COMPASS INCLUSIVE ASYMMETRIES

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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 $^9$Li target are used. 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. 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

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.

![COMPASS acceptance and $<Q^2>$ as a function of $x$ for this analysis.](image)

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

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

$$A^d \simeq D \ A_1^d$$  \hspace{1cm} (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$^b$:

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

$^a$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 $^6$, 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.

![Graph](image)

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

$^5$It is given by the ratio of the absorption cross-section on the deuteron to the sum of cross-sections on all elements constituting the target.
5. Summary

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

References