COMPASS INCLUSIVE ASYMMETRIES

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ON BEHALF OF THE COMPASS COLLABORATION

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We present COMPASS results for A_1^d asymmetry and g_1^d spin–dependent structure function in the low x (0.00004 $< x <$ 0.03) and low Q^2 (0.002 GeV^2 $< Q^2 <$ 1 GeV^2) region. The results are consistent with zero. Their precision in the low x region increased ten-fold compared to the results of the SMC, so far the only experiment which measured the low x and low Q^2 domain.

1. Introduction

COMPASS is an experiment at CERN focusing on the spin structure of the nucleon and hadron spectroscopy. For the spin studies 160 GeV polarized muon beam and a two cells polarized ^{6}LiD target are used [1]. Here we present new results for the deuteron spin asymmetry A_1^d and the spin–dependent structure function g_1^d for $Q^2 <$ 1 GeV^2. The results from the DIS region ($Q^2 >$ 1 GeV^2) have already been published [1,2]. The presented data come from 2002 and 2003 and their integrated luminosity corresponds to 1.5 fb^{-1}.

2. Event Selection

Incoming and scattered muon as well as an interaction vertex in the target are required. The kinematic cuts $Q^2 <$ 1 GeV^2, $x >$ 0.00004 and 0.1 $< y <$ 0.9 are used. The extrapolated trajectory of the incoming muon, in order to equalize fluxes seen by the two target cells, has to cross entirely both of them. At least one additional (charged) hadron track in the interaction

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vertex is required. It improves the vertex resolution and deals with the fact that information from hadron calorimeters is used in the COMPASS trigger system. The additional track should have $0.1 < E_h/\nu < 1.0$, and not be identified as a muon. In the region around $x \approx 0.0005$ the elastic electron–muon scattering is seen in the data, for events with one negative hadron candidate in the interaction vertex. These events are removed by the requirement that the angle between the hadron candidate and the virtual photon is larger than 5 mrad. The final data sample used in this analysis comprises 300 million events. The COMPASS acceptance in x and Q^2 is shown in Figure 1.
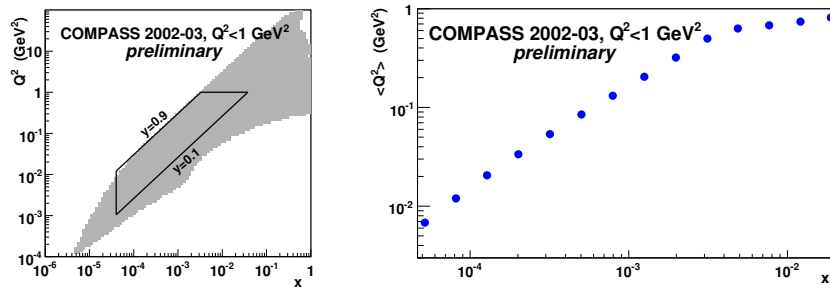

Figure 1.   COMPASS acceptance and $< Q^2 >$ as a function of x for this analysis.

3. A_1^d Asymmetry and g_1^d Structure Function

The cross-section asymmetry $A^d = (\sigma^{\uparrow\downarrow} - \sigma^{\uparrow\uparrow})/(\sigma^{\uparrow\downarrow} + \sigma^{\uparrow\uparrow})$ [a] is related to the virtual photon–deuteron asymmetry A_1^d by[b]:

$$A^d \simeq D\, A_1^d \tag{1}$$

where the so called virtual photon depolarization factor, D, depends on the event kinematics. The spin dependent structure function g_1^d is given by[b]:

$$g_1^d \simeq \frac{F_2^d}{2x(1+R)} A_1^d \tag{2}$$

where F_2^d and R are spin independent structure functions. The F_2 for $x > 0.0009$ and $Q^2 > 0.2$ GeV^2 is taken from [3] and from [4] in the rest of the

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[a] arrows correspond to relative orientation of the incoming muon and the target deuteron spins

[b] all factors which contains A_2^d were neglected since they are small in this analysis

phase space. Concerning R: For $Q^2 > 0.5$ R comes from [5] and for lower Q^2 a parametrization with the following constraints is obtained. R is proportional to Q^2 at the photoproduction limit and has the same value and 1st derivative as [5] at $Q^2 = 0.5$ GeV^2. The procedure which relates the observed number of muon–nucleon interactions to A_1^d is described in [1]. Apart from the depolarization factor and the number of collected events only the beam polarization, the target polarization and the so called dilution factor [c], have to be known in order to obtain A_1^d. The radiative corrections were calculated using TRAD[6] and POLRAD[7] programs.

4. Results

The results for A_1^d and g_1^d as functions of x are presented in Figures 2 and 3. The error bars mark statistical errors, the shaded band indicates the systematic ones. Most of the systematic uncertainty results from possible false asymmetries estimated in a way similar as in [1].

The values of A_1^d and g_1^d were found to be consistent with 0 in the investigated x range. Comparison with the SMC results [8] for $Q^2 < 1$ GeV^2 is shown in Figure 4. Only statistical errors are shown. The statistical precision of A_1^d and g_1^d in COMPASS is ten times better than in the SMC. The results of these two analyses are consistent in the overlap region.
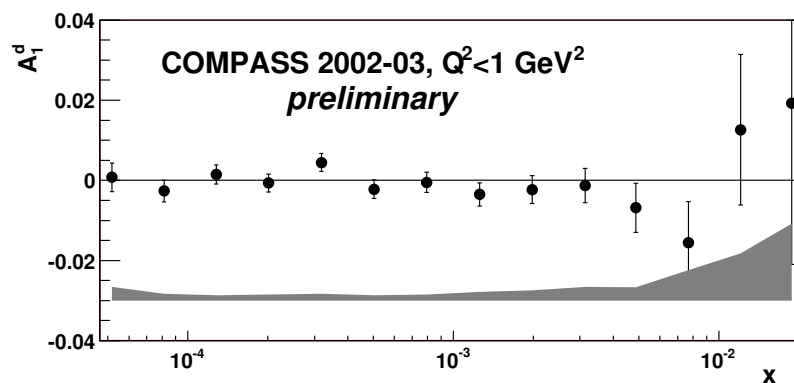

Figure 2.   The COMPASS results of the A_1^d in the low x and low Q^2 region.

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[c]it is given by the ratio of the absorption cross–section on the deuteron to the sum of cross–sections on all elements consistuiting the target

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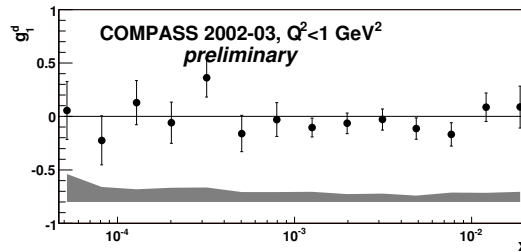Figure 3.   The COMPASS results of the g_1^d in the low x and low Q^2 region.
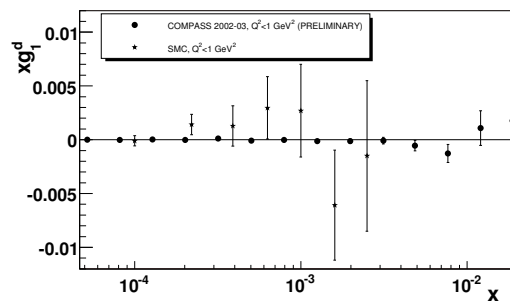

Figure 4.   The g_1^d world data in the low x region for $Q^2 < 1$ GeV^2. Note large error decrease for COMPASS.

5. Summary

The new results for A_1^d and g_1^d in the low x and low Q^2 region were presented. The values of A_1^d and g_1^d were found to be consistent with zero. The statical precision was improved considerable compared to previous experiments. The use of the 2004 data will roughly double the statistics.

References

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