Phenomenological study of longitudinally polarized SIDIS

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Unraveling the unknown

Nearly all the visible matter in the Universe consists of hadrons, and yet much is still unknown about them.

Their internal structure is described by a **non abelian gauge field theory** of quarks and gluons with **SU(3) color symmetry**, and no direct observation is allowed because of their **confined nature**.

3-dimensional maps

In order to get informations on the internal structure, physicists can

- probe the hadrons in **high-energy scattering processes**
- develope **maps in position and momentum space** to build an accurate description

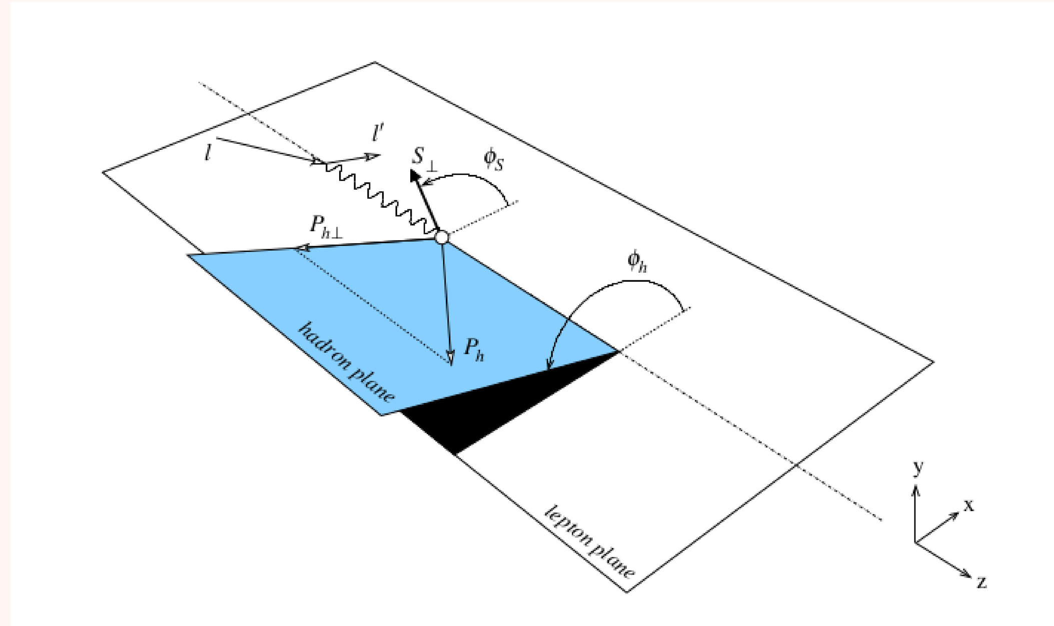
These maps are called **PDFs** and **FFs**, and they show a dependence on the *longitudinal momentum fraction* x and the *intrinsic transverse momentum* k_T of partons

		Quark polarization		
		Unpolarized (U)	Longitudinally Polarized (L)	Transversely Polarized (T)
Nucleon Polarization	U	$f_1 =$	*	naive T-odd $h_1^\perp =$ - Boer-Mulders
	L	*	$g_1 =$ - helicity	$h_{1L}^\perp =$ - transversity
	T	naive T-odd $f_{1T}^\perp =$ - Sivers	$g_{1T} =$ -	$h_1 =$ - $h_{1T}^\perp =$ -

		Quark polarization		
		Unpolarized (U)	Longitudinally Polarized (L)	Transversely Polarized (T)
Nucleon Polarization	U	D_1		naive T-odd $H_1^\perp$ - Collins
	L		G_{1L} -	$H_{1L}^\perp$ -
	T	naive T-odd $D_{1T}^\perp$ -	G_{1T} -	H_1 - $H_{1T}^\perp$ -

SIDIS

$$\ell(l) + N(P) \to \ell(l') + h(P_h) + X$$



SIDIS variables

$$x = \frac{Q^2}{2P\cdot q} \qquad y = \frac{P\cdot q}{P\cdot l} \qquad z = \frac{P\cdot P_h}{P\cdot l} \qquad \gamma = \frac{2Mx}{Q}$$

- $q = l - l'$, with $Q^2 = -q^2 > 0$
- In the region where $q_T \ll Q$, factorization theorems are valid

The aim of my thesis is to improve the knowledge of the 3D structure of hadrons exploiting the phenomenology of **longitudinally polarized SIDIS** through the implementation of **Nanga Parbat**, a fitting framework developed in Pavia by A. Bacchetta et al.

Defining the observables

Assuming one photon exchange, the **cross section** can be expressed in terms of a set of structure functions.

$$F_{UT,L}$$

- U → beam polarization
- T → target polarization
- L → photon polarization

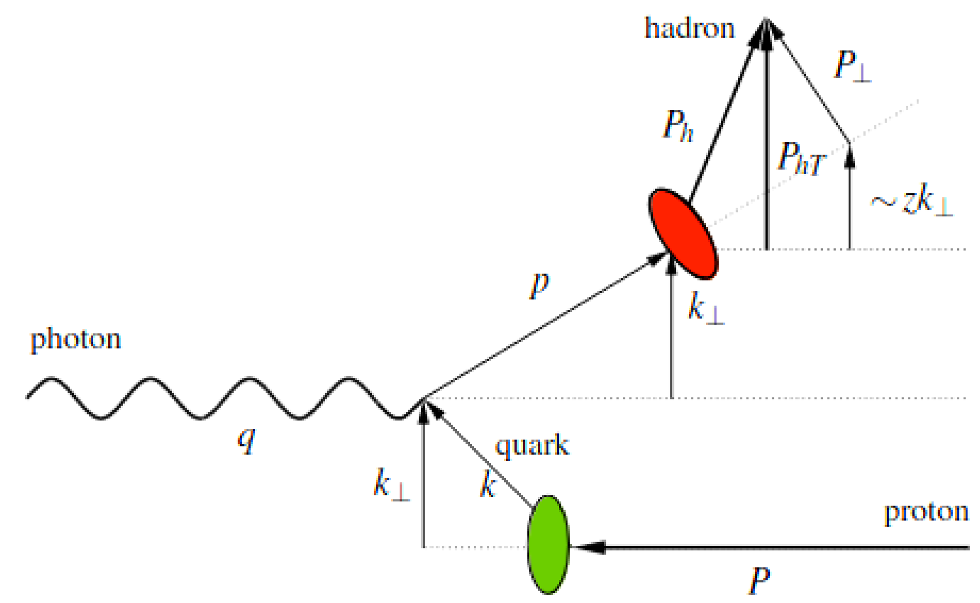
Asymmetries are good observables in **polarized processes**

$$A_{LL} = \frac{F_{LL}}{F_{UU,T}}$$

where

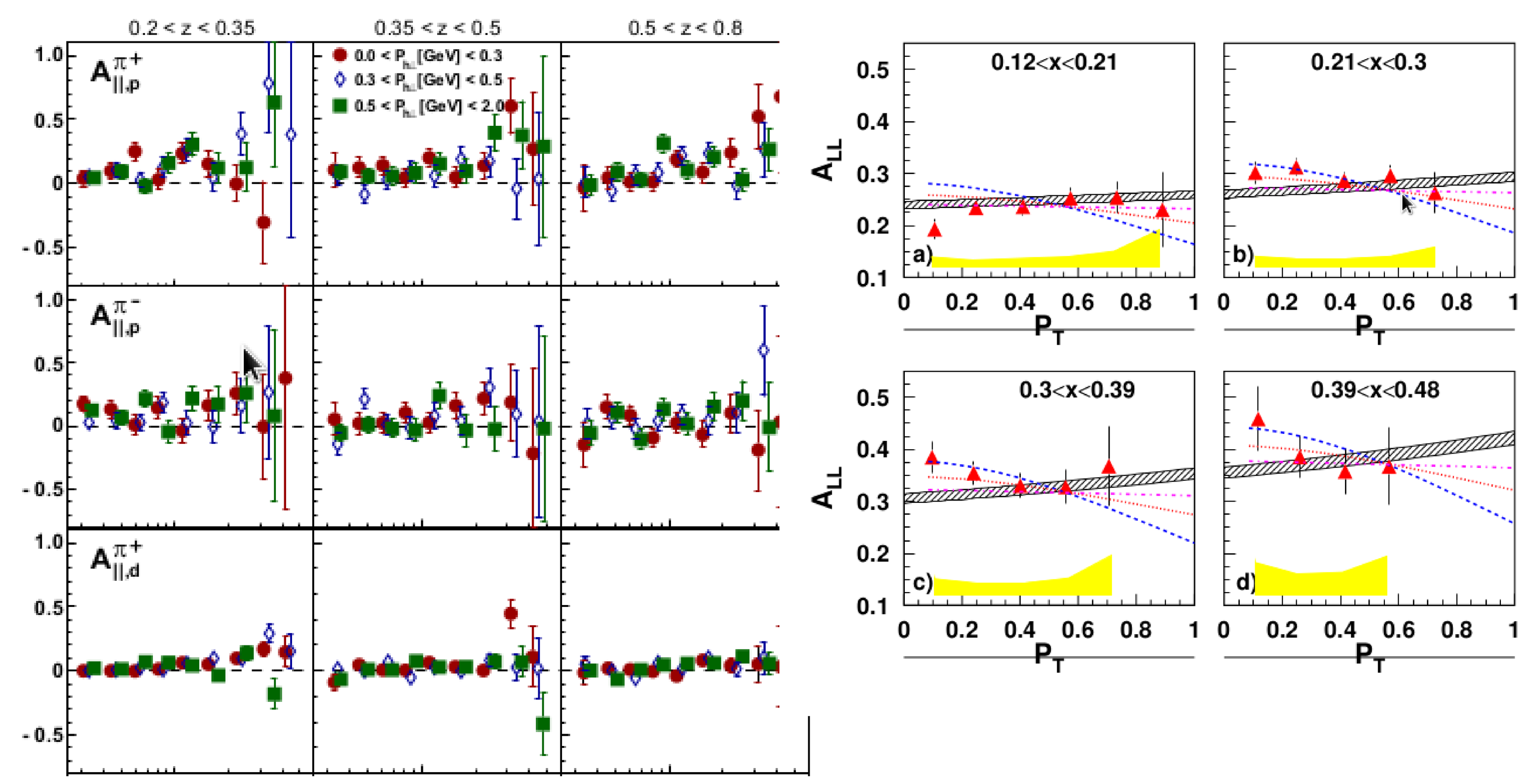
$$F_{LL} = \mathcal{C}[g_{1L}D_1] \qquad F_{UU,T} = \mathcal{C}[f_1 D_1]$$

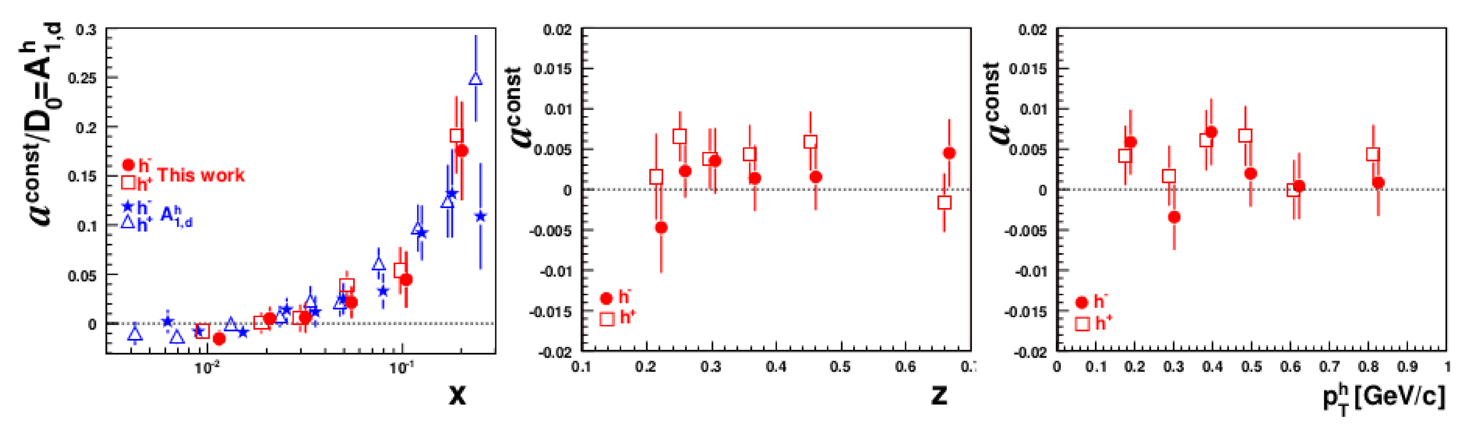
Structure of TMDs



$$F_{LL}(x,z,P_{hT}^2,Q^2) = x\sum_a \mathcal{H}_{LL}^a(Q^2,\mu^2)\int d^2k_\perp d^2P_\perp g_1^a(x,k_\perp{}^2;\mu^2)D_1^a(z,P_\perp^2;\mu^2)\delta^{(2)}(zk_\perp - P_{hT} + P_\perp)$$

Asymmetry: measurements





..and more complete data are coming from CLAS12!

References

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