COMPASS: Investigation into the nucleon spin structure

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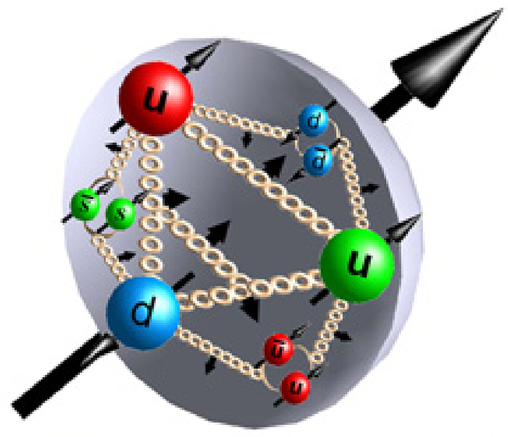
on behalf of the COMPASS Collaboration

Nucleon spin



- Quark contribution : $\Delta\Sigma = \Delta u + \Delta d + \Delta s$

  - Relative Quark-Parton Model: $\Delta\Sigma \approx 0.6$
  - Present world data [1] : $\Delta\Sigma = 0.30 \pm 0.01(stat)$

  $\Rightarrow$ Spin Crisis (EMC, 1988)

  - Inclusive measurement: $\Delta s \approx -0.08 \pm 0.01 \pm 0.02$
  - Semi-Inclusive measurement : $\Delta s = -0.02 \pm 0.02 \pm 0.02$ in the measured range & with assumption on D_s^h

  $\Rightarrow$ Strangeness Crisis

- ΔG positive or negative? Anyway close to zero 0 !

$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + \Delta G + L_{(q+g)}$$

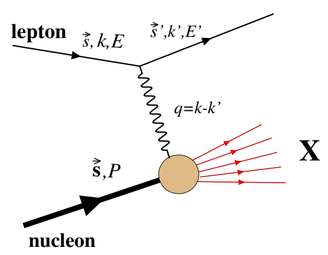
quark — gluon — orbital momentum

NEW Data with the Highest beam energy (200 GeV) in polarised DIS to explore the terra incognita : Low x and Large Q^2 regions

$\Rightarrow$ measurement of Δs and ΔG

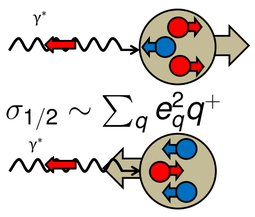
Processus

Polarised deep inelastic scattering: $\mu p \to \mu' X$



- Virtual-photon kinematics: $Q^2 = -q^2$, $\nu = E - E'$
- Fraction of the nucleon momentum carried by struck quark: $x \equiv x_{Bj} = \frac{Q^2}{2M\nu}$
- Fractional energy transfer to the nucleon: $y = \frac{\nu}{E}$

– Photon-nucleon spin asymmetry



$\sigma_{1/2} \sim \sum_q e_q^2 q^+$

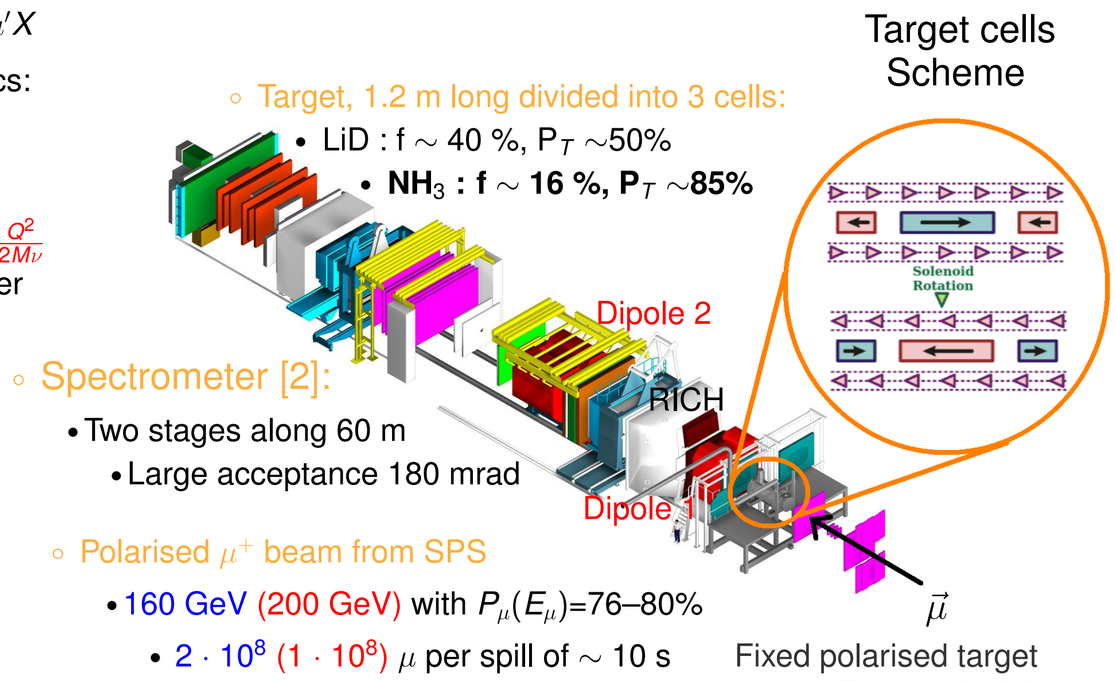
$\sigma_{3/2} \sim \sum_q e_q^2 q^-$

Quark densities:

$$q(x) \equiv q^+(x) + q^-(x)$$
$$\Delta q(x) \equiv q^+(x) - q^-(x)$$

$$A_1 = \frac{\sigma_{1/2} - \sigma_{3/2}}{\sigma_{1/2} + \sigma_{3/2}} \approx \frac{\sum_q e_q^2 \Delta q(x)}{\sum_q e_q^2 q(x)} = \frac{g_1(x)}{F_1(x)}$$

Experimental set-up



Spin asymmetry extraction

- Number of interactions:

$$N_{cell} = a\Phi n\bar{\sigma}(1 \pm fDP_BP_TA_1)$$

$\to$ a : acceptance
$\to$ Φ : flux
$\to$ n : target density
$\to$ $\bar{\sigma}$: total cross-section
$\to$ f : dilution factor
$\to$ D : depolarisation factor

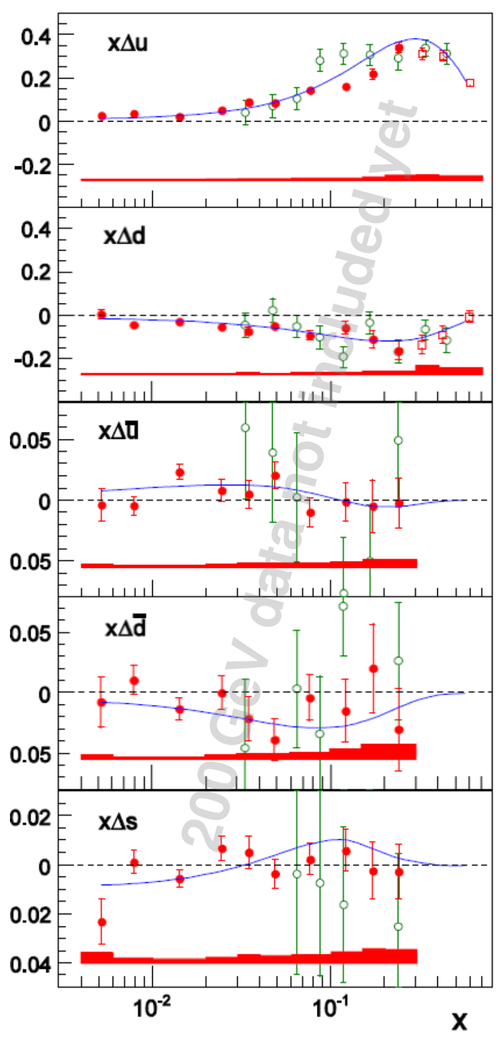
$$\delta \equiv \frac{N_{(u+d)}N'_c}{N'_{(u+d)}N_c}$$

$$\Downarrow$$

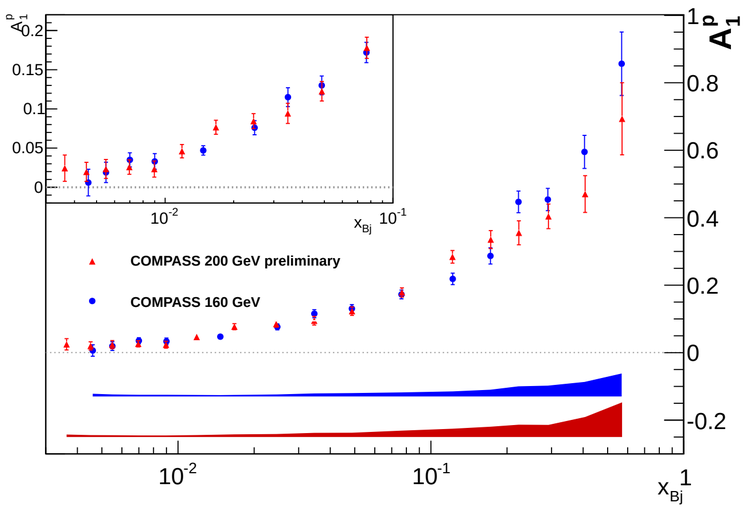
$$\alpha(\delta)\,\mathbf{A_1^2} + \beta(\delta)\,\mathbf{A_1} + \gamma(\delta) = 0$$

Results

Helicity distribution functions



Inclusive spin asymmetry A_1^p

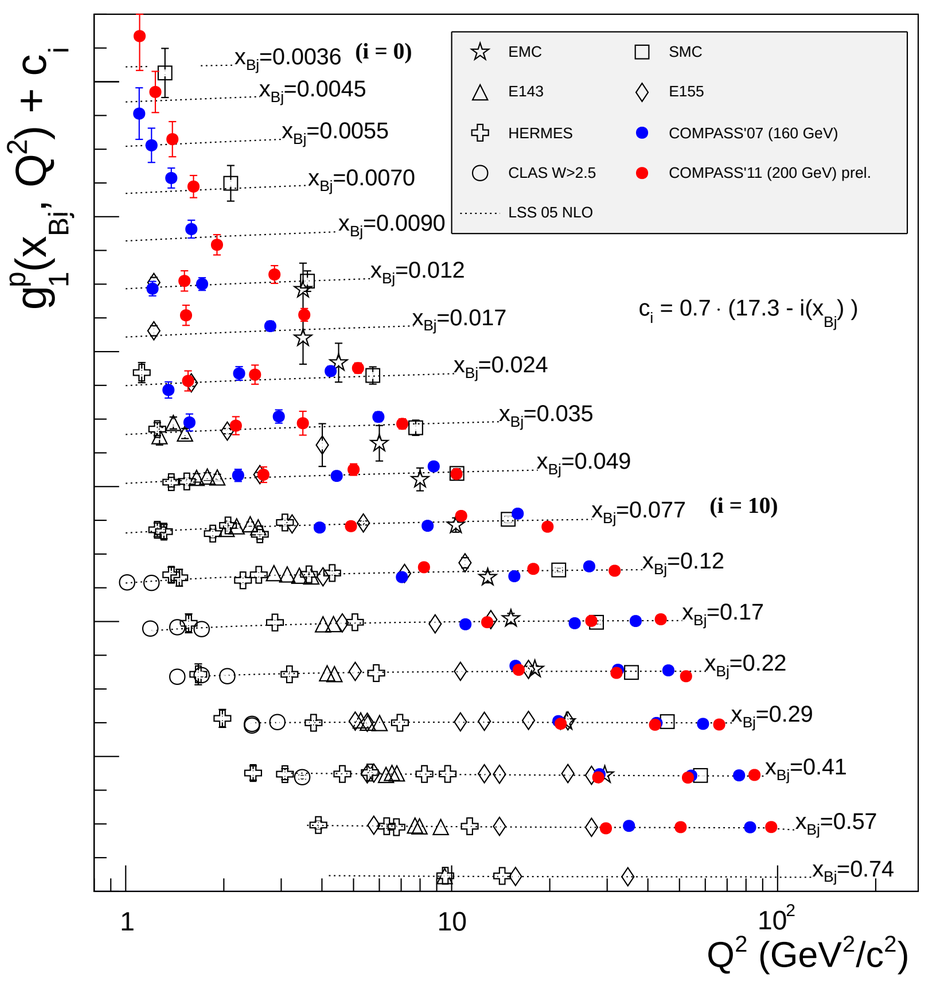


↳ Compass proton inclusive spin asymmetry A_1^p.

← Helicity quark distributions Δq vs x, COMPASS data are in red, HERMES in green and the DSSV predictions are in blue. They are extracted from the deuteron and proton inclusive asymmetry together with the semi-inclusive asymmetries of the pions and the kaons.

World data measurement of proton spin structure → function g_1^p vs Q^2. Indirect measurement of ΔG via Q^2 evolution.

Proton spin structure function g_1^p



Conclusion and Outlook

- Improvement of statistics with the new results at 200 GeV
- Extension of the measured region to lower x and larger Q^2
  - $\Rightarrow$ Indirect measurement of ΔG via g_1 COMPASS global fit
  - $\Rightarrow$ Extraction of Δq per flavour

References

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2. P. Abbon et al. (COMPASS Collaboration), NIM A577 (2007) 455
3. M.G. Alekseev at al. (COMPASS Collaboration), Phys. Lett. B 693 (2010) 227
4. E. Leader, A.V. Sidorov, D.B. Stamenov, Phys. Rev. D 73, 034023 (2006)