Spin duality on the neutron (^{3}He)

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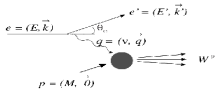
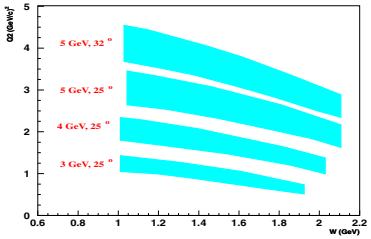
The E01-012 Experiment

- Inclusive experiment: $^3\vec{He}(\vec{e},e')X$



- Measure polarized cross sections and asymmetries in the resonance region for $1.0 < Q^2 < 4.0$ (GeV/c)^2



- Form g_1, g_2, A_1 and A_2 for ^{3}He
- Test duality on the neutron spin structure functions

Structure functions

Extract g_1 and g_2 directly from our data

$$g_1 = \frac{MQ^2\nu}{4\alpha_e^2}\,\frac{E}{E'}\,\frac{1}{E+E'}\left(\Delta\sigma_{//} + \tan(\theta/2)\,\Delta\sigma_{\perp}\right)$$

$$g_2 = \frac{MQ^2\nu^2}{4\alpha_e^2}\,\frac{1}{2E'(E+E')}\left(-\Delta\sigma_{//} + \frac{E+E'\cos\theta}{E'\sin\theta}\,\Delta\sigma_{\perp}\right)$$

Need external input of R to form A_1 and A_2

$$A_1 = \frac{A_{//}}{D(1+\eta\xi)} - \frac{\eta\,A_{\perp}}{d(1+\eta\xi)} \qquad A_2 = \frac{\xi\,A_{//}}{D(1+\eta\xi)} + \frac{A_{\perp}}{d(1+\eta\xi)}$$

(D and d depend of R)

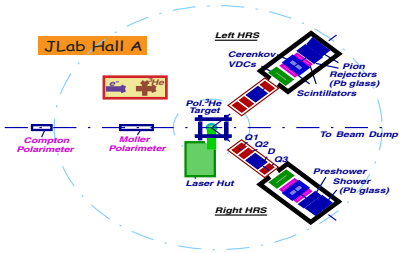
Motivations

Recent data of proton spin independent and dependent structure functions measured in the resonance region demonstrate Quark-Hadron Duality. Quark-Hadron Duality is observed when the nucleon resonances average on the high Q^2 scaling curve when an appropriate scaling variable is used. The goal of the experiment E01-012 is to provide precision data of the neutron spin structure function in order to:

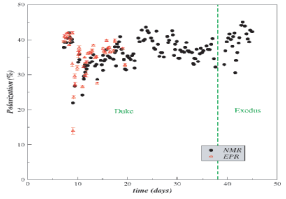
- Understand the transition between partons and hadrons
- Study of the interactions between quarks and gluons
  → might help us understand the mecanism of confinement
- Look into the spin and flavor dependence of Quark-Hadron Duality
- Possible access to the high x_{bj} region, where theoretical models predictions for A_1 are very different, if duality is demonstrated and well understood

Experimental setup

- JLab e$^-$ beam at 3, 4 and 5 GeV; P_{avg} = 77%
- High Resolution Spectrometers in symmetric configuration at 25° and 32° : double the statistics and control of the systematics
- Particle identification with Cerenkov counter combined with EM calorimeter: reduce pion contamination by 10^4 while keeping the electron efficiency > 99%
- Hall A polarized ^{3}He target:
  - based on spin exchange between optically pumped Rb and ^{3}He
  - Longitudinal and transverse configurations
  - High luminosity: 10^{36} s^{-1} cm^{-2}
  - Two independent polarimetries: NMR and EPR
  - Average polarization during E01-012 = 37%



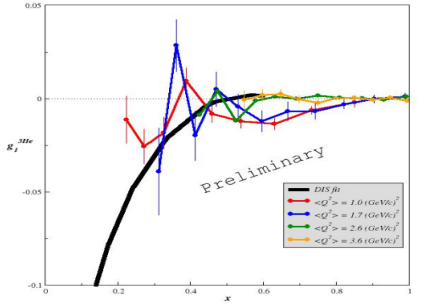
target performance

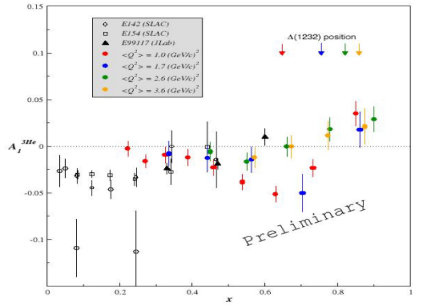


Conclusion

- E01-012 provides precision data of the spin structure functions on neutron (^{3}He) for $1.0 < Q^2 < 4.0$ (GeV/c)^2
- Test of Quark-Hadron Duality for neutron and ^{3}He spin structure functions by comparing E01-102 data with DIS data
- E01-012 data combined with proton data allow us to study the spin and flavor dependence of duality

Preliminary results for ^{3}He





Preliminary interpretations

- For $Q^2 < 2.0$ GeV^2, the Δ(1232) is large and negative in both g_1 and A_1.
- For $Q^2 > 2.0$ GeV^2, the Δ(1232) vanishes while the non-resonant backgroung is rising. Thus the g_1 resonance data oscillate around the DIS fit (no Q^2-evolution) showing a hint of Quark-Hadron Duality for g_1(^{3}He). In A_1(^{3}He), the resonance data follow the same trend as the DIS data and seem to show no Q^2-dependence.

- The polarised ^{3}He target is used as an effective neutron target and because of the dominant S state, the neutron spin structure functions are expected to show the same behavior as ^{3}He ones, since the effect of the two protons should be small.

^{3}He as neutron target

P_n = 86% and P_p = -2.8%