"New **directions** in science are **launched** by **new tools** much more often than by new concepts."

Freeman Dyson

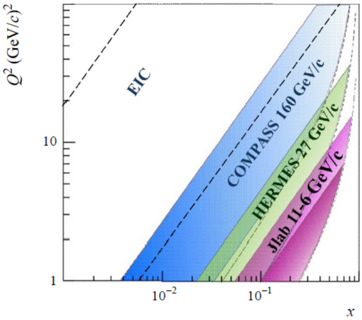
(Theorist, mathematician; IAS, Princeton)

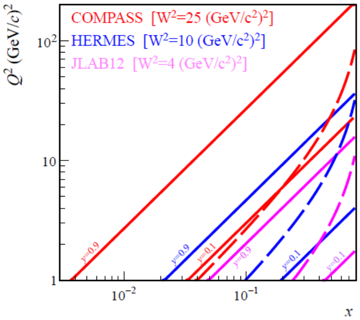
Motto

"Polarisation data has often been the graveyard of fashionable theories. If theorists had their way, they might well ban such measurements altogether out of self-protection."

J.D.Bjorken, 1987

Acceptance of SIDIS experiments



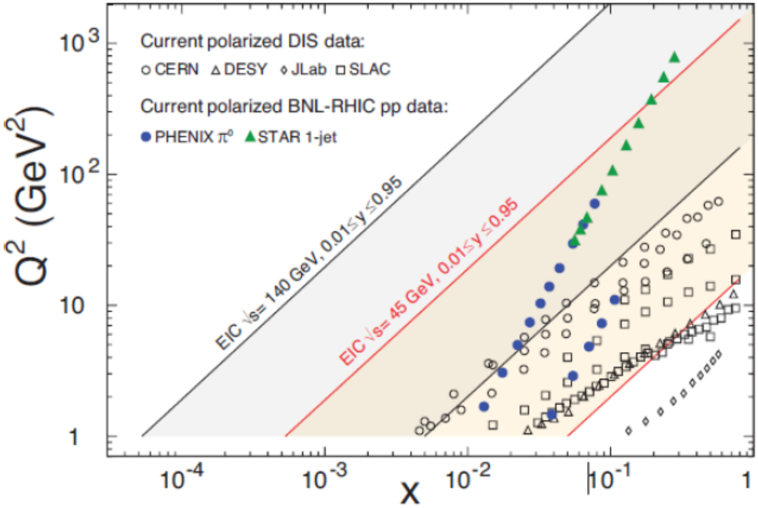


EIC limits: $\sqrt{s}$ = 140 GeV, y = 0.9
$\sqrt{s}$ = 40 GeV, y = 0.1

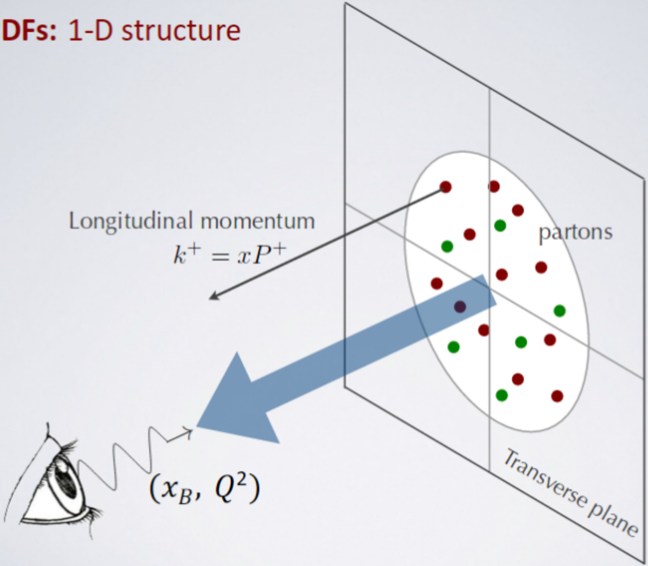
Full lines: $y = 0.1$ and $y = 0.9$
dashed – low W^2 boundaries

CERN-SPSC-2017-034

Acceptance of nucleon structure experiments



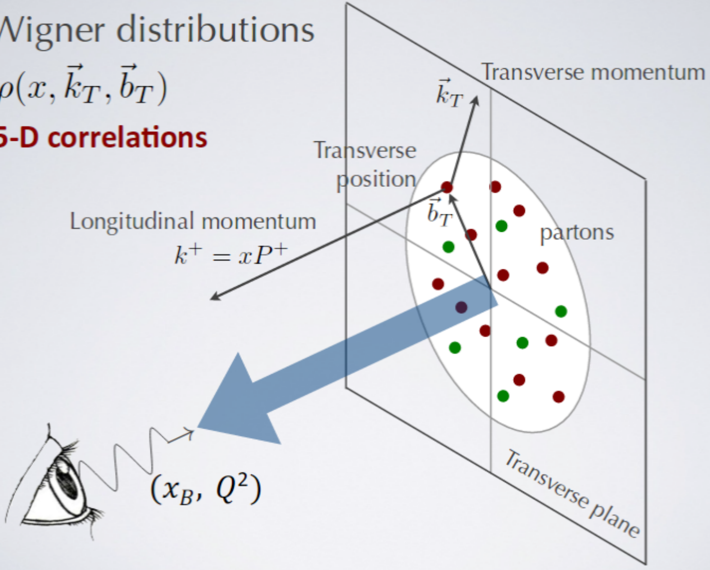
PDFs: 1-D structure



Wigner distributions

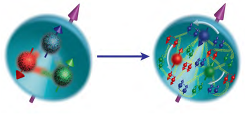
$\rho(x, \vec{k}_T, \vec{b}_T)$

5-D correlations



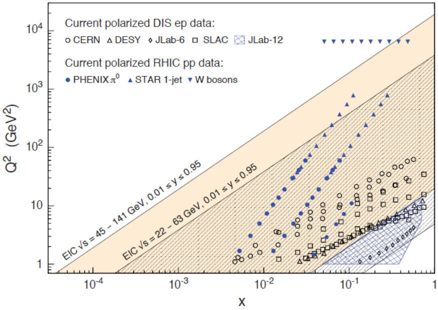
see, e.g., C. Lorcé, B. Pasquini, M. Vanderhaeghen, JHEP 1105 (11)

Nucleon spin “puzzle” at EIC

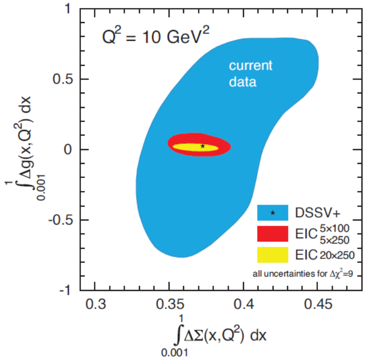


quark spins — gluon spins — quark&gluon orbital motion

$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + \Delta G + L_z$$



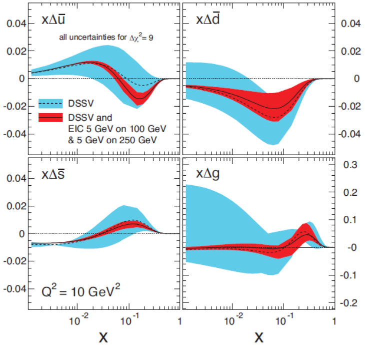
From “White paper2017”, arXiv:1708.01527v3



From “White paper”, arXiv:1212.1701

Parton separation at EIC pseudo-data (inclusive and semi-inclusive)

DIS + SIDIS

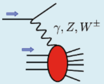


From "White paper", arXiv:1212.1701

EW DIS

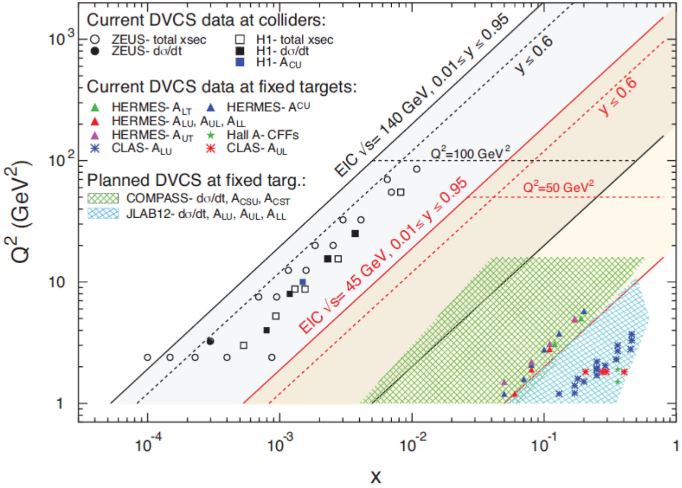
- $\Delta g(x)$ from scaling violation
- $\Delta\bar{u}, \Delta\bar{d}, \Delta s$ from SIDIS
- Flavor separation at high Q^2 via CC DIS:

$$g_1^{W^+} = \Delta\bar{u} + \Delta d + \Delta\bar{c} + \Delta s$$
$$g_1^{W^-} = \Delta u + \Delta\bar{d} + \Delta c + \Delta\bar{s}$$
$$g_5^{W^+} = \Delta\bar{u} - \Delta d + \Delta\bar{c} - \Delta s$$
$$g_5^{W^-} = -\Delta u + \Delta\bar{d} - \Delta c + \Delta\bar{s}$$



E. Aschenauer, SPIN2016

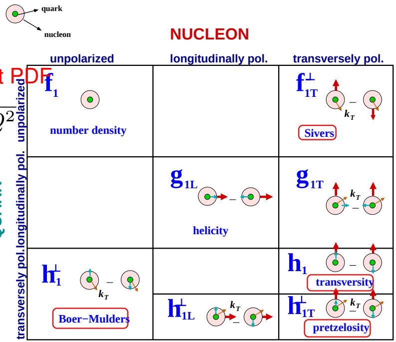
Acceptance of present and EIC DVCS



From “White paper”, arXiv:1212.1701

Partonic structure of the nucleon; TMD distribution functions

- In LT and considering k_T,
  8 PDF describe the nucleon
  $\Longrightarrow$ Transverse Momentum Dependent PDF
- QCD-TMD approach valid if $k_\mathrm{T} \ll \sqrt{Q^2}$
  (TMD factorisation)
- After integrating over k_T
  only 3 survive: f_1, g_1, h_1
- TMD accessed in SIDIS and DY
  by measuring azimuthal asymmetries
  with different angular modulations

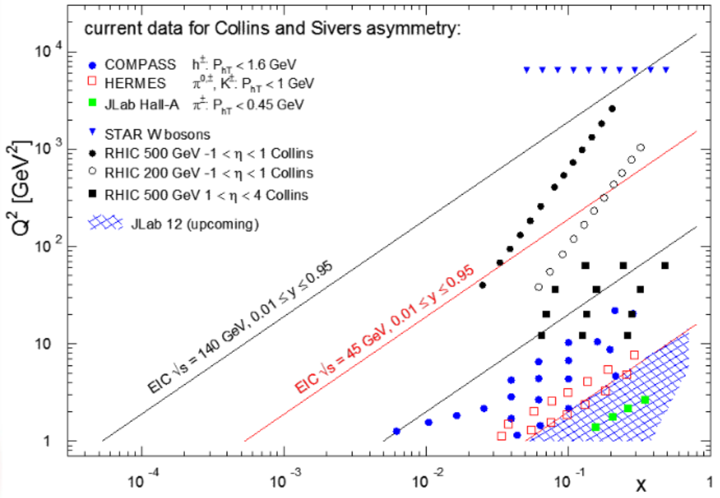


- SIDIS: e.g. $A_\mathrm{Sivers} \propto$ PDF $\otimes$FF
- DY: e.g. $A_\mathrm{Sivers} \propto$ PDF$^\mathrm{beam} \otimes$ PDF$^\mathrm{target}$
- OBS! Boer-Mulders and Sivers PDF are T-odd, i.e. process dependent

$$h_1^\perp(\mathrm{SIDIS}) = -h_1^\perp(\mathrm{DY}) \qquad f_{1T}^\perp(\mathrm{SIDIS}) = -f_{1T}^\perp(\mathrm{DY})$$

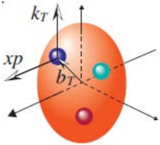
- TMD parton distributions need TMD Fragmentation Functions!

Sivers function at EIC

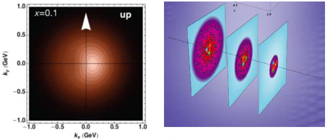


O. Eyser, SPIN2016

Theory



5D structure: Tomography



Distortion in k_T and b_T from fits

- extraction of PDFs (unpol., pol.), TMDs and GPDs from **global fits**
- **TMDs**: interplay between the perturbative (order accuracy) and the non-perturbative part (internal structure)
- **GPDs**: modelling and algorithms
- **Sign change issue** (Sivers TMD): understanding SSAs in pQCD
- $\boldsymbol{k_T}$**-** (high energy) vs. **TMD** factorisation
- $\boldsymbol{g_1}$**(x)** (helicity PDF) at small x **sensitive** to $ln^2(^1/_x)$ vs. $ln(^1/_x)$
- role of **gluon TMD** in the 3D structure of the nucleon
- **Lattice QCD**: from form factors and unpolarised PDFs to polarised PDFs

RICHER information

SPARES

Fluctuations and Market Friction in Financial Trading

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(May 15, 2006)

We study the relation between stock price changes and the difference in the number of sell and buy orders. Using a soft spin model, we describe the price impact of order imbalances and find an analogy to the fluctuation-dissipation theorem in physical systems. We empirically investigate fluctuations and market friction for a major US stock and find support for our model calculations.

PACS numbers: 05.45.Tp, 89.90.+n, 05.40.-a, 05.40.Fb

The unpredictable up and down movements in the stock market have always captured the interest and imagination of investors. The scientific investigation of these phenomena started with Bachelier's comparison of stock price dynamics with a random walk [1]. This study has been refined in many respects [2]. Interest has been devoted to the precise shape of the distribution of returns (difference of the logarithm of stock prices at different times), which is characterized by a high probability for large fluctuations [3–6].

After it was realized that large price fluctuations tend to cluster together in time, stock price returns were described by models of volatility (standard deviation of returns) changing in time [7,8]. This effect is captured in time series models, in which the volatility at a given time depends on the magnitude of previous returns [9,10]. It has been actively investigated how the stochastic properties of price dynamics can be related to the market microstructure, i.e. the rules and motivations according to which agents act in a financial market. Although the details of models differ [11–15], they have been successful in reproducing the empirical observations.

Here, we follow a different approach motivated by the sell orders (order imbalance), which acts as an external force. We study the dependence of stock price changes on order imbalance empirically by using the method of data analysis and some of the results of [21,22]. We find that the empirical results agree well with our model.

Model calculation: The observable quantity we are interested in is the logarithmic stock price changes within a time interval Δt

$$G_{\Delta t}(t) = \ln S(t) - \ln S(t-\Delta t)\ , \qquad (1)$$

where $S(t)$ is the price of a given stock at time t. Transaction prices at a stock exchange lie usually in a finite interval between the bid price (the price a trader offers to pay for a stock) and the ask price (the price at which a dealer is willing to buy the stock). In addition, the historical prices studied take only discrete (tick) values. This motivates to model price changes by a spin model, and for the virtue of easier analytical calculations by a soft spin model [23].

The spin variable we use is the "instantaneous return" $g(t) = \tau \frac{d}{dt} \ln S(t)$, where the average time interval between trades τ sets the time scale of the problem. The