Jefferson Lab

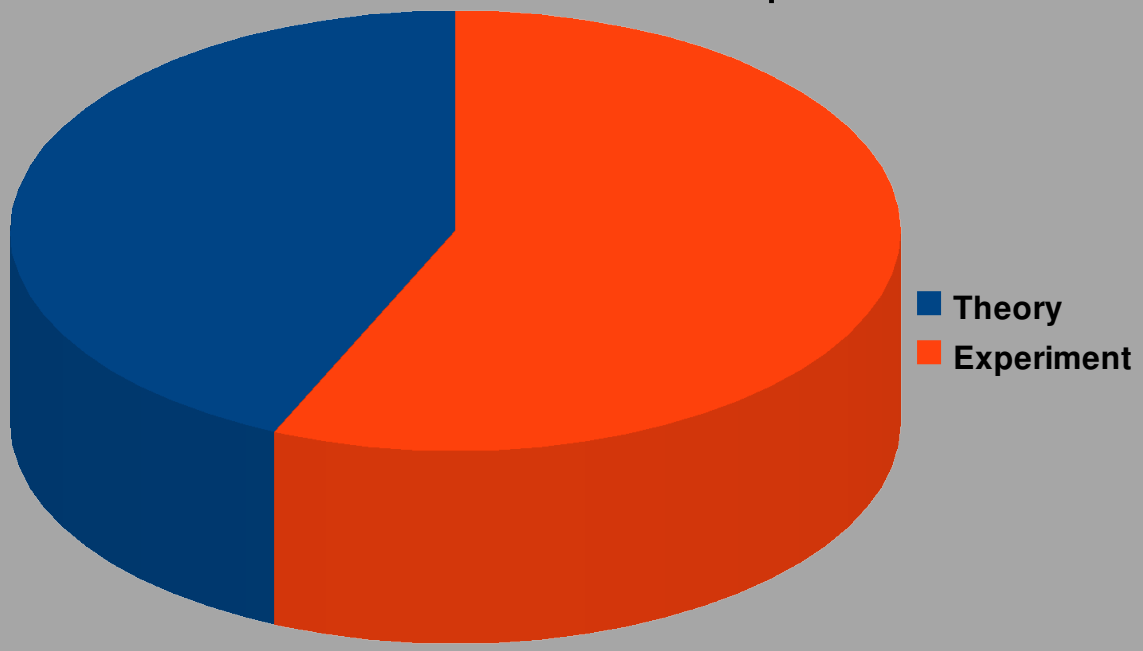
DIS 2011
Newport News, VA

Summary of WG6: Spin Physics Theory

Alexei Prokudin
Jefferson Laboratory

WG6:Spin Physics

- TOTAL – 60 talks
- Theory - 26 talks
- Experiment - 34 talks



WG6:Spin Physics

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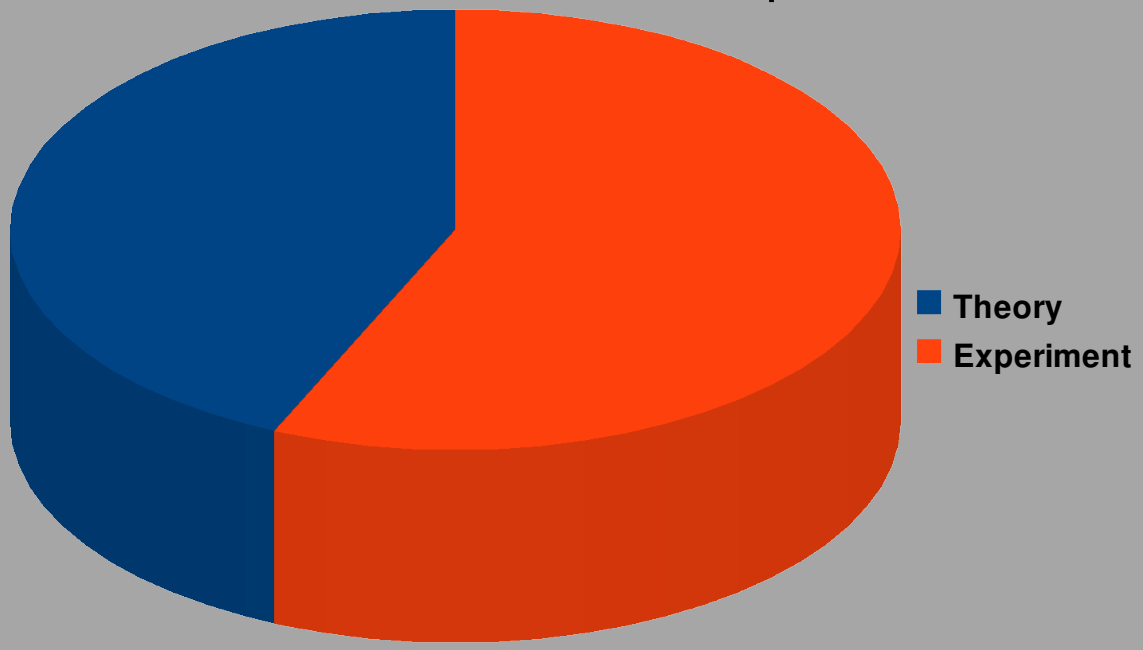


- Oleg Eyser (UCRiverside)
- Ami Rostomyan (DESY)
- Alexei Prokudin (JLab)

Open Issues

Andreas Metz

1. Longitudinal Spin Structure
   - What is Δg at low x ?

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

~30% ~0%(?) ~70(?)

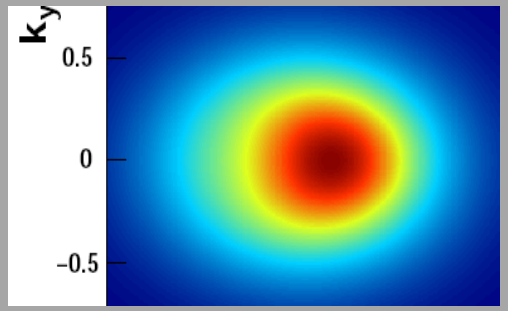
Jaffe, Manohar (1990)

Presense 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)

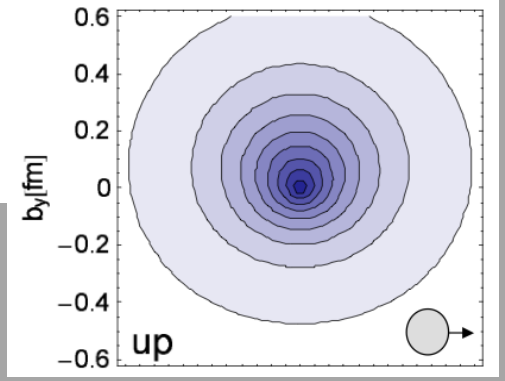


Generalized Parton Distributions (GPDs)

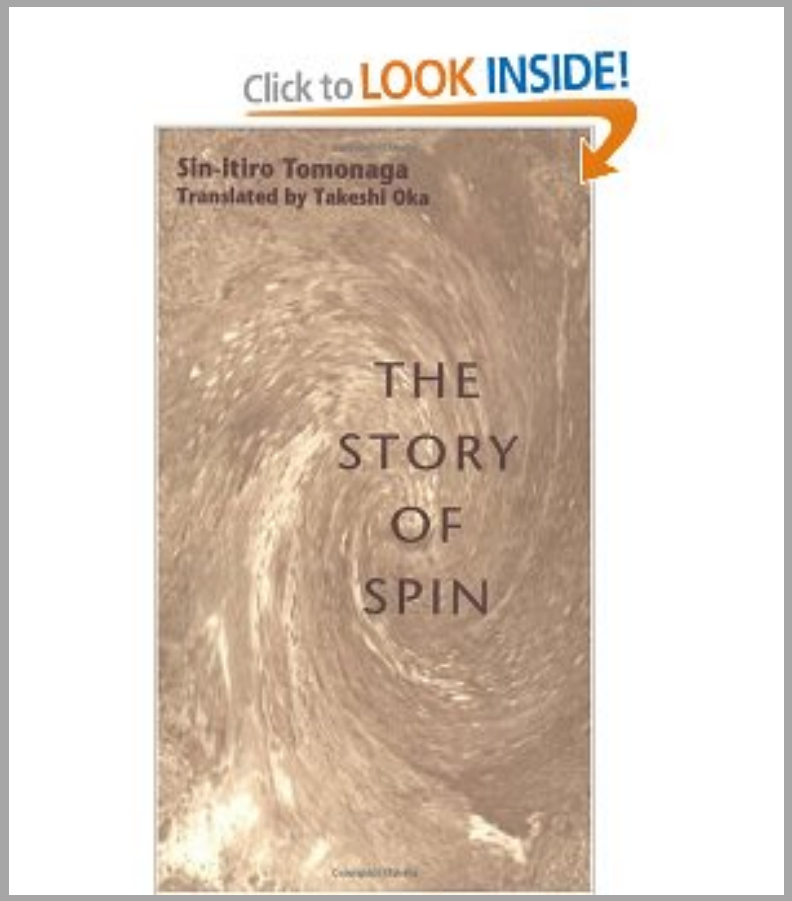
3. GPDs and Spin Sum Rule of the Nucleon
   - Is there an 'optimal' version of the spin sum rule ?

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

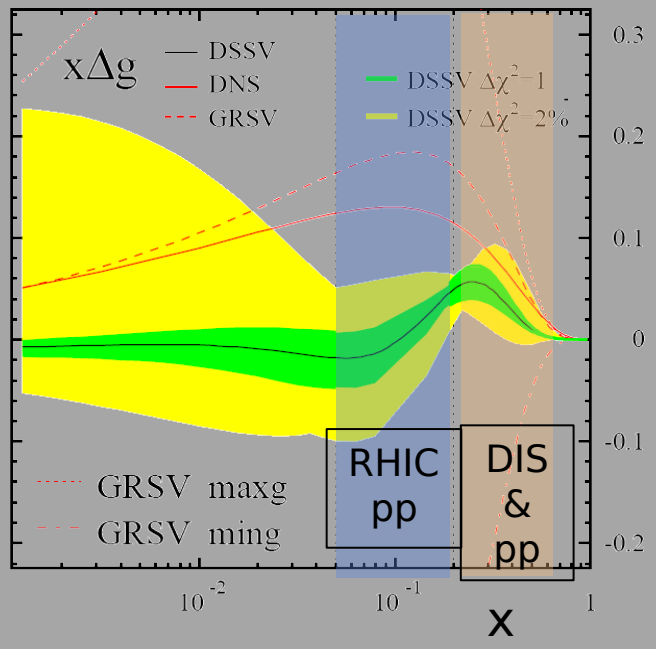
Ji (1996)



Helicity structure

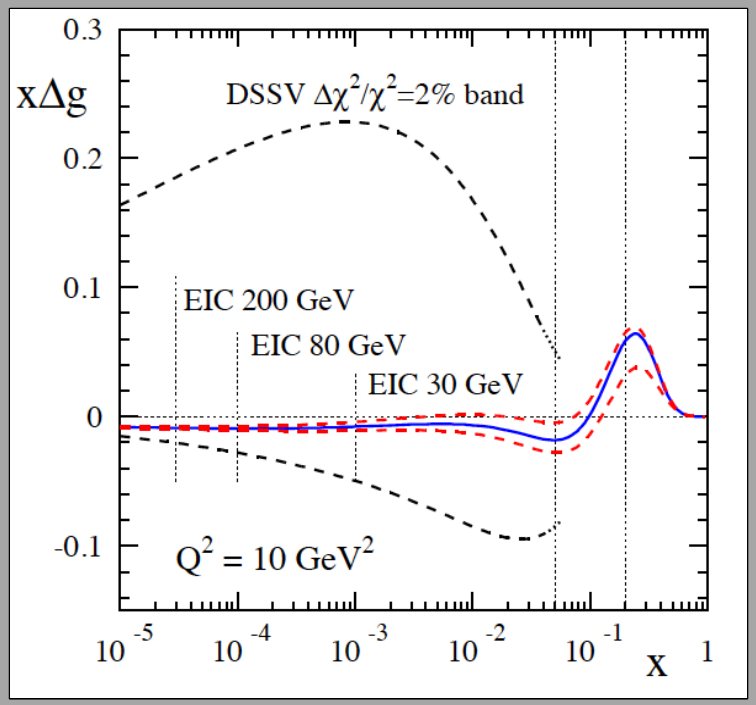


Marco Stratmann

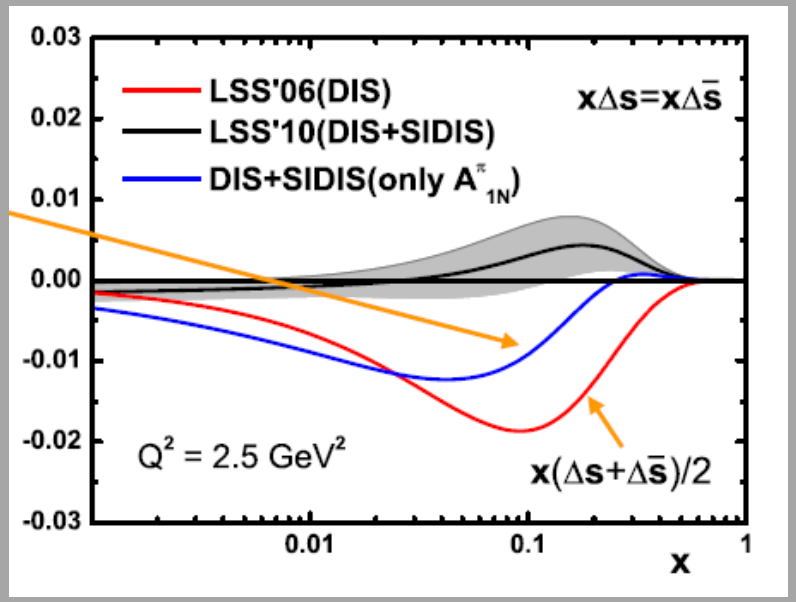


- Low x behavior unconstrained
significant polarization still possible
- DSSV global fit De Florian, Sassot, Stratmann, Vogelsang

Opportunities of spin studies at Electron Ion Collider

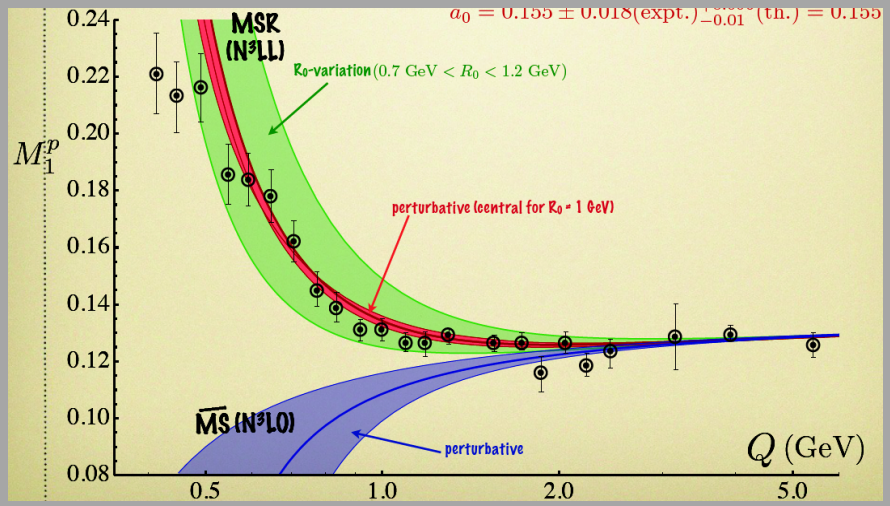


Dimiter Stamenov



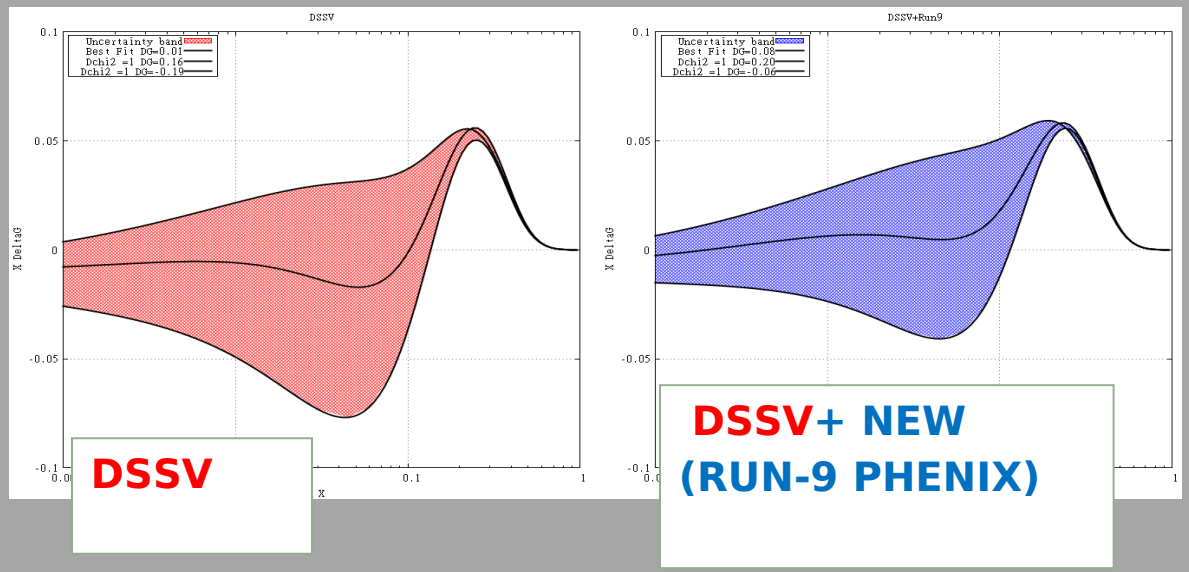
- Reliable Fragmentation Functions are needed for $\Delta s(x)$

Ambar Jain



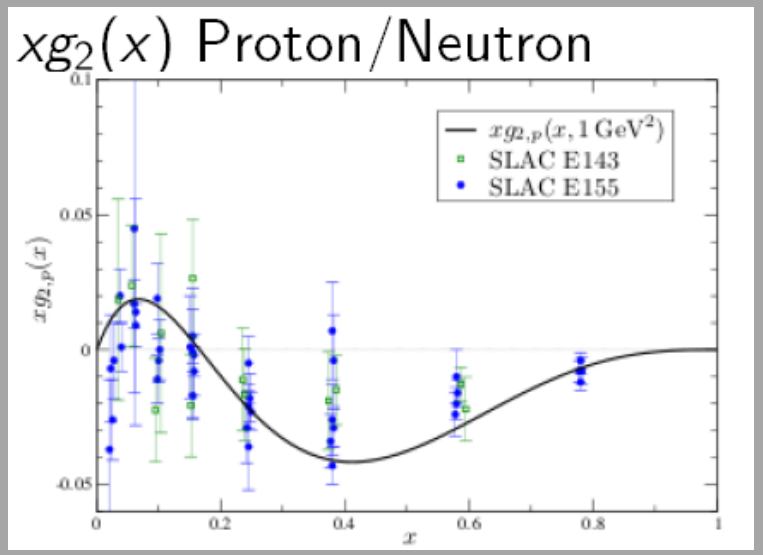
- Ellis-Jaffe sum rule can be improved with “R-evolution” up to low values of Q

Swadhin Taneja



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

Bjoern Pirnay

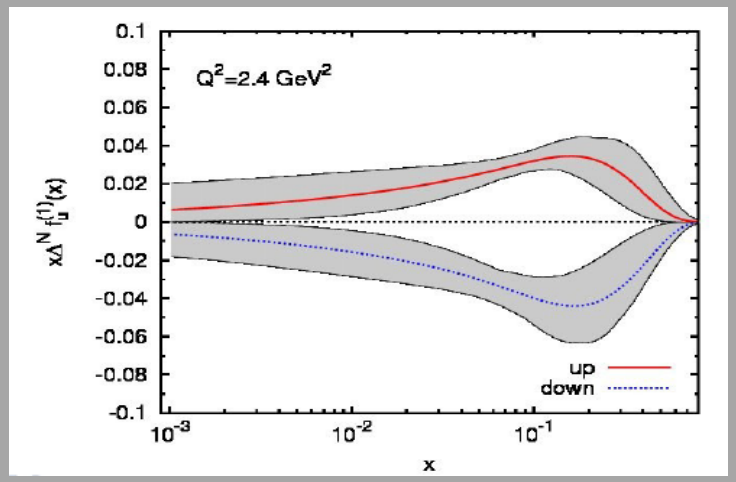


- Higher (>3) twist parton distributions and evolution
- g2(x) is described fairly well using LCWF

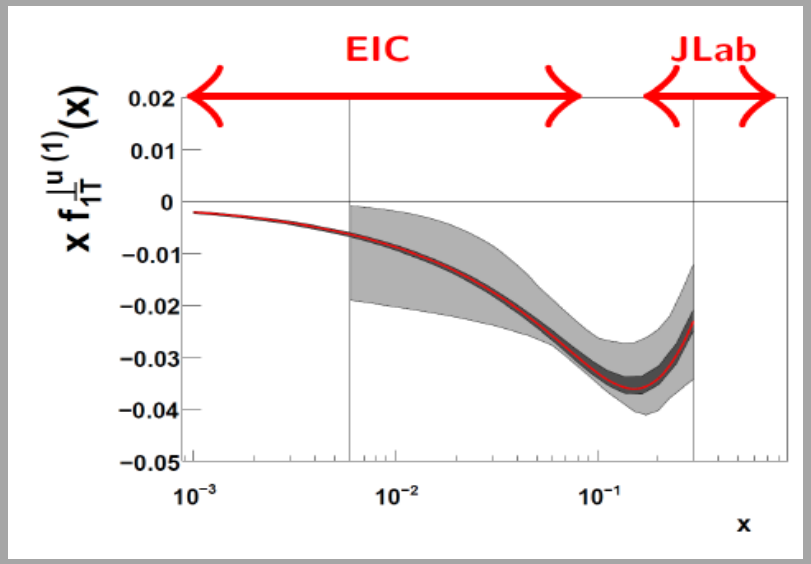
$$|p\rangle = |uud\rangle + |uudg\uparrow\rangle + |uudg\downarrow\rangle$$

Transverse structure

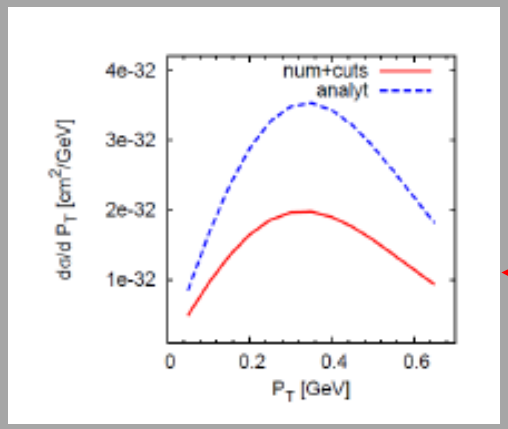
Stefano Melis



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

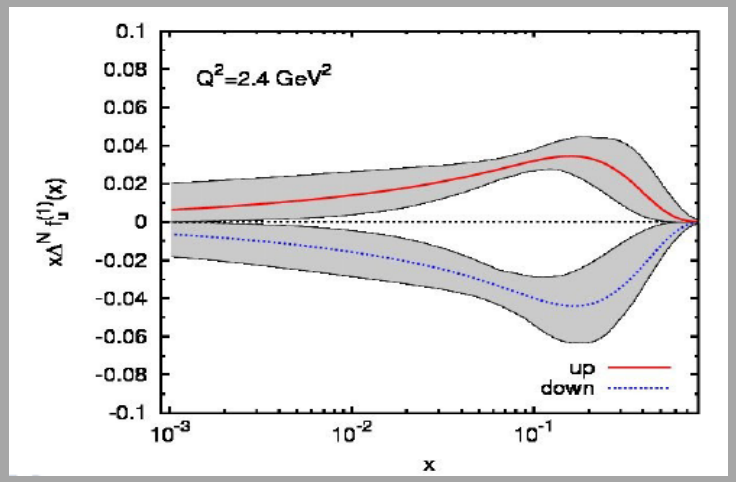


Elena Boglione



- Influence of physical cuts on parton momenta $k_\perp/Q << 1$ on variables at low Q

Stefano Melis



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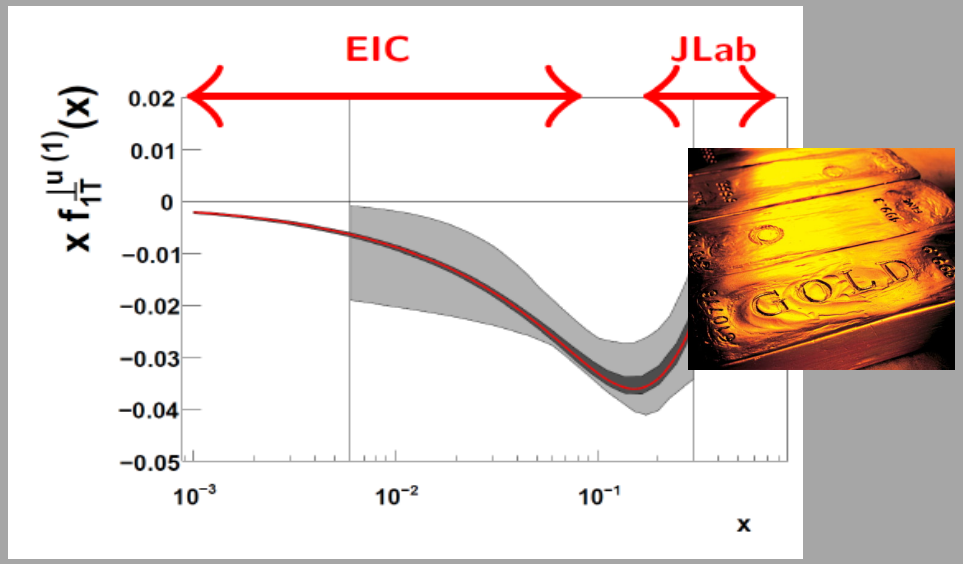

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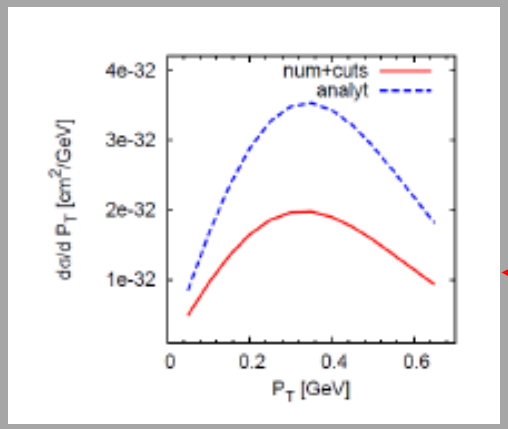

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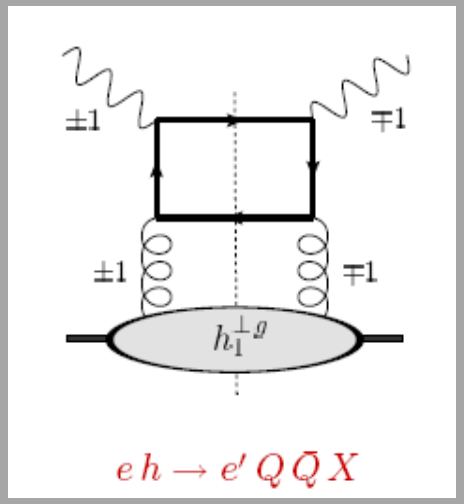
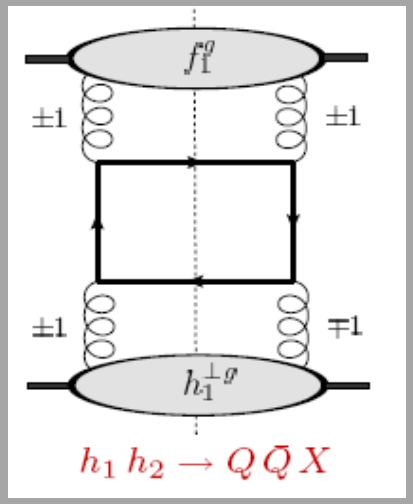
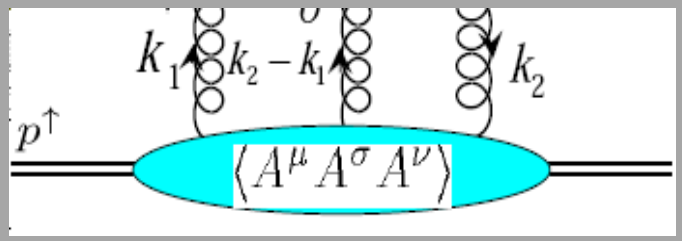




Cristian Pisano

- 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

Ted Rogers

- Related: Factorization Theorems:
  - Semi-Inclusive deep inelastic scattering. ✓
  - Drell-Yan. ✓
  - e^+/e^- annihilation. ✓
  - ~~$p + p \longrightarrow h_1 + h_2 + X$~~ !!

- Transverse Momentum Dependent distribution factorization and evolution

NLO of Collins-Soper-Sterman factorization is implemented

$$W^{\mu\nu} = \frac{8\pi^2 s}{Q^2} \sum_f H_f^{\mu\nu}(\hat{k}_A, \hat{k}_B) \int \mathrm{d}^2 \boldsymbol{b}_\mathrm{T}\, e^{i \boldsymbol{q}_{h\mathrm{T}} \cdot \boldsymbol{b}_\mathrm{T}} e^{-S(b_\mathrm{T}; Q; \mu_Q, \mu_0)} \times$$

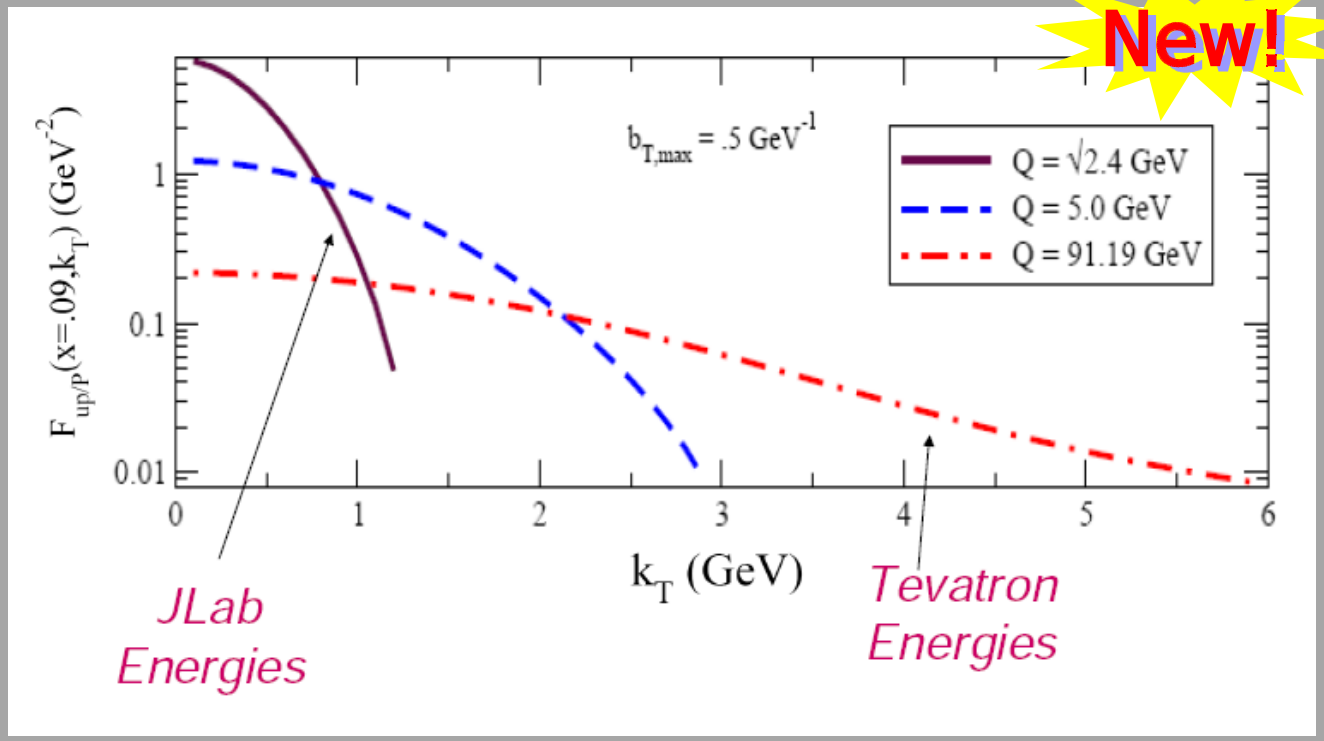
$$\times\, \tilde{f}_{f/H_A}(x_A, \boldsymbol{b}_\mathrm{T}; m^2, \mu_0)\, \tilde{f}_{\bar{f}/H_B}(x_B, \boldsymbol{b}_\mathrm{T}; m^2, \mu_0)$$

$$+ \text{ polarized terms} + \text{large } q_{h\mathrm{T}} \text{ correction, } Y + \text{p.s.c.}$$

$$e^{-S(b_\mathrm{T}; Q; \mu_Q, \mu_0)} = \exp\left\{ \ln \frac{Q^2}{m^2} \tilde{K}(b_\mathrm{T}; \mu_0) \right\} \times$$

$$\times \exp\left\{ \int_{\mu_0}^{\mu_Q} \frac{\mathrm{d}\mu'}{\mu'} \left[2\gamma(g(\mu'); 1) - \ln \frac{Q^2}{(\mu')^2} \gamma_K(g(\mu')) \right] \right\}$$

Ted Rogers

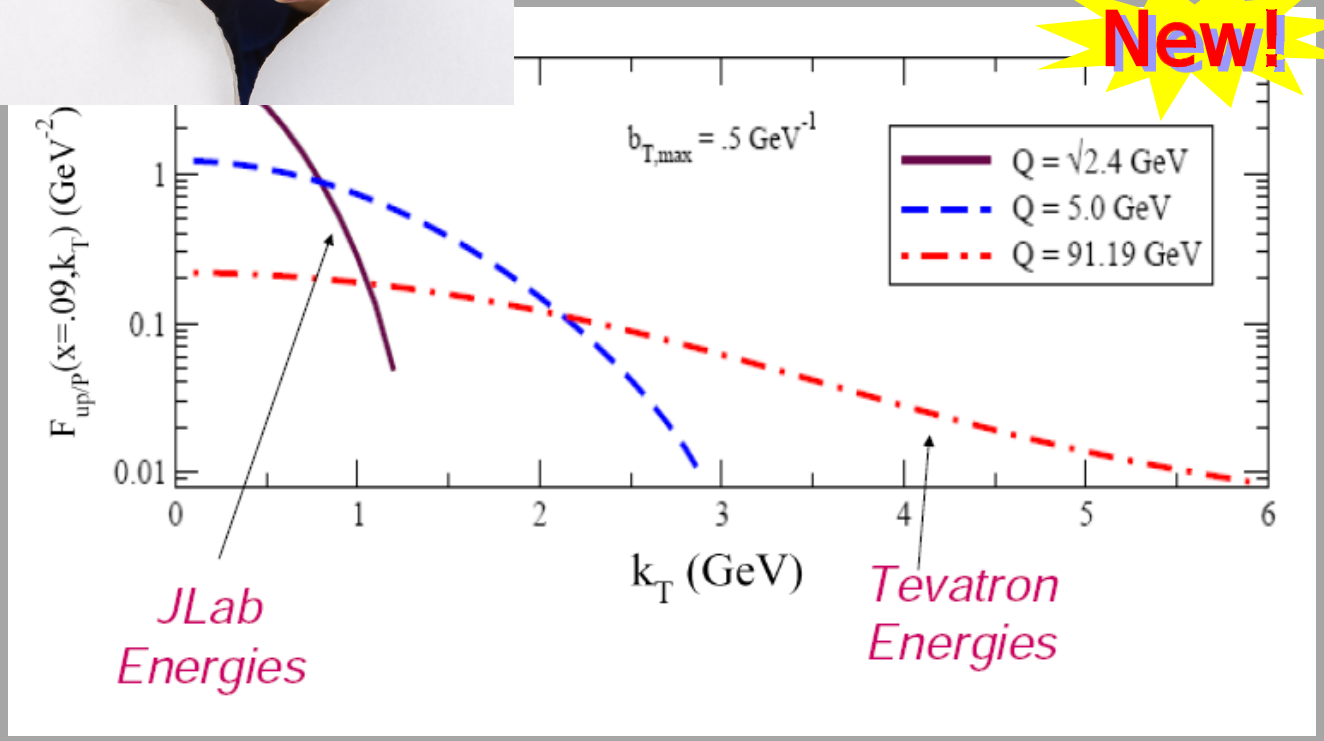


Collins (2011)

Aybat, Rogers (2011)

First implementation of NLO evolution of
Transverse Momentum Dependent distributions

Ted Rogers



Collins (2011)

Aybat, Rogers (2011)

Breakthrough of TMD phenomenology and theory in 2011

Igor Cherednikov

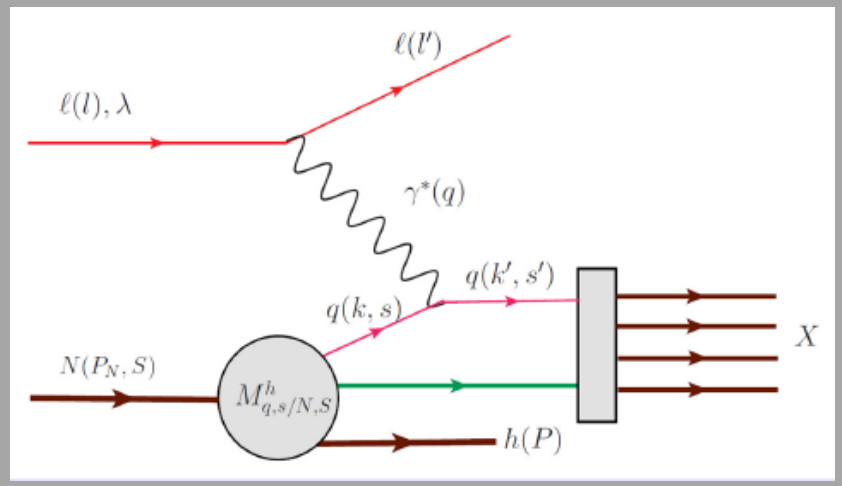
$$\theta\frac{\partial}{\partial\theta}\mathcal{F}_{[\mathrm{A_n}]}(x,\mathbf{b}_\perp;\mu,\theta) = [K_\mathrm{n}(\mu,\mathbf{b}_\perp) + G_\mathrm{n}(\mu,\theta)]\,\mathcal{F}_{[\mathrm{A_n}]}(x,\mathbf{b}_\perp;\mu,\theta)$$

$$\mu\frac{d}{d\mu}K_\mathrm{n} = -\mu\frac{d}{d\mu}G_\mathrm{n} = \gamma_\mathrm{cusp}$$

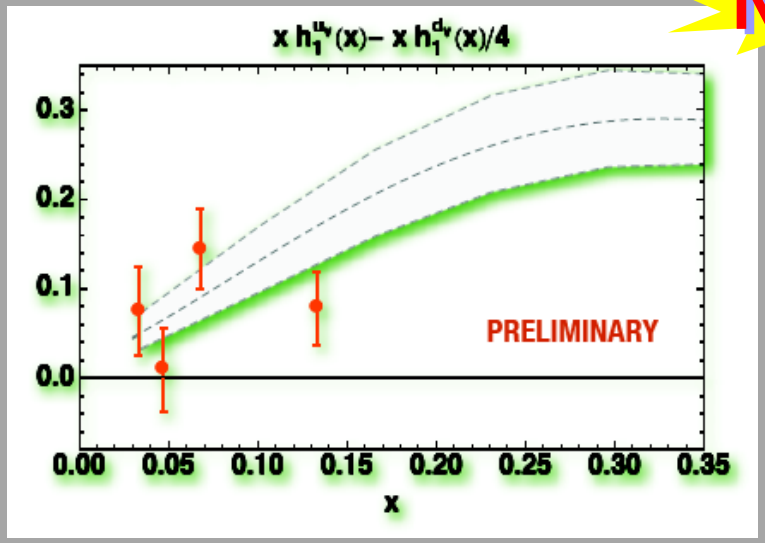
$$K_\mathrm{n}(\mu,\mathbf{b}_\perp) + G_\mathrm{n}(\mu,\theta) = -\frac{\alpha_s C_\mathrm{F}}{\pi}\ln\ \theta^2\mathbf{b}_\perp{}^2\mathcal{C}_\mathrm{n}$$

- Evolution of TMDs
- Both UV and rapidity dependence

Aram Kotzinian



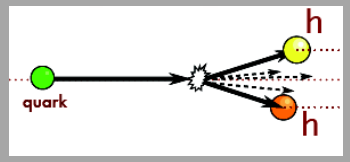
- Fracture functions
- SIDIS in target fragmentation region



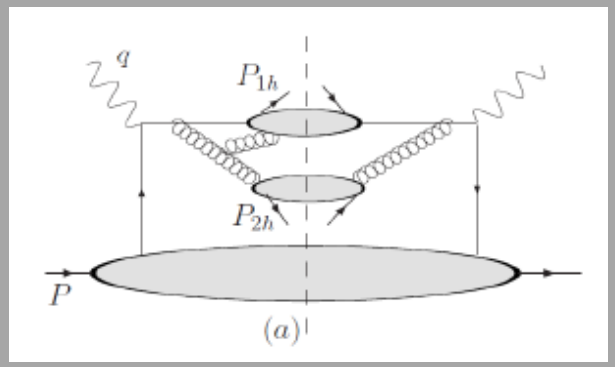
New!

Aurore Courtoy

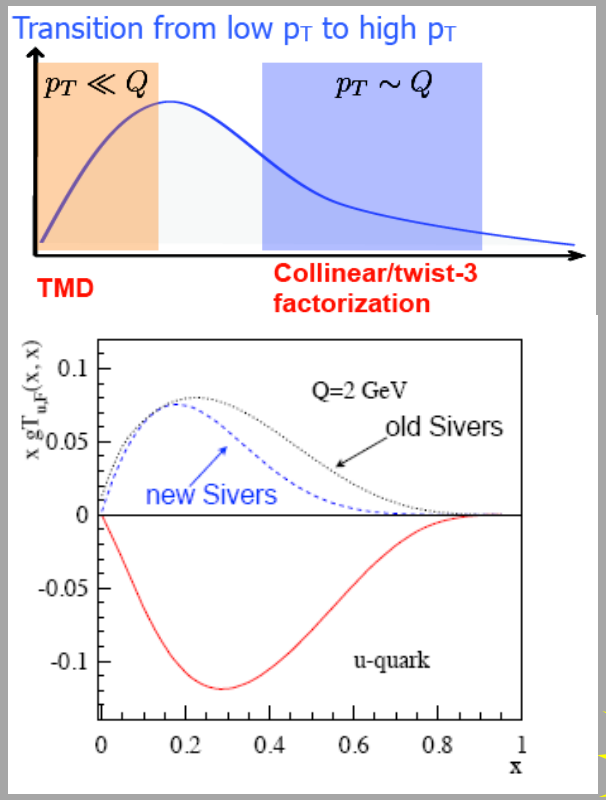
- Transversity from dihadron interference fragmentation
- BELLE + HERMES



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

$$gT_{q,F}(x,x) = -\int d^2k_\perp \frac{|k_\perp|^2}{M} f_{1T}^{\perp q}(x,k_\perp^2)|_{\rm SIDIS}$$

New!

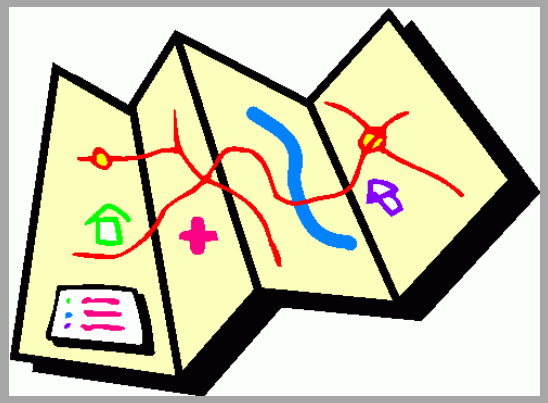
Leonard Gamberg

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

$$\tilde{f}_{1T}^{\perp a(1)}(x, z^2 \boldsymbol{b}_T^2)$$

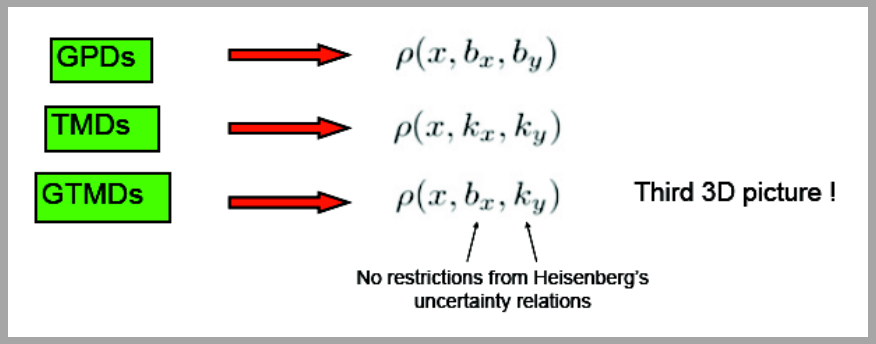
Generalized Parton Distributions and models

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



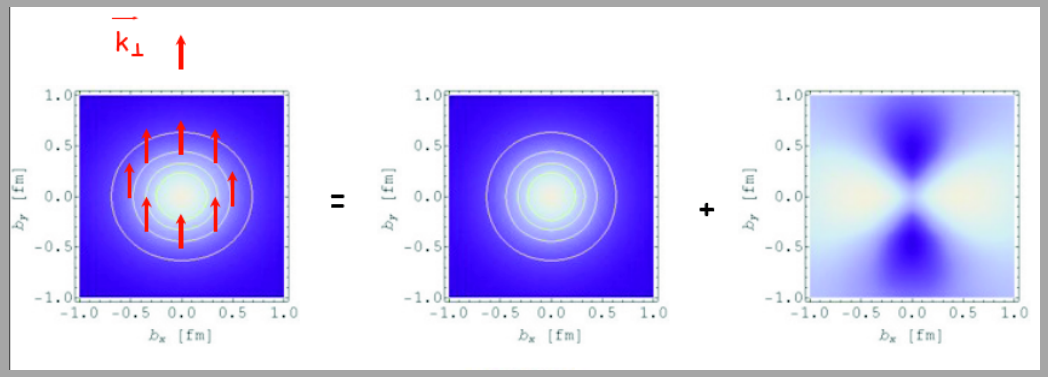
Dieter Mueller

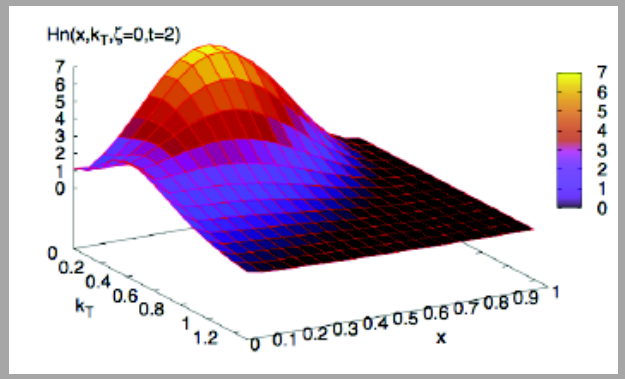
- Road map of Light Cone Waive Function modelling for
- GPDs and TMDs
- Effective LCWF valid at $Q^2 = 4\ \mathrm{GeV}^2$



Barbara Pasquini

- Wigner function modelling
- Nucleon tomography

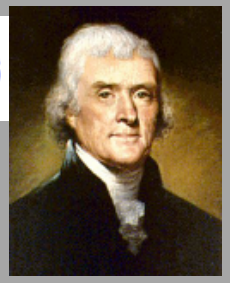




Simonetta Liuti

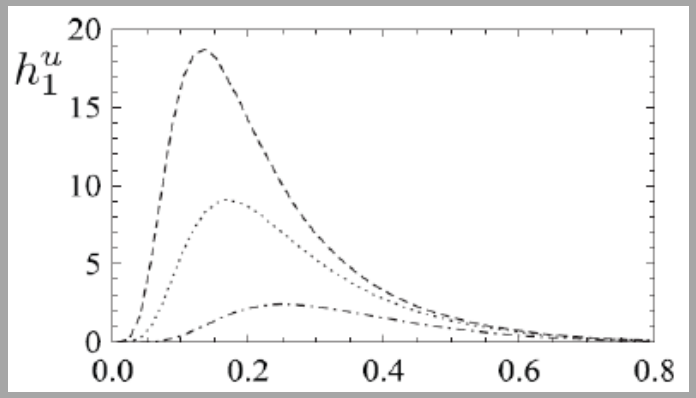
- Wigner function, GPDs, TMDs and OAM

Chiral odd GPDs



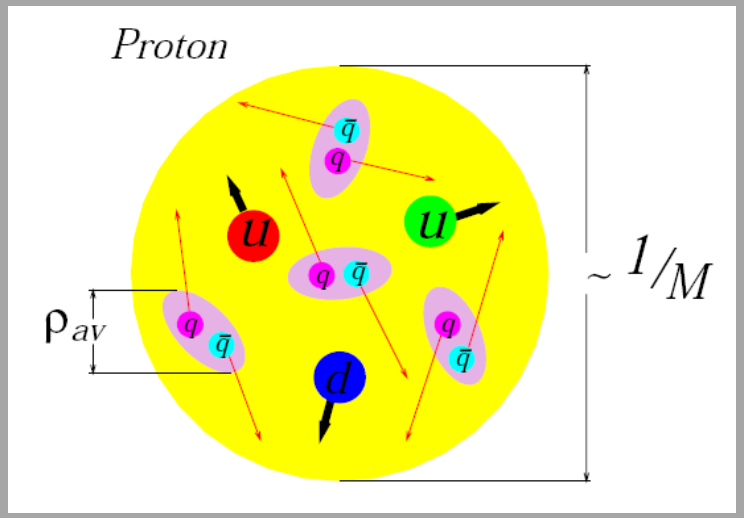
Gary Goldstein

- Chiral odd GPDs, possibilities at JLab



Petr Zavada

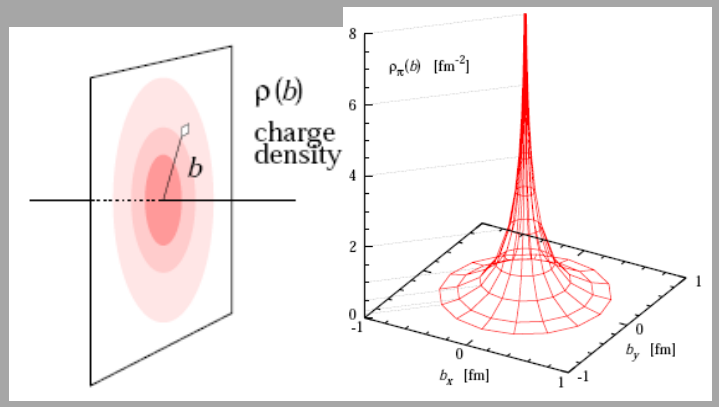
- Relation among TMDs in models
- 3D covariant model



Peter Schweitzer

- Intrinsic pT from QCD vacuum

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



Christian Weiss

- Transverse charge densities from form factors

CONCLUSIONS

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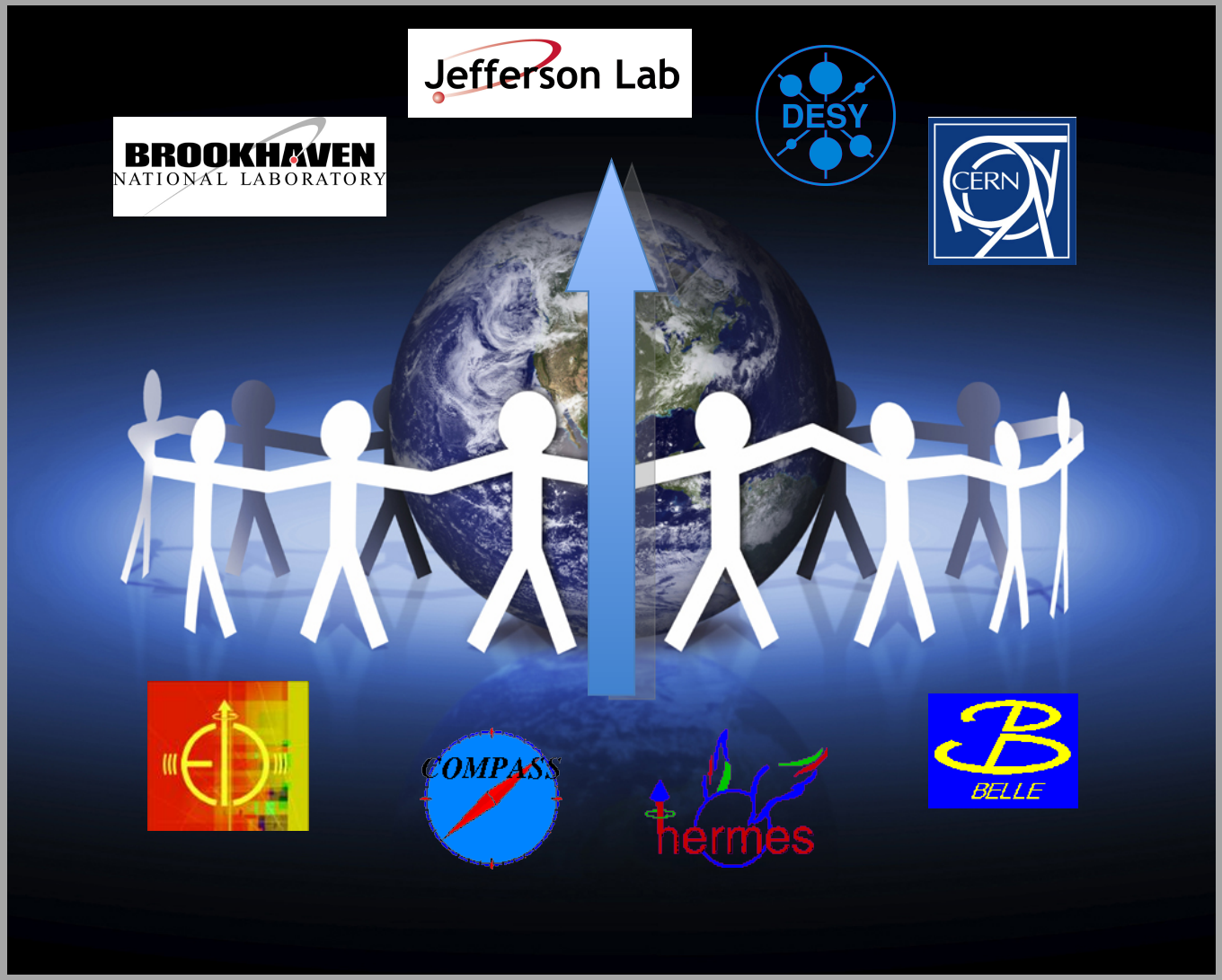
CONCLUSIONS