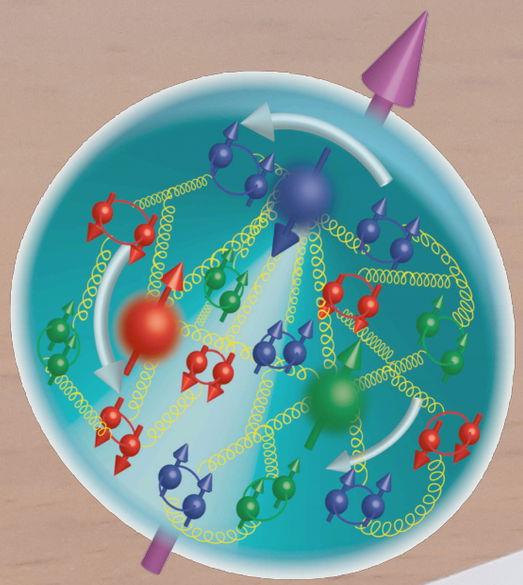

European Organization for Nuclear Research
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PHYSICS ON THE BACK OF AN ENVELOPE

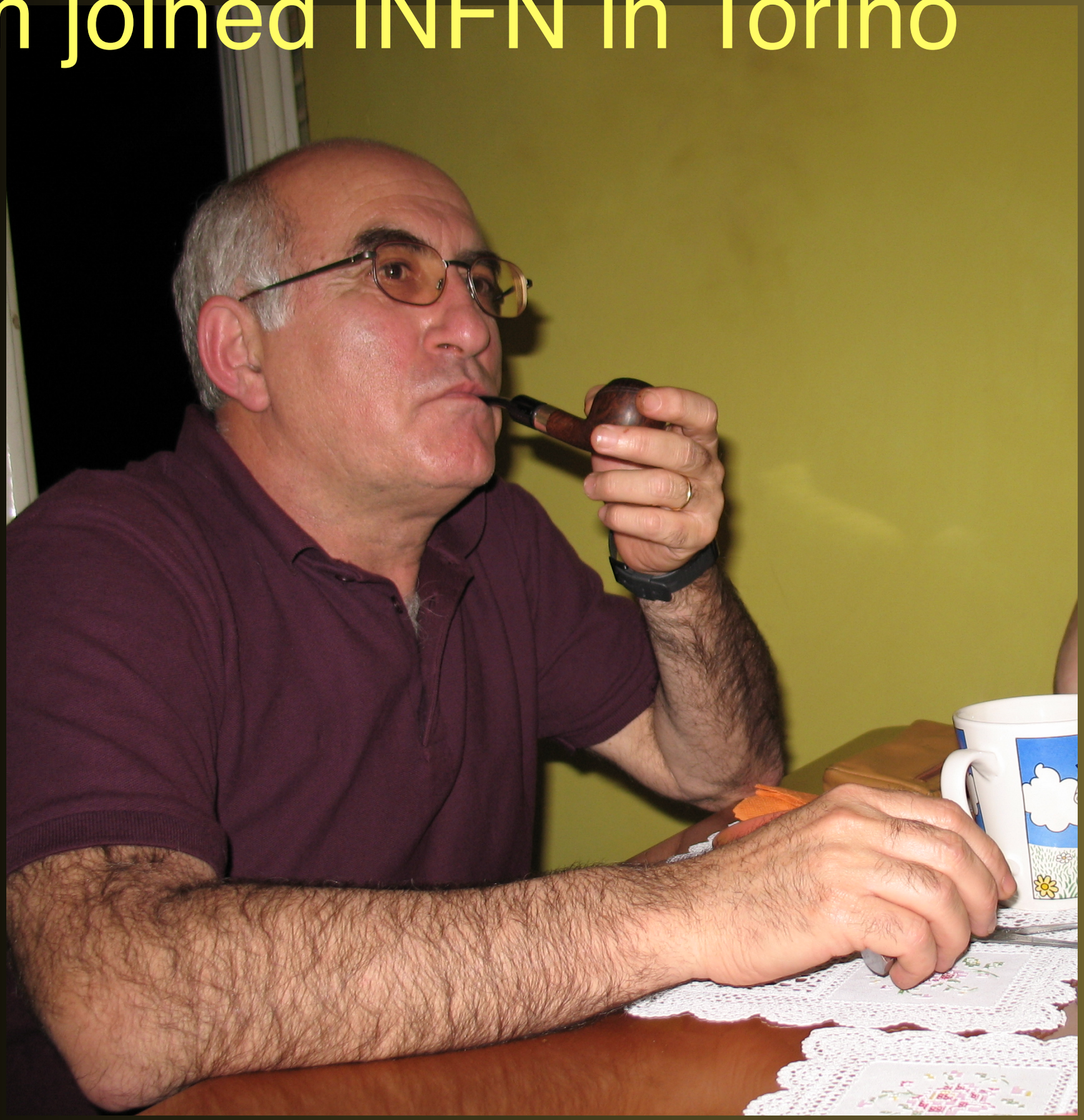
Alexei Prokudin

2003

Torino, Italy

Torino is famous for physics and mathematics

Aram joined INFN in Torino



Nuclear Physics B
Volume 441, Issues 1–2, 8 May 1995, Pages 234-256

New quark distributions and semi-inclusive electroproduction on polarized nucleons

Aram Kotzinian [1] ✉

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https://doi.org/10.1016/0550-3213(95)00098-D

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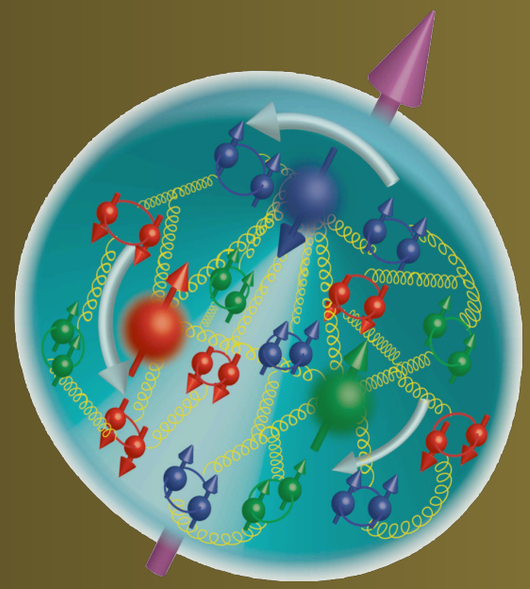
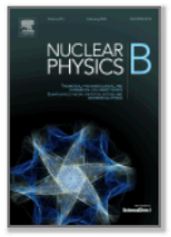


Abstract

The quark-parton model calculation including the effects of intrinsic transverse momentum and of all six twist-two distribution functions of quarks in polarized nucleons is performed. It is demonstrated that new twist-two quark distribution functions and polarized quark fragmentation functions can be investigated in semi-inclusive DIS at leading order in Q^2. The general expression for the cross-section of semi-inclusive DIS of polarized leptons on polarized nucleons in terms of structure functions is also discussed.

One of the founders of TMD theory for SIDIS

Nuclear Physics B
Volume 441, Issues 1–2, 8 May 1995, Pages 234-256



New quar
electropro

Aram Kotzinian [1] ✉

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https://doi.org/10.101

Abstract

The quark-parto
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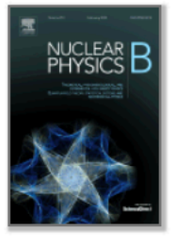
Nuclear Physics B
Volume 461, Issues 1–2, 19 February 1996, Pages 197-237



The complete tree-level result up to order 1/Q for polarized deep-inelastic leptoproduction

P.J Mulders [a, b], R.D Tangerman [a]

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https://doi.org/10.1016/0550-3213(95)00632-X Get rights and content

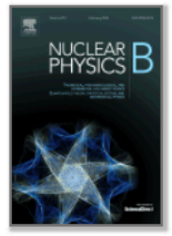
Abstract

We present the results of the tree-level calculation of deep-inelastic leptoproduction, including polarization of target hadron and produced hadron. We also discuss the dependence on transverse momenta of the quarks, which leads to azimuthal asymmetries for the produced hadrons.

ELSEVIER

Nuclear Physics B

Volume 441, Issues 1–2, 8 May 1995, Pages 234-256



New quar… electropro…

Aram Kotzinian [1] ✉

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https://doi.org/10.101…

Abstract

The quark-parto… momentum and… nucleons is perf… functions and p… inclusive DIS at … semi-inclusive I… functions is also…

ELSEVIER

Nuclear Physics B

The complet… polarized de…

P.J Mulders [a, b], R.D Tangerm…

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https://doi.org/10.1016/0550…

Abstract

We present the result… leptoproduction, incl… also discuss the depe… azimuthal asymmetri…

ELSEVIER

Physics Letters B

Volume 78, Issues 2–3, 25 September 1978, Pages 269-273

Azimuthal dependence in leptoproduction: A simple parton model calculation ☆

Robert N. Cahn [1]

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https://doi.org/10.1016/0370-2693(78)90020-5

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Abstract

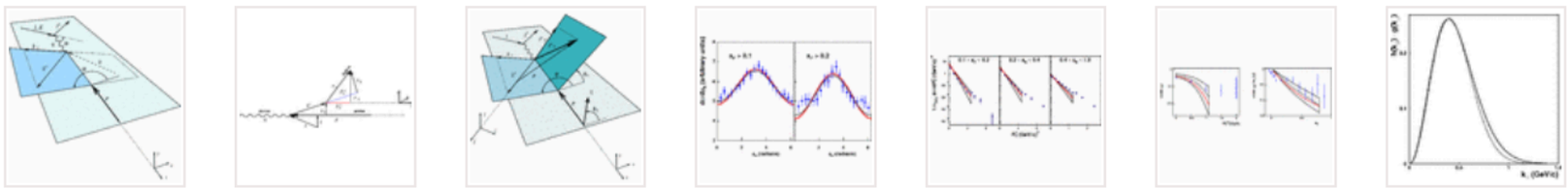
Semi-inclusive leptoproduction, $\ell + p \to \ell' + h + X$, is considered in the naive parton model. The scattered parton shows an azimuthal asymmetry about the momentum transfer direction. Simple derivations for the effects in ep, νp and $\bar{\nu} p$ scattering are given. Reduction of the asymmetry due to fragmentation of partons into hadrons is estimated. The results cast doubt on the utility of such azimuthal asymmetry as a clean test of quantum chromodynamics.

Role of Cahn and Sivers effects in deep inelastic scattering

M. Anselmino, M. Boglione, U. D'Alesio, A. Kotzinian, F. Murgia, and A. Prokudin
Phys. Rev. D **71**, 074006 – Published 12 April 2005

ABSTRACT

The role of intrinsic $\boldsymbol{k}_\perp$ in inclusive and semi-inclusive Deep Inelastic Scattering processes ($\ell p \to \ell h X$) is studied with exact kinematics within QCD parton model at leading order; the dependence of the unpolarized cross section on the azimuthal angle between the leptonic and the hadron production planes (Cahn effect) is compared with data and used to estimate the average values of $k_\perp$ both in quark distribution and fragmentation functions. The resulting picture is applied to the description of the weighted single spin asymmetry $A_{UT}^{\sin(\phi_\pi - \phi_S)}$ recently measured by the HERMES collaboration at DESY; this allows to extract some simple models for the quark Sivers functions. These are compared with the Sivers functions which succeed in describing the data on transverse single spin asymmetries in $p^\uparrow p \to \pi X$ processes; the two sets of functions are not inconsistent. The extracted Sivers functions give predictions for the COMPASS measurement of $A_{UT}^{\sin(\phi_\pi - \phi_S)}$ in agreement with recent preliminary data, while their contribution to HERMES $A_{UL}^{\sin\phi_\pi}$ is computed and found to be small. Predictions for $A_{UT}^{\sin(\phi_K - \phi_S)}$ for kaon production at HERMES are also given.



Our first paper, 257 citations

aram.kotzinian@cern.ch

$$\vec{\Sigma} = \begin{pmatrix} \vec{\sigma} & 0 \\ 0 & \vec{\sigma} \end{pmatrix}$$

$$\Sigma_x u_+ = \begin{pmatrix} \sigma_3 & 0 \\ 0 & \sigma_3 \end{pmatrix} \frac{1}{\sqrt{2}} \begin{pmatrix} \sqrt{2k} \\ 0 \\ \sqrt{2k} \\ 0 \end{pmatrix} = + u_+$$

$$\Sigma_x u_- = - u_-$$

Written on the back of an envelope

Torino is famous not only for physics

Torino is famous not only for physics

Discussions continued on the ski slopes

Sivers functions in not zero!

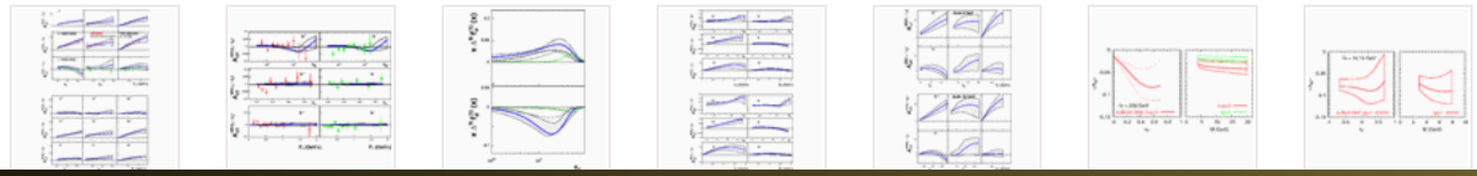
PHYSICAL REVIEW D
covering particles, fields, gravitation, and cosmology

Extracting the Sivers function from polarized semi-inclusive deep inelastic scattering data and making predictions

M. Anselmino, M. Boglione, U. D'Alesio, A. Kotzinian, F. Murgia, and A. Prokudin
Phys. Rev. D **72**, 094007 – Published 10 November 2005; Erratum Phys. Rev. D **72**, 099903 (2005)

ABSTRACT

The most recent data on the weighted transverse single spin asymmetry $A_{UT}^{\sin(\phi_h-\phi_S)}$ from HERMES and COMPASS Collaborations are analyzed within the LO parton model with unintegrated parton distribution and fragmentation functions; all transverse motions are taken into account, with exact kinematics, in the elementary interactions. The overall quality of the data is such that, for the first time, a rather well constrained extraction of the Sivers function for u and d quarks is possible and is performed. Comparisons with models are made. Based on the extracted Sivers functions, predictions for $A_{UT}^{\sin(\phi_h-\phi_S)}$ asymmetries at JLab are given; suggestions for further measurements at COMPASS, with a transversely polarized hydrogen target and selecting favorable kinematical ranges, are discussed. Predictions are also presented for single spin asymmetries in Drell-Yan processes at the Relativistic Heavy Ion Collider and the Facility for Antiproton and Ion Research at GSI-Darmstadt.



Our second paper, 218 citations

2005

Torino has new Ph.D. students!

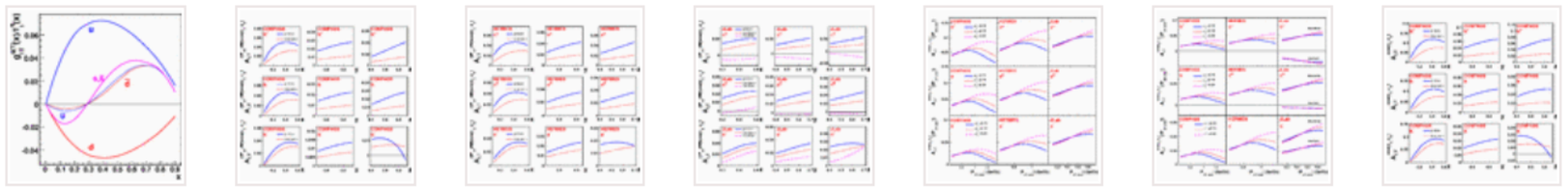
PHYSICAL REVIEW D
covering particles, fields, gravitation, and cosmology

Predictions for double spin asymmetry A_{LT} in semiinclusive DIS

A. Kotzinian, B. Parsamyan, and A. Prokudin
Phys. Rev. D **73**, 114017 – Published 16 June 2006

ABSTRACT

In the leading order of QCD parton model of semiinclusive deep inelastic scattering (SIDIS) the double spin asymmetry A_{LT} arises due to the longitudinal polarization of quarks in the transversely polarized nucleon. The corresponding k_T^2 weighted distribution function $g_{1T}^{(1)}$ can be related to ordinary helicity distribution $g_1(x)$ measured in DIS. Using recent parametrizations for (un)polarized distribution and fragmentation functions we calculated A_{LT} asymmetry on transversely polarized proton and deuteron targets for different types of hadron production. The predictions are given for COMPASS, HERMES, and JLab energies. The role of Lorentz invariance relations and positivity constraints are discussed.



Our third paper, 63 citations

SPIN 2006 What is memorable?

Experiments with food?

Meetings
with friends?

Meetings with friends?

Meetings with locals?

Choices, choices…

Imitating Buddha?

Touching Buddha?

Mastering local culture?

Kirin?

WARNING

Drinking distilled spirits, beer, coolers, wine and other alcoholic beverages may increase cancer risk, and, during pregnancy, can cause birth defects.

For more information go to www.P65warnings.ca.gov/alcohol

Sushi?

Well, it is physics discussions after all that is important!

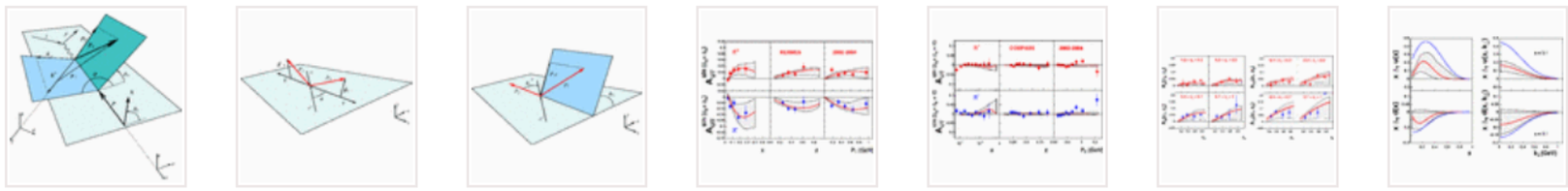
PHYSICAL REVIEW D
covering particles, fields, gravitation, and cosmology

Transversity and Collins functions from SIDIS and e^+e^- data

M. Anselmino, M. Boglione, U. D'Alesio, A. Kotzinian, F. Murgia, A. Prokudin, and C. Türk
Phys. Rev. D **75**, 054032 – Published 30 March 2007

ABSTRACT

A global analysis of the experimental data on azimuthal asymmetries in semi-inclusive deep inelastic scattering (SIDIS), from the HERMES and COMPASS Collaborations, and in $e^+e^- \to h_1 h_2 X$ processes, from the Belle Collaboration, is performed. It results in the extraction of the Collins fragmentation function and, *for the first time*, of the transversity distribution function for u and d quarks. These turn out to have opposite signs and to be sizably smaller than their positivity bounds. Predictions for the azimuthal asymmetry $A_{UT}^{\sin(\phi_S+\phi_h)}$, as will soon be measured at JLab and COMPASS operating on a transversely polarized proton target, are then presented.



Our fourth paper, 359 citations

Semi-inclusive deep-inelastic scattering in Wandzura-Wilczek-type approximation

S. Bastami, H. Avakian, A. V. Efremov, A. Kotzinian, B. U. Musch, B. Parsamyan, A. Prokudin ✉, M. Schlegel, G. Schnell, P. Schweitzer & K. Tezgin

Journal of High Energy Physics **2019**, Article number: 7 (2019) | Cite this article

88 Accesses | **4** Citations | **1** Altmetric | Metrics

Abstract

We present the complete cross-section for the production of unpolarized hadrons in semi-inclusive deep-inelastic scattering up to power-suppressed $\mathcal{O}\left(1/Q^2\right)$ terms in the Wandzura-Wilczek-type approximation, which consists in systematically assuming that $\bar{q}gq$-terms are much smaller than $\bar{q}q$-correlators. We compute all twist-2 and twist-3 structure functions and the corresponding asymmetries, and discuss the applicability of the Wandzura-Wilczek-type approximations on the basis of available data. We make predictions that can be tested by data from COMPASS, HERMES, Jefferson Lab, and the future Electron-Ion Collider. The results of this paper can be readily used for phenomenology and for event generators, and will help to improve the description of semi-inclusive deep-inelastic processes in terms of transverse momentum dependent parton distribution functions and fragmentation functions beyond the leading twist.

Our last year's paper, 17 citations

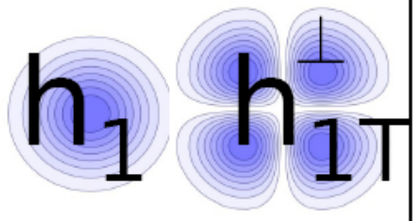
KOTZINIAN–MULDERS ASYMMETRY

N \ q	U	L	T
U	f_1		$h_1^\perp$
L		g_1	$h_{1L}^\perp$
T	$f_{1T}^\perp$	g_{1T}	h_1 $h_{1T}^\perp$

Kotzinian-Mulders function

Kotzinian (1995), Mulders, Tangerman (1995), Boer, Mulders (1998)

KOTZINIAN–MULDERS ASYMMETRY

N \ q	U	L	T
U			
L			
T			

Sometimes called “worm-gear” functions.

All two discussed by Aram and Piet

Kotzinian (1995), Mulders, Tangerman (1995), Boer, Mulders (1998)

Longitudinal quark polarization in transversely polarized nucleons

A. M. Kotzinian and P. J. Mulders
Phys. Rev. D **54**, 1229 – Published 1 July 1996

Article | References | Citing Articles (29) | PDF | Export Citation

ABSTRACT

Accounting for transverse momenta of the quarks, a longitudinal quark spin asymmetry exists in a transversely polarized nucleon target. The relevant leading quark distribution $g_{1T}(x,\ k_T^2)$ can be measured in semi-inclusive deep-inelastic scattering. The average k_T^2 weighted distribution function $g_{1T}^{(1)}$ can be obtained directly from the inclusive measurement of g_2.

Received 27 November 1995

DOI: https://doi.org/10.1103/PhysRevD.54.1229

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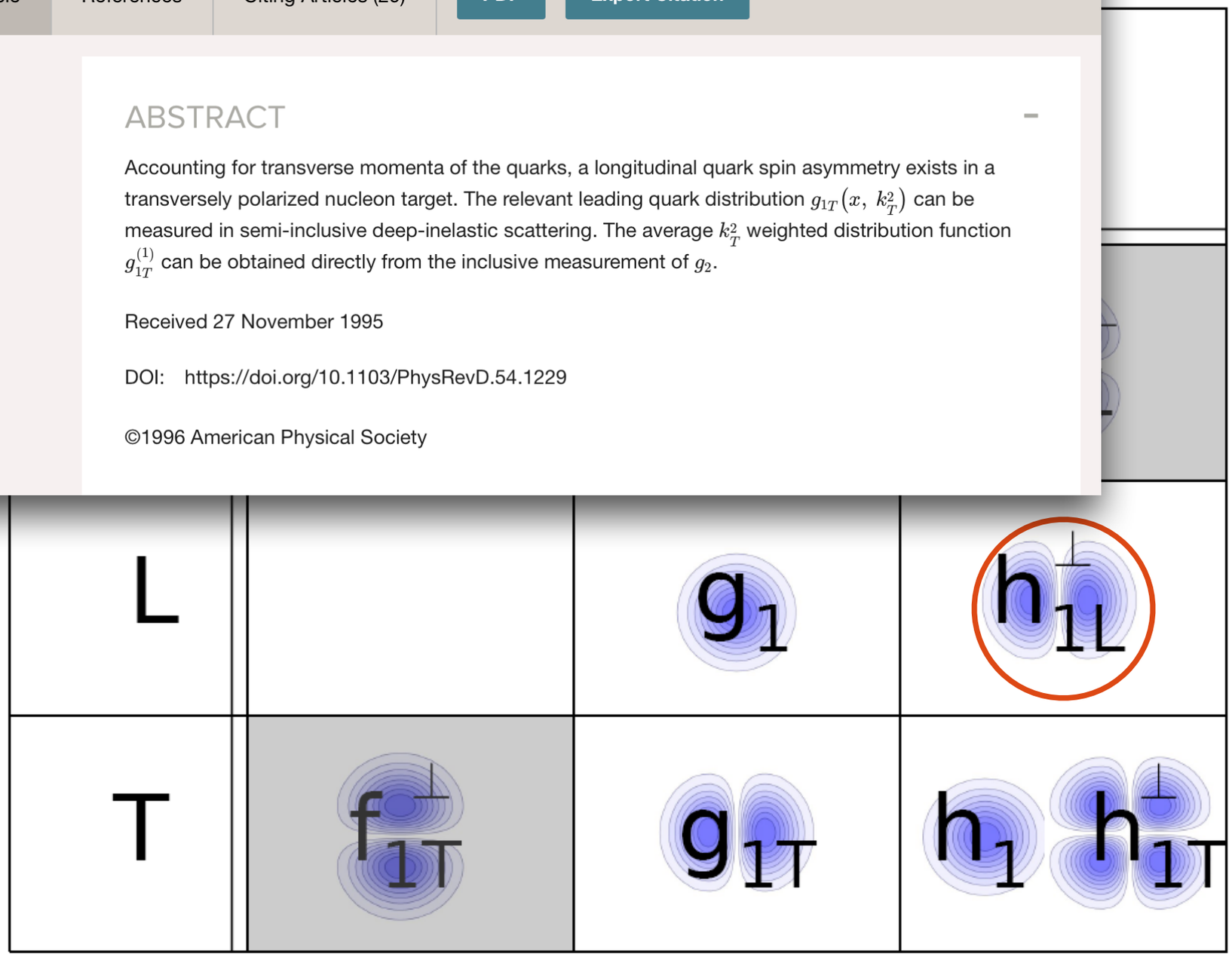

Kotzinian-Mulders function

Kotzinian (1995), Mulders, Tangerman (1995), Boer, Mulders (1998)

Longitudinal quark polarization in transversely polarized nucleons

A. M. Kotzinian and P. J. Mulders
Phys. Rev. D **54**, 1229 – Published 1 July 1996

Article | References | Citing Articles (29) | PDF | Export Citation

ABSTRACT

Accounting for transverse
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$g_{1T}^{(1)}$ can be obtained direct

Received 27 November 19

DOI: https://doi.org/10.11

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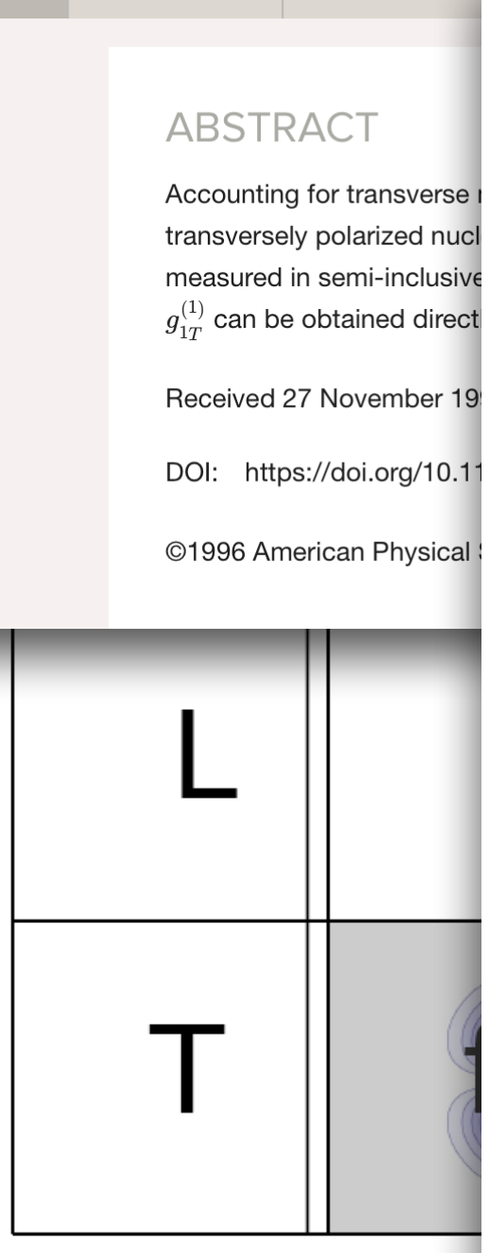

Kotzinian (1995), Mul

ELSEVIER

Physics Letters B
Volume 406, Issue 4, 14 August 1997, Pages 373-380

Probing transverse quark polarization via azimuthal asymmetries in leptoproduction

A.M. Kotzinian [a, 1] ✉, P.J. Mulders [b] ✉

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https://doi.org/10.1016/S0370-2693(97)00708-9

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Abstract

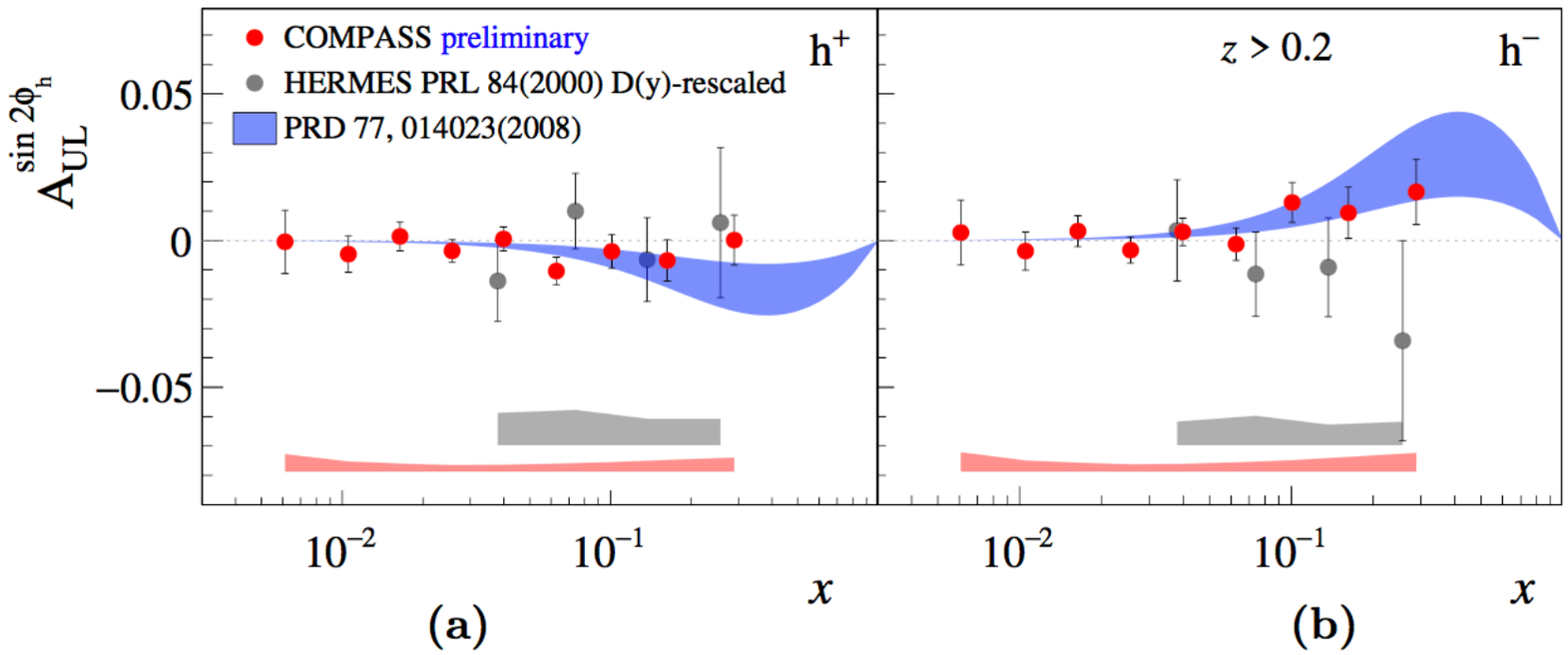
We consider the leading order result for polarized leptoproduction, putting emphasis on transverse momentum dependent effects appearing in azimuthal asymmetries.

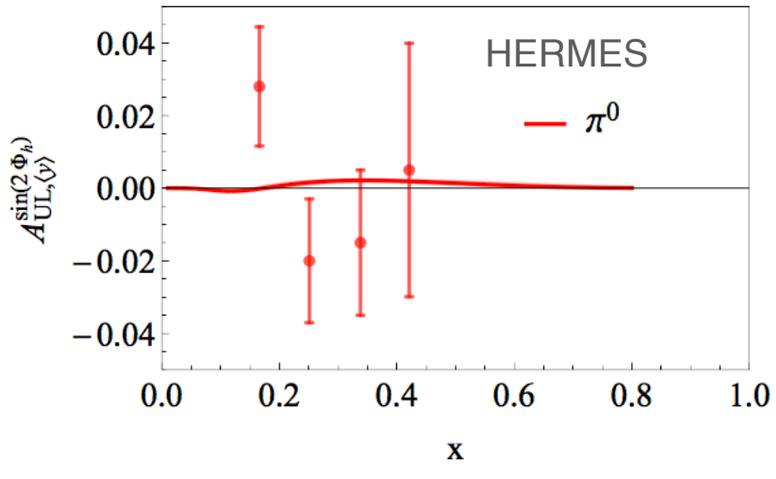
Measurements of weighted cross sections enable extraction of the distribution of transversely polarized quarks. We focus on the distribution in a longitudinally polarized hadron and estimate the expected asymmetries in leptoproduction.

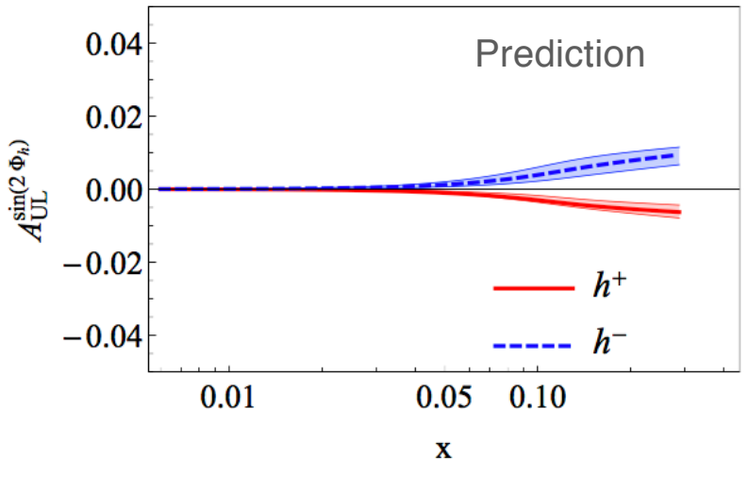
ders

KOTZINIAN-MULDERS ASYMMETRY

$$A_{UL}^{\sin 2\phi_h} \sim h_{1L}^{\perp} \otimes H_1^{\perp}$$







KOTZINIAN-MULDERS ASYMMETRY

$h_{1L}^{\perp}(x, k_T)$

$g_{1T}^{\perp}(x, k_T)$

Should be named Kotzinian-Mulders functions?

Happy Birthday!

Ծնունդդ շնորհավոր!

Many years of good health!