi} = \frac{\Delta S(x) + \Delta V(x) r(z)}{S(x) + V(x) r(z)}$$

$$\begin{aligned}
S(x) &= s(x) + \bar{s}(x) \\
\Delta S(x) &= \Delta s(x) + \Delta \bar{s}(x) \\
V(x) &= 4[u(x) + \bar{u}(x)] + d(x) + \bar{d}(x) \\
\Delta V(x) &= 4[\Delta u(x) + \bar{\Delta} u(x)] + \Delta d(x) + \bar{\Delta} d(x)
\end{aligned}$$

$r(z)$ from *unpolarized* $\Phi$ yields in different $x$-bins at fixed $z$:

$$\frac{\sigma_p^{\Phi}(x_1, z)}{\sigma_p^{\Phi}(x_2, z)} = \frac{\langle \frac{1+(1-y)^2}{Q^2 xy} \rangle_1 [S(x_1) + V(x_1) r(z)]}{\langle \frac{1+(1-y)^2}{Q^2 xy} \rangle_2 [S(x_2) + V(x_2) r(z)]}$$

Virtual photon asymmetry $A_1$

$$A_1^h = \frac{1}{P_B P_T D f} A_h^{exp},$$

$$A_h^{exp} = \frac{N_h^{\uparrow\downarrow} - N_h^{\downarrow\downarrow}}{N_h^{\uparrow\downarrow} + N_h^{\downarrow\downarrow}}$$

$A_1^h$ from LEPTO+POLDIS with GRV94+GRSV96 PDF's

$$A_1^h = \frac{\sum_q \Delta q(x, Q^2) D_q^h(z, Q^2)}{\sum_q q(x, Q^2) D_q^h(z, Q^2)}$$

Statistical accuracy:

LEPTO $\rightarrow$ COMGEANT $\rightarrow$ CORAL

$$\delta A_1^h = \frac{1}{\overline{P_B P_T D f} \sqrt{N_h}},$$

$$N_h = N_h^{\uparrow\downarrow} + N_h^{\downarrow\downarrow}$$

## Estimation of $\phi$ production statistics for 1 year COMPASS run

| | |
|---|---|
| Beam energy | 160 $GeV$ |
| $\phi$ production cross section | 2.4 nb |
| RICH ($p > 2.5\ GeV/c$ for both kaons) | 93 % |
| RICH efficiency | 98 % |
| Acceptance for $K^+K^-$ | 74 % |
| Rec. eff. ($K^+K^-$) | 49 % |
| Luminosity | $4.3 \cdot 10^{37} cm^{-2} day^{-1}$ |
| Days per year | 38 day |
| $\phi$ per year | $7.1 \cdot 10^5$ |
| $\phi$ ($x_F > 0$) | $6.1 \cdot 10^5$ |
| $\phi$ ($x_F > 0$), ($z > 0.3$) | $2.6 \cdot 10^5$ |
| $\phi$ ($x_F > 0$), ($z > 0.5$) | $1.1 \cdot 10^5$ |

## GRV94+GRSV96 Dynamical PDF's

"Standard" scenario:

LO, $Q^2 = 4GeV^2$

$$\Delta u = 0.918,\ \Delta d = -0.339,\ \Delta g = 1.27$$

$$\Delta \bar{q} = -0.059,\ \Delta s = -0.059$$

NLO, $Q^2 = 4GeV^2$

$$\Delta u = 0.914,\ \Delta d = -0.338\ \Delta g = 1.44$$

$$\Delta \bar{q} = -0.068,\ \Delta s = -0.068$$

"Valence" scenario:

LO, $Q^2 = 4GeV^2$

$$\Delta u = 0.918,\ \Delta d = -0.339,\ \Delta g = 1.36$$

$$\Delta \bar{q} = -0.072,\ \Delta s = -0.000$$

NLO, $Q^2 = 4GeV^2$

$$\Delta u = 0.914,\ \Delta d = -0.338\ \Delta g = 1.49$$

$$\Delta \bar{q} = -0.081,\ \Delta s = -0.004$$

All PDF's are in satisfactory agreement with DIS data

POLDIS with GRSV96 LO describes well SMC SIDIS data

## $\Phi$ production asymmetry in LO

| $x_{min}$ | Scenario | $z > 0.3$ | | $z > 0.5$ | |
|---|---|---|---|---|---|
| | | $A_1$ | $\delta A_1$ | $A_1$ | $\delta A_1$ |
| 0.004 | $\Delta s \neq 0$ | -0.043 | 0.019 | -0.081 | 0.029 |
| | $\Delta s = 0$ | 0.009 | | 0.008 | |
| 0.05 | $\Delta s \neq 0$ | -0.133 | 0.043 | -0.095 | 0.067 |
| | $\Delta s = 0$ | 0.096 | | 0.108 | |

## $\Phi$ production asymmetry in NLO

| $x_{min}$ | Scenario | $z > 0.3$ | | $z > 0.5$ | |
|---|---|---|---|---|---|
| | | $A_1$ | $\delta A_1$ | $A_1$ | $\delta A_1$ |
| 0.004 | $\Delta s \neq 0$ | -0.050 | 0.019 | -0.079 | 0.029 |
| | $\Delta s = 0$ | 0.004 | | 0.006 | |
| 0.05 | $\Delta s \neq 0$ | 0.020 | 0.043 | -0.038 | 0.067 |
| | $\Delta s = 0$ | 0.108 | | 0.120 | |

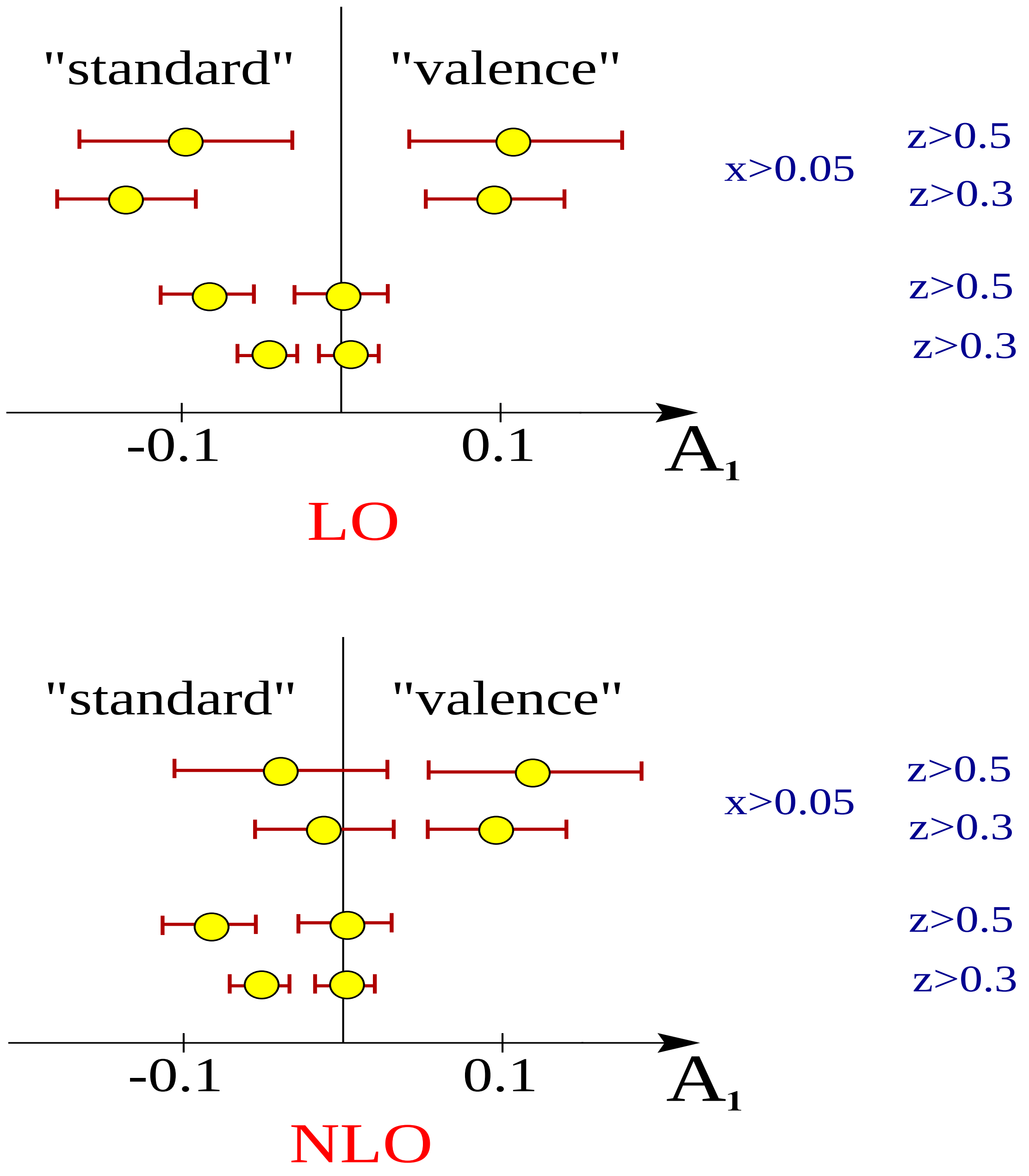



Figure 10: *Calculated $\Phi$ production asymmetry*

## $K^+$ production asymmetry in LO

| $x_{min}$ | Scenario | $z > 0.3$ | | $z > 0.5$ | |
|---|---|---|---|---|---|
| | | $A_1$ | $\delta A_1$ | $A_1$ | $\delta A_1$ |
| 0.004 | $\Delta s \neq 0$ | -0.001 | 0.007 | -0.005 | 0.011 |
| | $\Delta s = 0$ | 0.023 | | 0.025 | |
| 0.05 | $\Delta s \neq 0$ | 0.070 | 0.014 | 0.065 | 0.0323 |
| | $\Delta s = 0$ | 0.111 | | 0.118 | |

## $K^-$ production asymmetry in LO

| $x_{min}$ | Scenario | $z > 0.3$ | | $z > 0.5$ | |
|---|---|---|---|---|---|
| | | $A_1$ | $\delta A_1$ | $A_1$ | $\delta A_1$ |
| 0.004 | $\Delta s \neq 0$ | -0.035 | 0.006 | -0.046 | 0.010 |
| | $\Delta s = 0$ | -0.016 | | -0.024 | |
| 0.05 | $\Delta s \neq 0$ | -0.015 | 0.015 | -0.047 | 0.023 |
| | $\Delta s = 0$ | 0.031 | | 0.011 | |

## Conclusions

- It is possible to extract $\Delta S$ "directly" from $\Phi$-production asymmetry and yield
- More than $3\sigma$ separation for both $K$- and $\Phi$-production asymmetries
- COMPASS can distinguish between "Valence " ($\Delta s = 0$) and "Standard " ($\Delta s \neq 0$) scenarios