HERMES highlights on the longitudinal-momentum structure of the nucleon

\[ S_z = \frac{1}{2} \left( \frac{1}{2} \Delta x + \Delta G + L_x^2 + L_y^2 \right) \]

**Experimental Prerequisites**

**Forward spectrometer**
- Triangular beam configuration
- Photon identification
- Charged particle identification
- Magnetic spectrometer
- Cherenkov Shower Counter
- Detector: Hadron Calorimeter, Magnetic Spectrometer

**Measurement with high accuracy**
- Very clean reaction conditions

**Measurement of Charge Asymmetry**
- Longitudinally polarized 27.6 GeV electron/proton beam at HERA

**Proton-deuteron multiplicity asymmetry**
- Reflects different valence quark content
- Improved precision in determinations in the systematic uncertainty

**LO prediction:**
- Good agreement with CTEQ6+GS for \( p^+ \) and \( K^- \)
- CTEQ6-looser-performed well for \( p^- \)

**Measurement of the Spin Asymmetry in the Photoproduction of Pairs of High-\( p_T \) Hadrons at HERMES**
- Large \( p_T \) hadron pairs come from photon gluon fusion processes:
  - They carry information of the gluon spin

**High-\( p_T \) hadron pairs:**
- From HERA collider
- From photoproduction

**Measured asymmetry:**
- An incoherent superposition of different hard and soft subprocess asymmetries:
  \[ A_{LL}^{\text{hadrons}}(p_T) = \sum_\text{processes} f_{LL} \cdot A_{LL}^\text{process} \]

**Methodologies:**
- Factorization
- Assumptions
- No change in \( s_{LL} \)
- No information on \( u/d \) content
- Cross-section at \( 2\pi \)

**Background:**
- All other subprocesses

**Main contributing process:**
- Gluon-gluon quasi-elastic

**H1 measurement:**
- VME's (M1, M2)
- Longitudinally polarized quark production in deep-inelastic semi-inclusive scattering

**Charged Kaon Multiplicities in LO**
- Use data at 27.6 GeV
- Charged kaons from \( K^- \) and \( K^+ \)

**Charge difference asymmetries**
- Charge conjugation symmetry of fragmentation functions
- Leading order, leading twist, current fragmentation assumptions

**Evolved to Q^2 = 2.5 GeV^2**
- For \( u_L(x) \) CTEQ6 LO used

**Measurement of Parton Distributions of Strange Quarks in the Nucleon from Charged-Kaon Production in Deep-Inelastic Scattering on the Deuteron**
- Strange quarks carry no isospin, thus the same in proton and neutron
- Use vectorial probe and target to extract strange-quark distributions
- Only need inclusive asymmetries and \( K^- \) asymmetries, as well as \( K^-K^+ \) multiples on \( D \)
- Strange-quark fragmentation function either directly from data or from parameterizations

**Proton-deuteron multiplicity asymmetry**
- Reflects different valence quark content
- Improved precision in determinations in the systematic uncertainty

**LO prediction:**
- Good agreement with CTEQ6+GS for positive hadrons
- Better discrepancy for negative hadrons

**3.3 Multiplicities**
-Instead of cross section: no luminosity uncertainty

**2.6.1 Multiplicities of charged pions and kaons from semi-inclusive deep-inelastic scattering on the proton and the deuteron**

**HERA/CTEQ6+Kretzer**
- CTQ6+Kretzer
- \( \sigma \frac{d^2 \alpha}{d^2 \Delta} \) (\( x, Q^2 \))
- \( \frac{\sigma_{NN}^x}{\sigma_{NN}^x} \Rightarrow \frac{\sigma_{NN}^x}{\sigma_{NN}^x} \)
- \( \Delta S = 0.037 \pm 0.019 \pm 0.027 \)