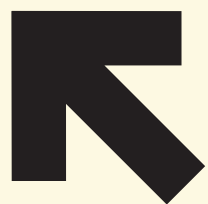




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Phenomenology of Twist-3 PDFs



A presentation of the work I'm doing under the supervision of ● Dr. Alexey Vladimirov

Part of the project: NextGenerationEU/ PRTR Nuevas fronteras ● en la tomografía de nucleones

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**The
problem**



It's simple, but it comes with a twist

Structure function g_2 in the Spin-sensitive part of the hadronic tensor:

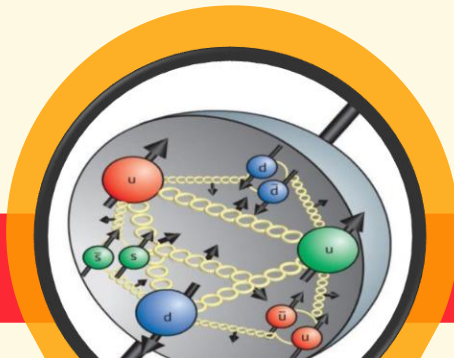
DIS:

$$\frac{d\sigma^{\mathcal{H},S}}{d\Omega dE'} = \mathcal{H} \frac{2\alpha^2}{MQ^4\nu} \frac{E'}{E} \left\{ [q^2(k \cdot S) - (k \cdot q)(q \cdot S)] g_1 + q^2 \left[(k \cdot S) - (S \cdot q) \left(\frac{P \cdot k}{P \cdot q} \right) \right] g_2 \right\}$$

Twist expansion:

$$\begin{cases} g_1(x_B, Q^2) = g_1(x_B, Q^2)^{\text{twist } 2} + g_1(x_B, Q^2)^{\text{twist } 4} + \dots \\ g_2(x_B, Q^2) = g_2(x_B, Q^2)^{\text{twist } 2} + \boxed{g_2(x_B, Q^2)^{\text{twist } 3}} + \dots \end{cases}$$

This



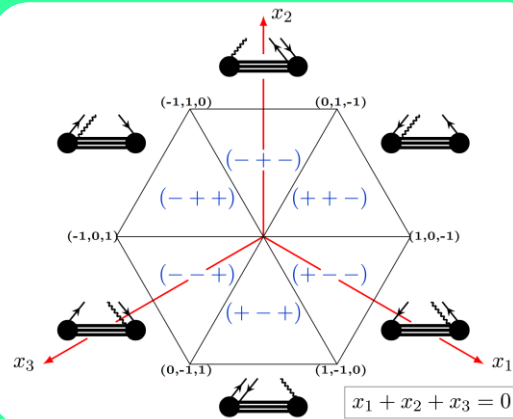
Takeaway: we study the hadron structure (its spin)



But what is the Twist ??

Twist 2 :
2 particles interacting
(2-parton dynamics)

Abundance of experimental data.



Here they live

Very few experimental data.
Time for an update!!

Twist 3 :
Interference due to the
emission / absorption of 3
partons

A decorative graphic featuring a green line that curves from the left edge, goes down, and then right. A blue circle with the number '2' is positioned to the left of the green line's vertical segment. A light blue line curves from the bottom edge, goes left, and then up. A red line curves from the top edge, goes left, and then down. Two black dots are placed on the green line: one on the upper curve and one on the horizontal segment.

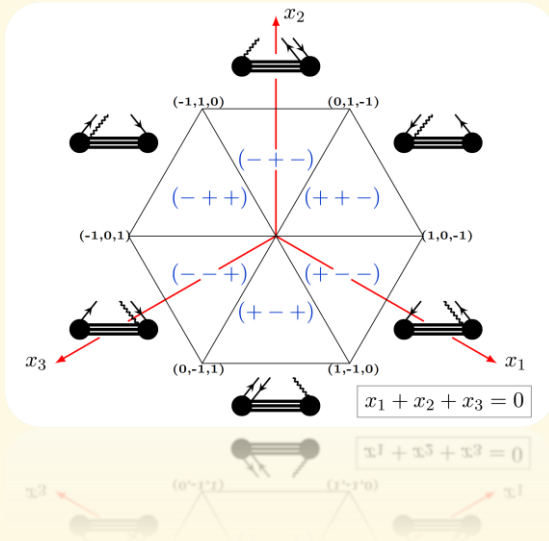
2

Difficulties along the way



Our enemies

Usually PDFs are 1-Dimensional objects. Easy to handle 😊 ➡ Twist-2 terms
Analyzing Twist-3 implies adding up 1 dimension. Intertwined dynamics ☹️



The analytical structure of twist-3 PDFs is unknown

Also, We're the first to implement the full evolution of the PDFs
With the energy scale. The 2-D setting is not simple to handle

Takeaway: 2 Dimensions means more complex manipulations, which present in all analysis regarding twist-3

A decorative graphic consisting of several thick, rounded lines in green, blue, and red. A green line starts from the left, curves down, then right, and then up. A blue line starts from the bottom, curves left, then up, and then right. A red line starts from the top right and curves left. There are two small black dots: one on the green line at its top curve and one on the blue line at its right end. A brown circle with the number 3 is positioned to the left of the green line's vertical segment.

3

Status of the problem



Let it snow. Snowflake

- Analytical calculations = Unmanageable
- Only approach = Fits to develop a numerical model

We use the FORTRAN software “Snowflake” (A.Vladimirov 2024) as our means to compute the evolution of Twist-3 PDFs. **Novel approach**

$$[g_2^{\text{twist } 3}(x_B, Q^2)]^{\text{tree}} = 2 \sum_q e_q^2 \int d\xi_1 d\xi_2 \mathcal{K}(\xi_1, \xi_2; x_B) D_q^+(\xi_1, \xi_2) Q^2$$

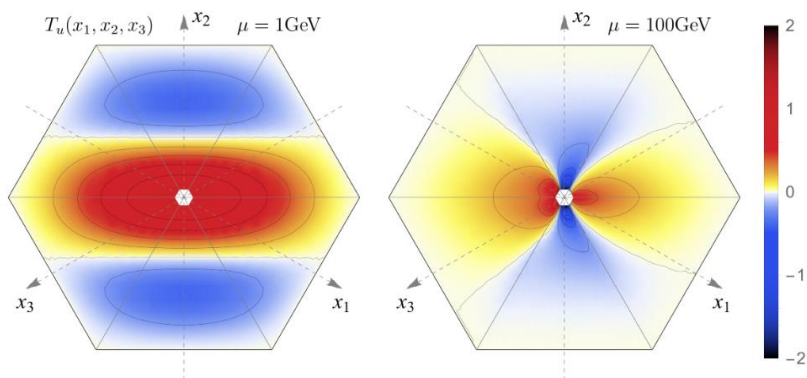


Figure 5: Evolution of the flavor-up distribution T_u of eqn.(4) from 1 GeV to 100 GeV. The boundary conditions are specified in eqn.(80).

Evolution of the diff. Cross section

$$\left. \left(\frac{d\sigma^{\mathcal{H},S}}{d\Omega dE'} \right)^{\text{twist } 3} \right|_{\mu_2^2} = \left[\mathbb{I} \circ \left(\frac{d\sigma^{\mathcal{H},S}}{d\Omega dE'} \right)^{\text{twist } 3} \right] \Big|_{\mu_1^2}$$



A decorative graphic consisting of thick, rounded lines in green, blue, and red. A green line starts from the left, curves down, and then continues horizontally. A blue line starts from the bottom, curves up, and then continues horizontally. A red line starts from the top right and curves down. There are three black dots: one on the green line at its top curve, one on the blue line at its top curve, and one on the green line at its right end.

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**Why should
we care now?
The EIC**

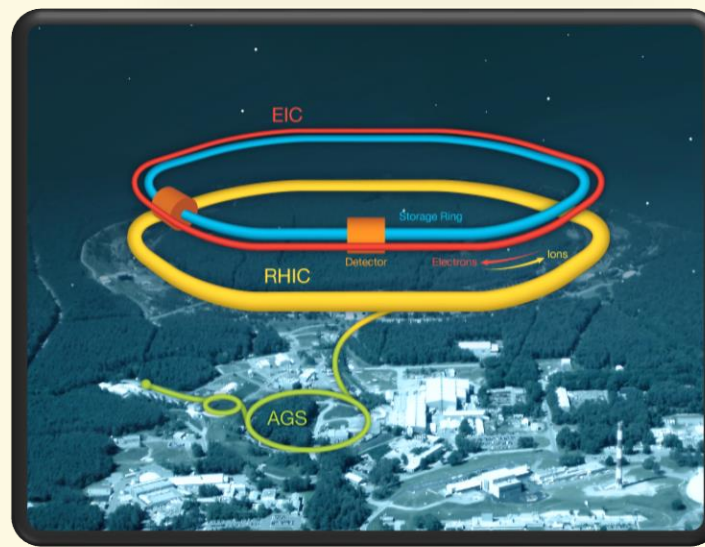
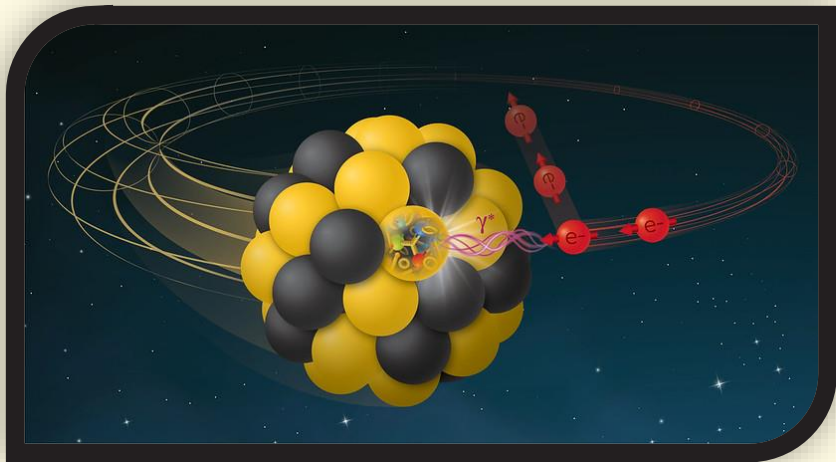


What's the EIC?

- **Electron Ion Collider**
- **Brookhaven National Laboratory (U.S.A)**
- **To enter commission by the mid 30's (not that far from now)**
- **Explicitly designed to study the strong force (QCD)**
- **Addresses / Studies the polarized DIS (our problem)**
- **Operates in a new range of energies (susceptible to Twist-3!)**



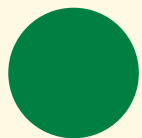
Takeaway: the EIC will put to the test our theories on the inner structure of composite matter, so let's prepare!



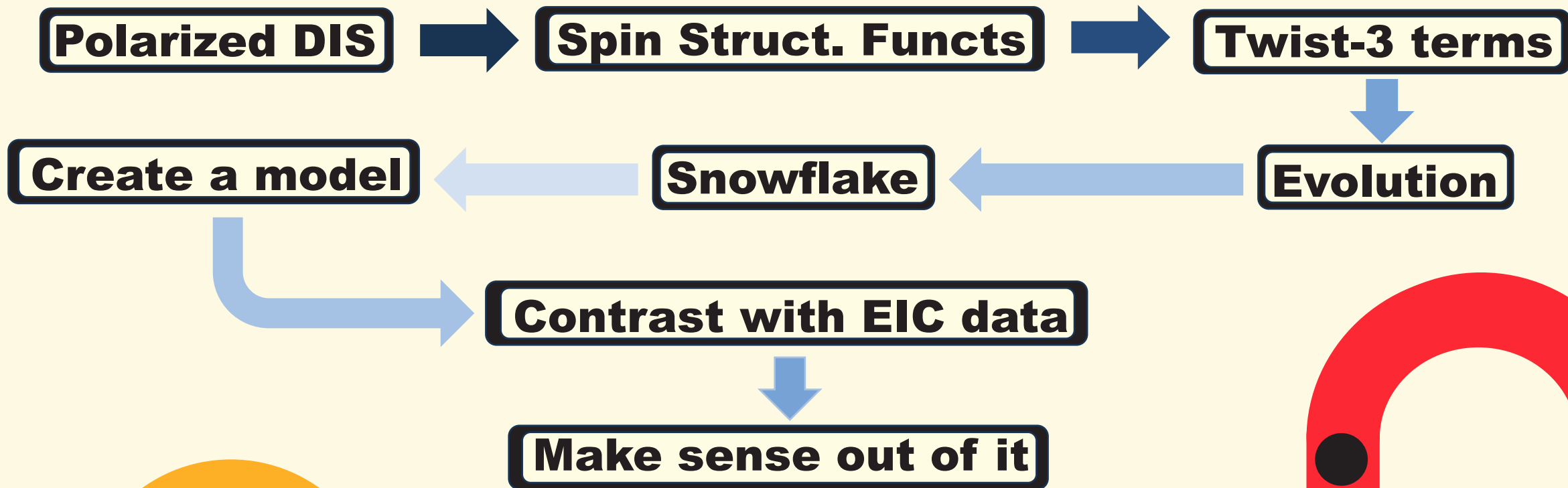


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In summary



The PLAN



Takeaway: we have a long-term plan

The image features a minimalist, abstract graphic design on a light cream background. On the left side, there are thick, rounded lines in red and orange. A vertical orange line runs down the left edge, with two horizontal red lines crossing it. A black dot is positioned at the intersection of the orange line and the lower red line. To the right, a vertical red line descends from the top right, with a black dot on its upper portion and a large green circle at its base. The text 'Thank you!' is centered in a bold, black, sans-serif font.

Thank you!