Summary of WG6: Spin Physics

Theory

DIS 2011
Newport News, VA

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WG6: Spin Physics

- TOTAL – 60 talks
- Theory - 26 talks
- Experiment - 34 talks
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- Oleg Eyser (UCRiverside)
- Ami Rostomyan (DESY)
- Alexei Prokudin (JLab)
Open Issues

1. Longitudinal Spin Structure
   - What is $\Delta g$ at low $x$?

Andreas Metz

\[ \frac{1}{2} = \frac{1}{2} (\Delta q + \Delta \bar{q}) + \Delta G + L_z \]

\sim 30\% \quad \sim 0\% (?) \quad \sim 70\% (?)

Jaffe, Manohar (1990)

Presence of OAM suggests Transverse Momentum Dependent Distributions (TMDs)

2. Transverse Spin Structure
   - Can the sign change of the Sivers effect be confirmed in Drell-Yan (or in $W$-production)?

\[ f_{1T}^{\perp} \big|_{DY} = - f_{1T}^{\perp} \big|_{DIS} \]

Collins (2002)

Generalized Parton Distributions (GPDs)

3. GPDs and Spin Sum Rule of the Nucleon
   - Is there an 'optimal' version of the spin sum rule?

\[ \frac{1}{2} = \sum_q J^q + J^g \]

Ji (1996)

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Helicity structure
Marco Stratmann

- Low x behavior unconstrained
- Significant polarization still possible
- DSSV global fit De Florian, Sassot, Stratmann, Vogelsang

Opportunities of spin studies at Electron Ion Collider

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Reliable Fragmentation Functions are needed for $\Delta s(x)$.

Ellis-Jaffe sum rule can be improved with “R-evolution” up to low values of $Q$. 
Swadhin Taneja

Impact of the newest RHIC data on $\Delta g(x)$

Bjoern Pirnay

- Higher (>3) twist parton distributions and evolution
- $g_2(x)$ is described fairly well using LCWF

$$|p\rangle = |uud\rangle + |uudg\uparrow\rangle + |uudg\downarrow\rangle$$
Transverse structure
Stefano Melis

- Sivers function (T-odd, transverse momentum dependent) extraction from newest data HERMES, COMPASS
- Opportunities of TMD studies at EIC

Elena Boglione

- Influence of physical cuts on parton momenta \( \mathbf{k}_T/Q \ll 1 \) on variables at low Q
Stefano Melis

- Sivers function (T-odd, transverse momentum dependent) extraction from newest data HERMES, COMPASS
- Opportunities of TMD studies at EIC

Elena Boglione

- Influence of physical cuts on parton momenta $k_{\perp}/Q << 1$ on variables at low $Q$
• Linearly polarized gluons can be accessed in various channels
• Opportunities of studies at EIC, LHeC

Kazuhiro Tanaka
Shinsuke Yoshida

• Tri-gluon correlations, Qiu-Sterman matrix elements
• SSA in open charm production,
• SIDIS and PP

Wilco den Dunnen

• Background study for transversity study at RHIC
• Transverse Momentum Dependent distribution factorization and evolution

NLO of Collins-Soper-Sterman factorization is implemented

\[
W_{\mu\nu} = \frac{8\pi^2 s}{Q^2} \sum_f H_{f}^{\mu\nu}(\hat{k}_A, \hat{k}_B) \int d^2 b_T e^{i q_{hT} \cdot b_T} e^{-S(b_T; Q; \mu_Q, \mu_0)} \times \\
\times \tilde{f}_{f/H_A}(x_A, b_T; m^2, \mu_0) \tilde{f}_{\bar{f}/H_B}(x_B, b_T; m^2, \mu_0) \\
+ \text{polarized terms + large } q_{hT} \text{ correction, } Y + \text{p.s.c.}
\]

\[
e^{-S(b_T; Q; \mu_Q, \mu_0)} = \exp \left\{ \ln \frac{Q^2}{m^2} \tilde{K}(b_T; \mu_0) \right\} \times \\
\times \exp \left\{ \int_{\mu_0}^{\mu_Q} \frac{d\mu'}{\mu'} \left[ 2\gamma(g(\mu')); 1 \right] \ln \frac{Q^2}{(\mu')} \gamma_K(g(\mu')) \right\}
\]
First implementation of NLO evolution of Transverse Momentum Dependent distributions

Collins (2011)
Aybat, Rogers (2011)
Breakthrough of TMD phenomenology and theory in 2011

Collins (2011)
Aybat, Rogers (2011)
Igor Cherednikov

- Evolution of TMDs
- Both UV and rapidity dependence

Aram Kotzinian

- Fracture functions
- SIDIS in target fragmentation region

\[
\theta \frac{\partial}{\partial \theta} F_{[A_n]} (x, b_\perp; \mu, \theta) = [K_n(\mu, b_\perp) + G_n(\mu, \theta)] F_{[A_n]} (x, b_\perp; \mu, \theta)
\]

\[
\mu \frac{d}{d\mu} K_n = -\mu \frac{d}{d\mu} G_n = \gamma_{\text{cusp}}
\]

\[
K_n(\mu, b_\perp) + G_n(\mu, \theta) = -\frac{\alpha_s C_F}{\pi} \ln \theta^2 b_\perp^2 C_n
\]
Aurore Courtoy

- Transversity from dihadron interference fragmentation
- BELLE + HERMES

Jian Zhou

- Dihadron fragmentation functions for large mass
- Matching with collinear approach with single hadron FF
Zhongbo Kang

- Transition from low to high PT
- "sign mismatch" and possible solutions

Leonard Gamberg

- Bessel-weighted asymmetries in SIDIS
- Possibility to study directly Fourier transformed TMDs experimentally

\[ gT_{q,F}(x, x) = - \int d^2 k_\perp \frac{|k_\perp|^2}{M} f_{1T}^{q}(x, k_\perp^2) \mid_{\text{SIDIS}} \]
Generalized Parton Distributions and models
Dieter Mueller

- Road map of Light Cone Waive Function modelling for GPDs and TMDs
- Effective LCWF valid at $Q^2 = 4 \text{ GeV}^2$

Barbara Pasquini

- Wigner function modelling
- Nucleon tomography

$\mathcal{L} = \bar{\psi} (i \frac{\partial}{\partial x} - m) \psi - \frac{1}{2} \phi \left( \frac{\partial^2}{\partial x^2} + \lambda^2 \right) \phi + g \bar{\psi} \psi \phi$
Simonetta Liuti

- Wigner function, GPDs, TMDs and OAM

Gary Goldstein

- Chiral odd GPDs, possibilities at JLab

Petr Zavada

- Relation among TMDs in models
- 3D covariant model

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Peter Schweitzer

- Intrinsic $p_T$ from QCD vacuum

$$\langle p_T^2 \rangle_{\text{sea}} \sim 3 \langle p_T^2 \rangle_{\text{val}}$$

Christian Weiss

- Transverse charge densities from form factors