Re-evaluation of the Parton Distributions of Strange Quarks in the Nucleon

Uses the final HERMES kaon Multiplicities from SIDIS

[A. Airapetian et al.,Phys. Rev. D (in press)]

H. E. Jackson – DIS 2013

Physics Letters B 666 (2008) 446–450

Contents lists available at ScienceDirect

Physics Letters B

www.elsevier.com/locate/physletb

Measurement of parton distributions of strange quarks in the nucleon from charged-kaon production in deep-inelastic scattering on the deuteron

HERMES Collaboration

[aa] *Yerevan Physics Institute, 375036 Yerevan, Armenia*

A R T I C L E   I N F O

Article history:
Received 3 June 2008
Received in revised form 18 July 2008
Accepted 23 July 2008
Available online 6 August 2008
Editor: L. Rolandi

PACS:
13.60.-r
13.88.+e
14.20.Dh
14.65.-q

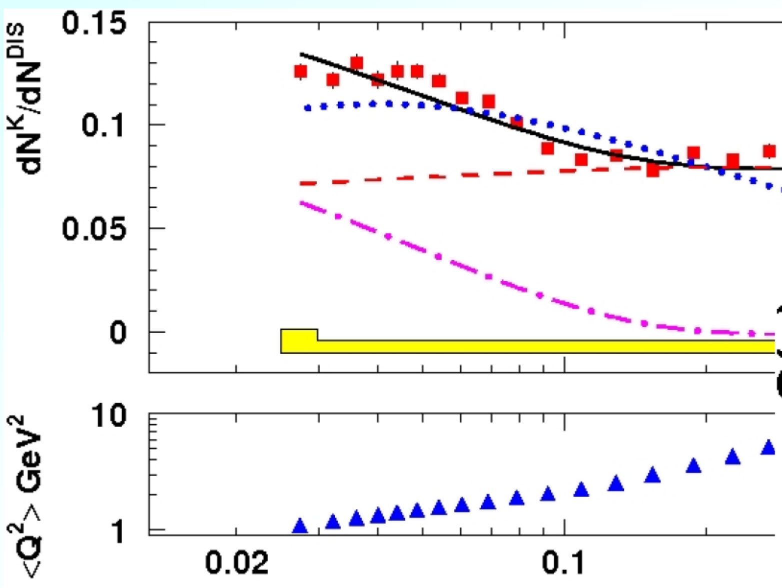
A B S T R A C T

The momentum and helicity density distributions of the strange quark sea in the nucleon are obtained in leading order from charged-kaon production in deep-inelastic scattering on the deuteron. The distributions are extracted from spin-averaged $K^{\pm}$ multiplicities, and from $K^{\pm}$ and inclusive double-spin asymmetries for scattering of polarized positrons by a polarized deuterium target. The shape of the momentum distribution is softer than that of the average of the $\bar{u}$ and $\bar{d}$ quarks. In the region of measurement $0.02 < x < 0.6$ and $Q^2 > 1.0$ GeV^2, the helicity distribution is zero within experimental uncertainties.

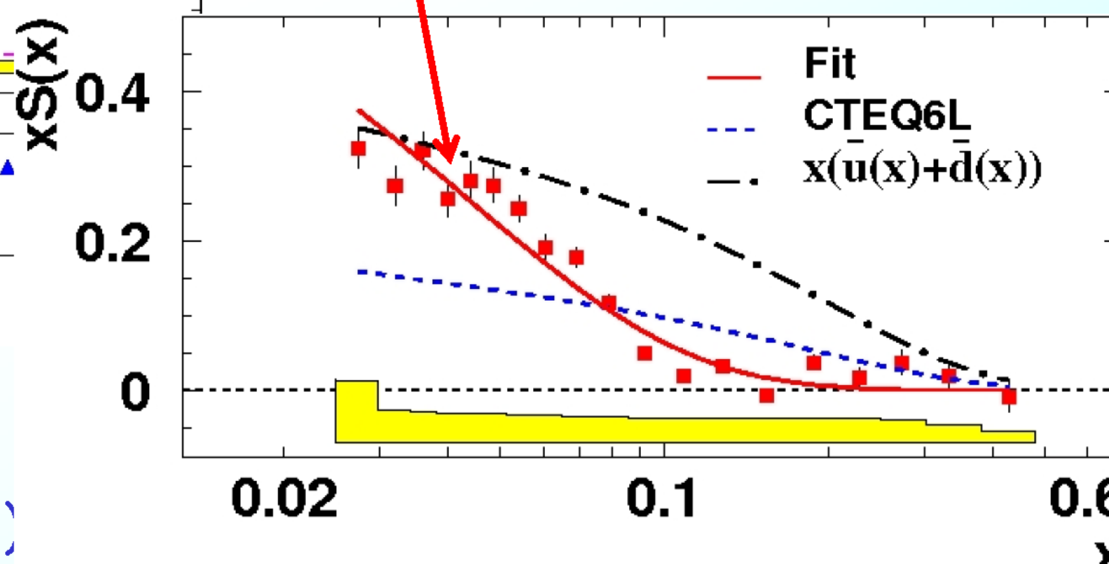
The strange sea: S(x) from $K^{\pm}$ multiplicities

$$\frac{dN^{K\pm}}{dN^{DIS}} = \frac{Q(x)\int D_Q^K(z)dz + S(x)\int D_S^K(z)dz}{5\,Q(x) + 2\,S(x)} \xrightarrow{x>0.3} \frac{\int D_Q^K(z)dz}{5}$$

P.L. B666 (2008) 466



- S(x) from CTEQ6L with $\int D_Q^K(z)dz$ & $\int D_S^K(z)dz$ as free parameters (dotted) does not fit the data



- S(x) much softer than assumed by current PDFs (mainly based on $\overset{(-)}{\nu}N\rightarrow\mu^+\mu^-X$)

Take $\int D_S^K(z)dz = 1.27 \pm 0.13$ from de Florian et al.

Signal for S(x)=0 at LO

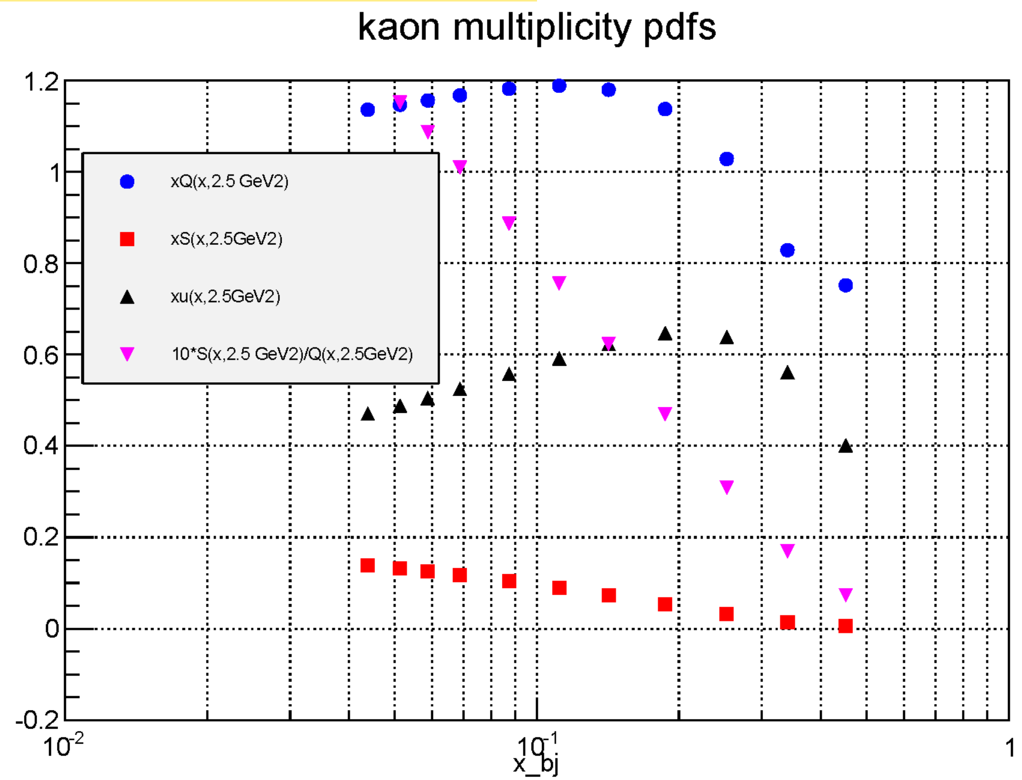
In leading order:

$$M^{K^\pm}(x) \equiv \frac{d^2N^K(x)}{d^2N^{DIS}(x)} = \frac{[\int 1}{}$$

where $f(x) = S(x)/Q(x) \ll 1.$

$$5M^{K^\pm}(x) = \left[\int \mathcal{D}_Q^K(z)dz + f(x)\right.$$

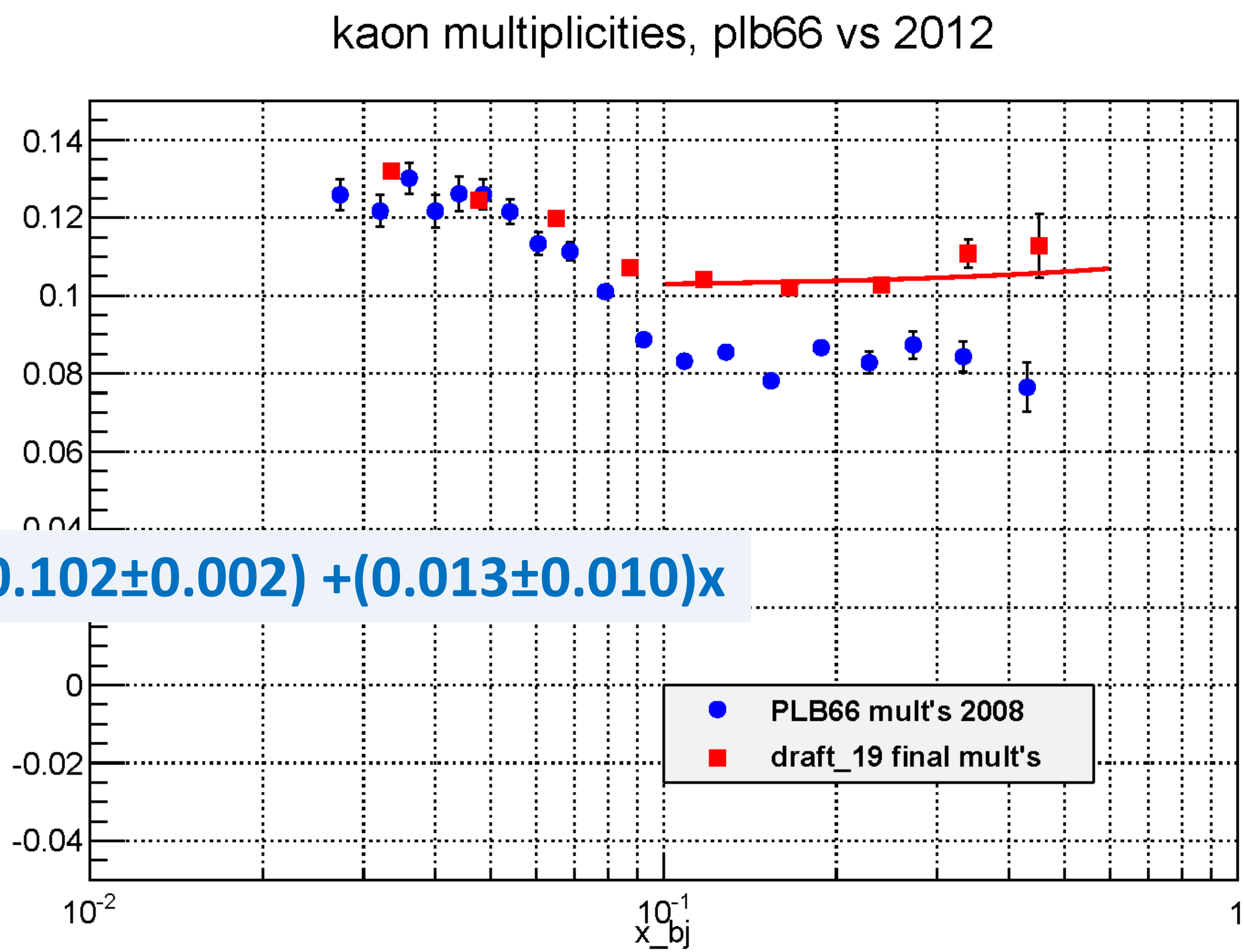
$$\frac{d5M^{K^\pm}(x)}{d(x)} = \frac{df(x)}{d(x)}\left[(1 - \frac{4}{5}f(x))\right.$$



dM(x)/dx < 0 if S(x)≠ 0

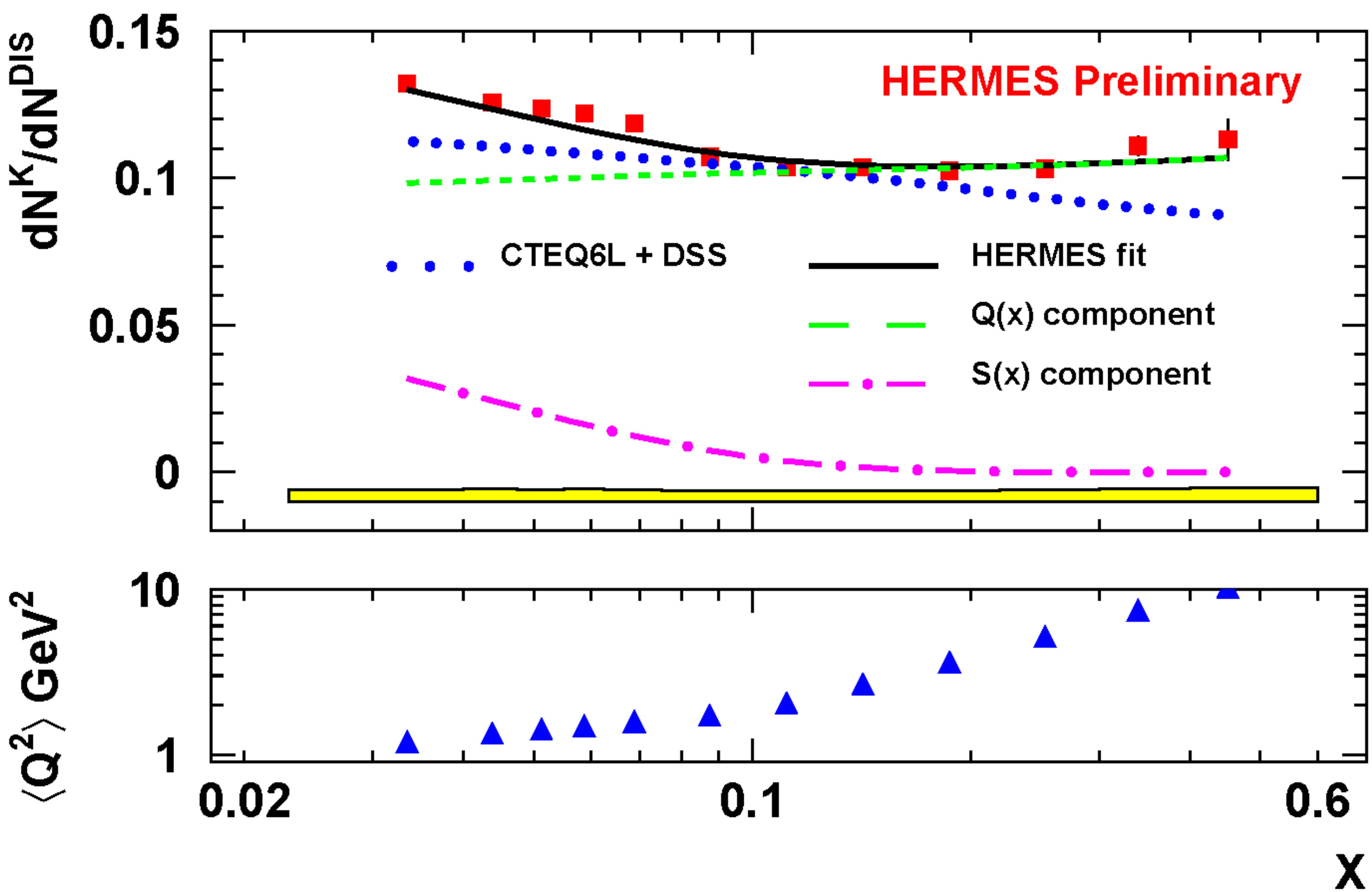
Signature for S(x)=0 → dM(x)/dx≥0

Fit of Q(x) component to M(x)=p[0]+p[1]*x_bj

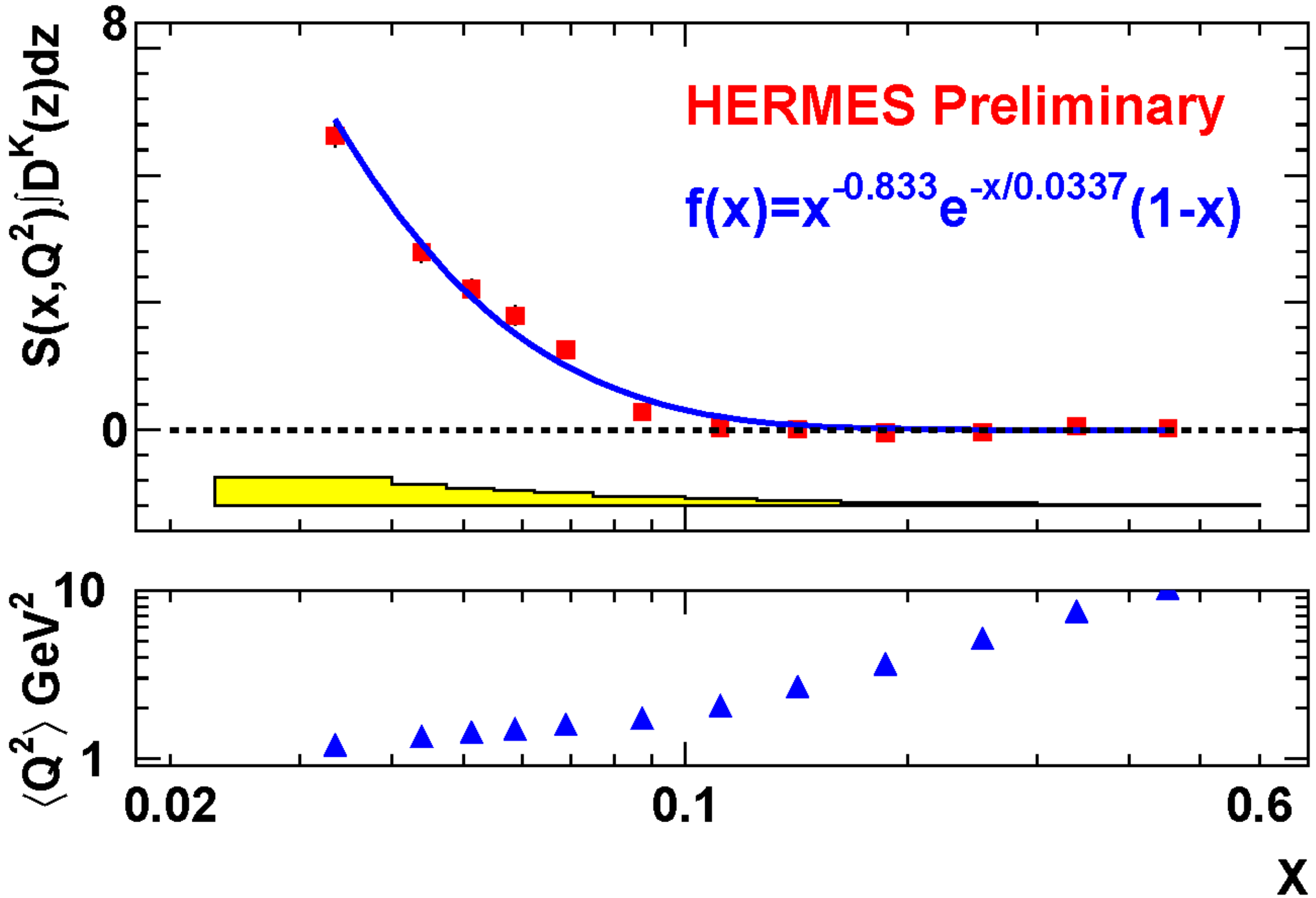


M(x)=(0.102±0.002) +(0.013±0.010)x

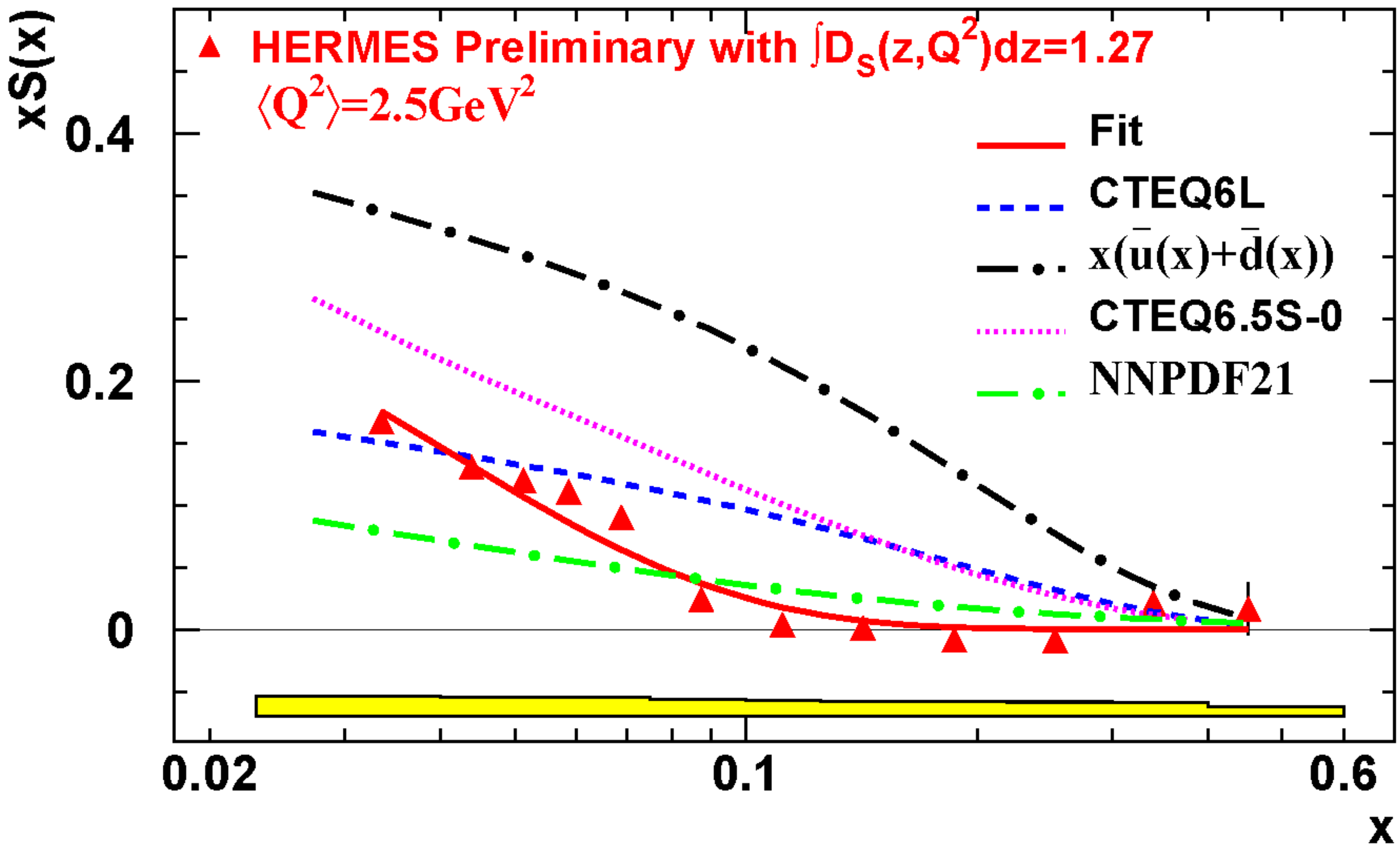
Revised fit to kaon charged multiplicity



Fit to Component arising from $S(x)\int D^K(z)dz = x^{-a}\, e^{-x/b}(1-x)$

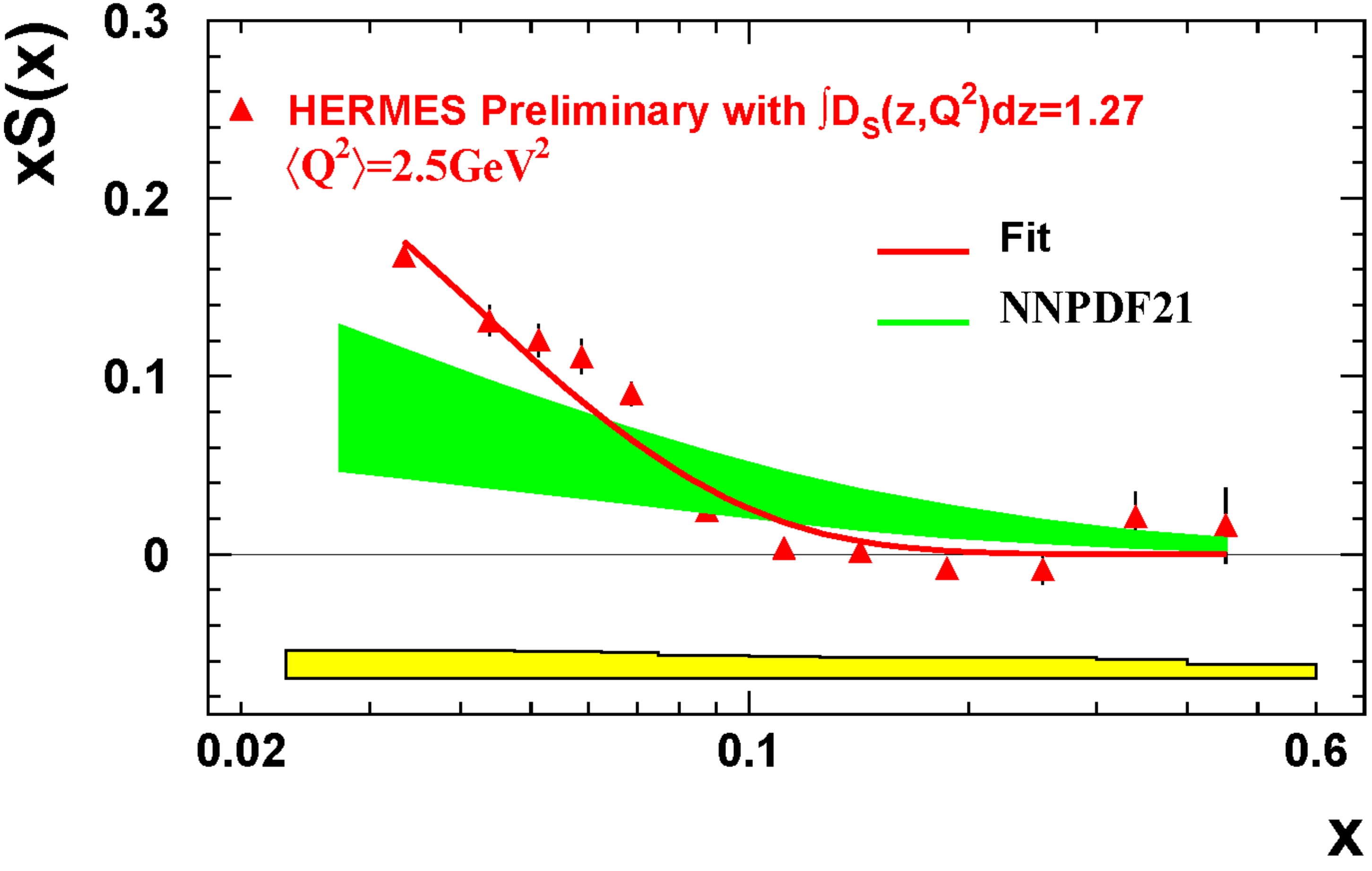


Strange parton distribution S(x) - revised



$$\text{Fit}(x) = x^{-0.867\pm0.019}e^{-0.331\pm0.014}(1-x)$$

Comparison with prediction of the NNPDF Collaboration



Summary

- $S(x) \approx 0$ with the measurement error for $x \geq 0.15$, as reported in PLB666, 446 (2008).
- $S(x)$ is similar in shape but ≈ 0.6 in magnitude of the data reported in 2008.
- In magnitude, but not detailed shape , $S(x)$ as extracted here is close to the recent predictions of the NNPDF collaboration **(NPB 855, 153 (2012).**
- **The shape of $S(x)$ suggests the possibility that the strange quark pdf may be a surrogate for a sea dominated by the gluon splitting component (see Chang & Peng, PLB 704, 197 (2011).**

Extra's

Comparison PLB666 with HERMES (2013)