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Erratum: Spin asymmetries $A_1$ of the proton and the deuteron in the low $x$ and low $Q^2$ region from polarized high energy muon scattering

[Phys. Rev. D 60, 072004 (1999)]


(Spin Muon Collaboration)
(Published 21 August 2000)

PACS number(s): 13.60.Hb, 13.88.1 of the proton and the deuteron in the low $Q^2$ region.

The cross section $A_1$ and $A_1^d$ presented in [1] were measured in the kinematic region where the four-momentum transfer $Q^2$ extended down to 0.01 GeV$^2$. A full account of the formalism is given in [2]. In this kinematic region one cannot neglect $m^2/Q^2$ terms in the expression for the cross section. These terms were correctly taken into account in the unpolarized part of the cross section, $\sigma$ [cf. Eq. (2.2) in [2]]; they were however omitted in the polarized part, $\Delta \sigma$ [Eqs. (2.4)–(2.6) in [2]].

The cross sections $\Delta \sigma_\parallel$ and $\Delta \sigma_\perp$, corresponding to the two configurations where the nucleon spin is either along or orthogonal to the muon spin [cf., Eq. (2.4) in [2]] should be written as follows:

$$\frac{d^2 \Delta \sigma_\parallel}{dx \, dQ^2} = \frac{16 \pi \alpha^2 y}{Q^4} \left[ 1 - \frac{y}{2} - \frac{y^2 y^2}{4} - \frac{m^2}{Q^2} \right] g_1 - \frac{y^2 y}{2} g_2. \tag{1}$$

and

$$\frac{d^3 \Delta \sigma_\perp}{dx \, dQ^2 \, d\phi} = -\cos \phi \frac{8 \alpha^2 y}{Q^4} \sqrt{1 - \frac{y^2 y^2}{4}} \left[ \frac{y}{2} \left( 1 + \frac{2 m^2}{Q^2} \right) g_1 + g_2 \right]. \tag{2}$$

The measured asymmetries $A_1$ and $A_\perp$ are related to $A_1$ and $A_2$ [cf., Eqs (2.7)–(2.8) in [2]] through the depolarization factor $D$,

$$D = \frac{y [ (1 + y^2 y/2) (2 - y) - 2 y^2 m^2/Q^2 ]}{y^2 (1 - 2 m^2/Q^2)(1 + y^2) + 2 (1 + R)(1 - y - y^2 y^2/4)}, \tag{3}$$

the factor $d$ for the orthogonal spin configuration,

$$d = \frac{\sqrt{1 - y - y^2 y^2/4 (1 + y^2 y/2)}}{(1 - y/2) (1 + y^2 y/2) - y^2 m^2/Q^2} D, \tag{4}$$

and kinematic factors $\eta$ and $\xi$,

$$\eta = \frac{y (1 - y - y^2 y^2/4 - y^2 m^2/Q^2)}{(1 + y^2 y/2) (1 - y/2) - y^2 m^2/Q^2}. \tag{5}$$
The only approximation applied in these equations is in neglecting terms \( m_\mu^2/Q^2 \) which are of the order of \( 10^{-7} \) in our kinematic range. With the above definition the depolarization factor is always smaller than unity.

The missing \( m_\mu^2/Q^2 \) terms in the polarized part of the cross section is most apparent at low \( Q^2 \). Therefore our low \( x \), low \( Q^2 \) data presented in [1] were reanalyzed using the corrected equations. The results for the reanalyzed proton and deuteron spin asymmetries \( A_{1p}^{p,d} \) and spin structure functions \( g_1^{p,d} \) are given here in Tables I and II for newly accessed region at low \( Q^2 \). The change in \( A_{1p}^{p,d} \) and in its statistical error is significant only in the two bins corresponding to the smallest values of \( x \) and \( Q^2 \). The average values of \( x \) and \( Q^2 \) change in the first bin of \( x \) because \( D \) is used in the weight calculations. Changes at higher \( x \) are negligible and the physics conclusions given in [1] are unchanged.

### Table I. Modifications to Tables III and V in Ref. [1]. The asymmetry \( A_{1p}^{p} \) and the spin structure function \( g_1^{p} \) at the average \( Q^2 \) for newly accessed region at low \( x \).

<table>
<thead>
<tr>
<th>( x )</th>
<th>( \langle Q^2 \rangle ) (GeV(^2))</th>
<th>( A_{1p}^{p} )</th>
<th>( g_1^{p} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00011</td>
<td>0.03</td>
<td>0.026±0.023±0.009</td>
<td>3.5±3.1±0.4</td>
</tr>
<tr>
<td>0.00022</td>
<td>0.06</td>
<td>0.019±0.019±0.005</td>
<td>2.5±2.5±0.6</td>
</tr>
<tr>
<td>0.00039</td>
<td>0.10</td>
<td>0.002±0.020±0.002</td>
<td>0.3±2.5±0.2</td>
</tr>
<tr>
<td>0.00063</td>
<td>0.17</td>
<td>-0.004±0.022±0.002</td>
<td>-0.4±2.3±0.2</td>
</tr>
</tbody>
</table>

### Table II. Modifications to Tables IV and VI in Ref. [1]. The asymmetry \( A_{1d}^{d} \) and the spin dependent structure function \( g_1^{d} \) at the average \( Q^2 \) for newly accessed region at low \( x \).

<table>
<thead>
<tr>
<th>( x )</th>
<th>( \langle Q^2 \rangle ) (GeV(^2))</th>
<th>( A_{1d}^{d} )</th>
<th>( g_1^{d} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00011</td>
<td>0.03</td>
<td>-0.013±0.050±0.006</td>
<td>-1.7±6.6±0.6</td>
</tr>
<tr>
<td>0.00022</td>
<td>0.06</td>
<td>0.056±0.040±0.015</td>
<td>7.6±5.3±1.6</td>
</tr>
<tr>
<td>0.00039</td>
<td>0.10</td>
<td>0.030±0.043±0.008</td>
<td>3.7±5.3±1.0</td>
</tr>
<tr>
<td>0.00063</td>
<td>0.17</td>
<td>0.047±0.046±0.012</td>
<td>5.0±4.9±1.2</td>
</tr>
</tbody>
</table>
