POLARISED PARTON DENSITIES FROM THE FITS TO THE DEEP INELASTIC SPIN ASYMMETRIES ON NUCLEONS

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We have updated our next to leading order QCD fit for polarised parton densities [S. Tatur, J. Bartelski, M. Kurzela, *Acta Phys. Pol.* **B31**, 647 (2000)] using recent experimental data on the deep inelastic spin asymmetries on nucleons. Our distributions have functional form inspired by the unpolarised ones given by MRST (Martin, Roberts, Stirling and Thorne) fit. In addition to usually used data sample (averaged over variable Q^2 for the same value of x variable) we have also considered the points with the same x and different Q^2. Our fits to both groups of data give very similar results with substantial antiquark contribution in the measured region of x. In the first case we get rather small ($\Delta G = 0.31$) gluon polarisation. For the non averaged data the best fit is obtained when gluon contribution vanishes at $Q^2 = 1\,\mathrm{GeV}^2$. Our new parametrisation of parton densities and additional experimental data taken into account do not change much our previous results.

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Quite a lot of data exist for the deep inelastic spin asymmetries on different nucleon targets. The data come from experiments made at SLAC [2–10], CERN [11–16] and DESY [17,18]. The newest data on proton [9,16,18] and deuteron targets [9,10,16] have smaller statistical errors and can improve phenomenological fits.

The analysis of the EMC group results [11] started an interest in studying polarised structure functions. The suggestion from Ref. [19] was that polarised gluons may be responsible for the little spin carried by quarks. The progress made in theoretical calculations [20] enables one to perform next to leading (NLO) order QCD fits [21–26] and polarised parton distributions (*i.e.* for quarks, antiquarks and gluons) were determined. Many groups obtained high gluon polarisation (however, determined with a big error). The aim of this paper is to extend our next to leading order QCD analysis given in [1] by taking into account, in addition to all previously considered data, also proton data [18] from HERMES (DESY) and deuteron data [10] from E155 experiment (SLAC). We will also use different fit for parton unpolarised distributions [27]. The main conclusion gotten in [1] was that gluon contribution is negligible at $Q^2 = 1\,\mathrm{GeV}^2$. In spite of the fact that we use now different parametrisation for parton distributions our results (in particular on gluon polarisation) do not change very much.

As in [1] we will make fits to two samples of the data. In the first group we will have data for the same x (strictly speaking for the near values) and different Q^2 and in the second the "averaged" data, where one averages over Q^2 (the errors are smaller and Q^2 dependence is smeared out). In most of the fits to experimental data only the second sample (namely, with averaged Q^2 dependence) was used. Our fits use the both sets of the data (the first group contains 417 points and the second 160 points). The gotten results are very similar for different samples of data points (the same conclusion was already drawn in [1]). We have already stressed [28] that making a fit to spin asymmetries enables one to avoid the problem with higher twist contributions which are probably less important in such a case (see also for example [29]).

Experiments on unpolarised targets provide information on the unpolarised quark densities $q(x, Q^2)$ and $G(x, Q^2)$ inside the nucleon. These densities can be expressed in term of $q^{\pm}(x, Q^2)$ and $G^{\pm}(x, Q^2)$, *i.e.* densities of quarks and gluons with helicity along or opposite to the helicity of the parent nucleon.

$$q = q^{+} + q^{-}\,, \qquad\qquad G = G^{+} + G^{-}\,. \tag{1}$$

The polarised parton densities, *i.e.* the differences of q^{+}, q^{-} and G^{+}, G^{-} are given by:

$$\Delta q = q^{+} - q^{-}\,, \qquad\qquad \Delta G = G^{+} - G^{-}\,. \tag{2}$$

We will try to determine $q^{\pm}(x, Q^2)$ and $G^{\pm}(x, Q^2)$, in other words, we will try to connect unpolarised and polarised data.

Let us start with the formulas for unpolarised quark parton distributions gotten (at $Q^2 = 1\,\mathrm{GeV}^2$) from the one of recent fits performed by Martin, Roberts, Stirling and Thorne [27]. One has for valence quarks (one uses $\Lambda_{\overline{MS}}^{n_f=4} = 0.3$ GeV and $\alpha_s(M_Z^2) = 0.120$):

$$\begin{aligned} u_v(x) &= 0.6051x^{-0.5911}(1-x)^{3.395}(1+2.078\sqrt{x}+14.56x)\,, \\ d_v(x) &= 0.0581x^{-0.7118}(1-x)^{3.874}(1+34.69\sqrt{x}+28.96x)\,, \end{aligned} \tag{3}$$

whereas for the antiquarks:

$$\begin{aligned} 2\bar{u}(x) &= 0.4M(x) - \delta(x)\,, \\ 2\bar{d}(x) &= 0.4M(x) + \delta(x)\,, \\ 2\bar{s}(x) &= 0.2M(x)\,. \end{aligned} \tag{4}$$

The singlet contribution $M = 2[\bar{u} + \bar{d} + \bar{s}]$ is given by:

$$M(x) = 0.2004x^{-1.2712}(1-x)^{7.808}(1+2.283\sqrt{x}+20.69x)\,, \tag{5}$$

and the isovector part ($\delta = \bar{d} - \bar{u}$) is:

$$\delta(x) = 1.290x^{0.183}(1-x)^{9.808}(1+9.987x-33.34x^2)\,. \tag{6}$$

Unpolarised gluon distribution is given by:

$$G(x) = 64.57x^{-0.0829}(1-x)^{6.587}(1-3.168\sqrt{x}+3.251x)\,. \tag{7}$$

We will split q and G, as was already discussed in Ref. [1], into two parts in such a manner that the distributions $q^{\pm}(x,Q^2)$ and $G^{\pm}(x,Q^2)$ remain positive. At the end of the paper we will discuss the consequences of relaxing the positivity conditions. Our expressions for $\Delta q(x) = q^{+}(x) - q^{-}(x)$ are parametrised as follows:

$$\begin{aligned} \Delta u_v(x) &= x^{-0.5911}(1-x)^{3.395}(a_1+a_2\sqrt{x}+a_4x)\,, \\ \Delta d_v(x) &= x^{-0.7118}(1-x)^{3.874}(b_1+b_2\sqrt{x}+b_3x)\,, \\ \Delta M(x) &= x^{-0.7712}(1-x)^{7.808}(c_1+c_2\sqrt{x})\,, \\ \Delta\delta(x) &= x^{0.183}(1-x)^{9.808}c_3(1+9.987x-33.34x^2), \\ \Delta G(x) &= x^{-0.0829}(1-x)^{6.587}(d_1+d_2\sqrt{x}+d_3x)\,. \end{aligned} \tag{8}$$

It is very important what assumptions one makes about the sea contribution. From the MRST fit for unpolarised structure functions the natural assumption would be: $\Delta\bar{s} = \Delta\bar{d}/2 = \Delta\bar{u}/2$. This assumption together with the condition that SU(3) combination of densities: $a_8 = \Delta u + \Delta d - 2\Delta s$

should be equal to the value determined from the semileptonic hyperon decays could be very restrictive. The quantity Δs is pushed into negative values and so is non-strange sea. Instead of connecting Δs in some way to non-strange sea value we introduce additional free parameters for the strange sea contribution namely

$$\Delta M_s = x^{-0.7712}(1-x)^{7.808}(c_{1s} + c_{2s}\sqrt{x})\,. \tag{9}$$

In this way we will have additional independent parameters for the strange quarks. Hence, in our fits we will start with fourteen parameters. Comparing the expression (5) with (8) and (9) we see that in ΔM (and ΔM_s) there is no term behaving like $x^{-1.2712}$ at small x (we assume that ΔM and hence all sea distributions have finite integral) which means that we split ΔM into two parts (ΔM^+ and ΔM^-) in such manner that the most singular term in the sea contribution drops out. Hence, in the fitting procedure we are using functions that are suggested by the fit to unpolarised data. Maybe not all parameters are important in the fit and it could happen that some of the coefficients in Eqs. .(8),(9) taken as free parameters in the fit are small or in some sense superfluous. Putting them to zero or eliminating them increase χ^2 only a little but makes $\chi^2/N_{\rm DF}$ smaller. We will see that this is the case with some parameters introduced in Eqs. (8),(9).

In order to get the unknown parameters in the expressions for polarised quark and gluon distributions (Eqs. (8),(9)) we calculate the spin asymmetries (starting from initial $Q^2 = 1$ GeV^2) for measured values of Q^2 and make a fit to the experimental data on spin asymmetries for proton, neutron and deuteron targets. The spin asymmetry $A_1(x,Q^2)$ can be expressed via polarised structure function $g_1(x,Q^2)$ as

$$A_1(x,Q^2) \cong \frac{(1+\gamma^2)g_1(x,Q^2)}{F_1(x,Q^2)} = \frac{g_1(x,Q^2)}{F_2(x,Q^2)}[2x(1+R(x,Q^2))]\,, \tag{10}$$

where $R = [F_2(1+\gamma^2) - 2xF_1]/2xF_1$ whereas F_1 and F_2 are the unpolarised structure functions and $\gamma = 2Mx/Q$. We will take the new determined value of R from the [30]. The factor $(1+\gamma^2)$ plays non negligible role for x and Q^2 values measured in SLAC experiments. In calculating $g_1(x,Q^2)$ and $F_2(x,Q^2)$ in the next to leading order we will follow procedure described in [1] following the method described in [21,32] performing calculations with Mellin transforms and then calculating Mellin inverse. Having calculated the asymmetries according to equation (10) for the value of Q^2 obtained in experiments we can make a fit to asymmetries on proton, neutron and deuteron targets. We will take into account 417 points (193 for proton, 171 for deuteron and 53 for neutron). We will not fix $a_8 = \Delta u + \Delta d - 2\Delta s$ value but we will add experimental point $a_8 = 0.58 \pm 0.1$ with enhanced (to 3σ)

error. That means we will simply add to χ^2 corresponding to experimental points for spin asymmetries the term connected with experimental point from hyperon decays. We will discuss how this additional experimental point influences our results.

The fit with all fourteen parameters from Eqs. (8),(9) gives $\chi^2 = 340.4$. It seems that some of the parameters of the most singular terms are superfluous and we can eliminate them. We will put $d_1 = d_2 = 0$ (such assumption gives that $\delta G/G \sim x$ for small x), $b_1 = 0$ (the most singular term in Δd_v) and assume $c_{1s} = c_1$ (*i.e.* the most singular terms for strange and non-strange sea contributions are equal). Fixing these four parameters in the fit practically does not change χ^2 but improves $\chi^2/N_{\rm DF}$. The resulting χ^2 per degree of freedom is better than in the previous fit and one gets $\chi^2/N_{\rm DF} = \frac{341.1}{418-10} = 0.84$. In this case we get the following values of parameters from the fit to all existing (above mentioned) data for $Q^2 \geq 1{\rm GeV}^2$ for spin asymmetries:

$$\begin{array}{lll} a_1 = 0.61 \pm 0.00\,, & a_2 = -6.1 \pm 0.19\,, & a_4 = 15.7 \pm 0.42\,, \\ b_2 = -1.56 \pm 0.20\,, & b_3 = -0.43 \pm 0.49\,, & \\ c_1 = -0.40 \pm 0.03\,, & c_2 = 4.15 \pm 0.00\,, & \\ c_{1s} = c_1\,, & c_{2s} = -0.28 \pm 0.83\,, & \\ c_3 = -1.29 \pm 2.53\,, & & \\ d_3 = 2.01 \pm 11.2\,. & & \end{array} \tag{11}$$

Actually also the parameter d_3 could be put equal to zero without increasing $\chi^2/N_{\rm DF}$. We get in this case the smallest $\chi^2/N_{\rm DF} = \frac{341.1}{418-9} = 0.83$. That means that d_3 is not well determined in the fit and the best $\chi^2/N_{\rm DF}$ is without gluonic contribution.

The obtained quark and gluon distributions lead for ($Q^2 = 1$ GeV^2) to the following integrated (over x) quantities: $\Delta u = 0.80 \pm 0.02$, $\Delta d = -0.65 \pm 0.03$, $\Delta s = -0.21 \pm 0.05$, $\Delta u_v = 0.67 \pm 0.02$, $\Delta d_v = -0.59 \pm 0.02$, $2\Delta \bar{u} = 0.14 \pm 0.03$, $2\Delta \bar{d} = -0.07 \pm 0.03$.

These numbers yield the following predictions: $a_0 = \Delta u + \Delta d + \Delta s = -0.06 \pm 0.07$, $a_3 = \Delta u - \Delta d = 1.45 \pm 0.02$, $\Delta G = 0.04 \pm 0.19$, $\mathit{\Gamma}_1^p = 0.111 \pm 0.006$, $\mathit{\Gamma}_1^n = -0.096 \pm 0.006$, $\mathit{\Gamma}_1^d = 0.007 \pm 0.005$.

We have positively polarised sea for up and negatively for down quarks and very strongly negatively polarised sea for strange quarks. Because of the big negative value of Δs the quantity a_0 is also negative. The gluon polarisation is small. The value of a_3 was not assumed as an input in the fit (as is the case in nearly all fits [24]) and comes out slightly higher than the experimental value. The quantity $\Delta\delta$, which contributes to the value of a_3 comes out relatively big from the fit (coefficient in front of $\Delta\delta$ is equal to that in δ) but with very big error. Putting $c_3 = 0$ increases χ^2 to 342.0 and also the number per degree of freedom is bigger. Hence, the value of $\Delta\delta$ is not very well determined.

As was already mentioned in [1] the asymptotic behaviour at small x of our polarised quark distributions is determined by the unpolarised ones and hence do not have the expected theoretically Regge type behaviour. Some of the quantities in our fit change rapidly for $x \leq 0.003$.

Hence, we will present quantities integrated over the region from x=0.003 to x=1 (it is practically integration over the region which is covered by the experimental data, except non controversial extrapolation for highest x). The corresponding quantities for our basic fit are $\Delta u = 0.85$ ($\Delta u_v = 0.56$, $2\Delta\bar{u} = 0.29$), $\Delta d = -0.48$ ($\Delta d_v = -0.57$, $2\Delta\bar{d} = 0.09$), $\Delta s = -0.12$, $a_0 = 0.25$, $\Delta G = 0.04$, $\Gamma_1^p = 0.123$, $\Gamma_1^n = -0.056$, $\Gamma_1^d = 0.036$, $a_3 = 1.32$. In this region the obtained values of sea contributions are relatively high and those of valence quarks relatively small. Gluon contribution practically vanishes. There is relatively strong dependence of different quantities in the unmeasured region ($0 \leq x \leq 0.003$). Maybe the unpolarised MRST parton distributions (with the above mentioned modifications) do not describe quite correctly the small x behaviour of polarised parton distributions. On the other hand the fit to the data is very good. So, the values of integrated quantities in the measured region, we consider as more reliable then in the whole region. With the value of $\Delta s = -0.12$ in the measured region of x we have $a_0 = 0.25$ and with $\Delta s = -0.21$ in the whole region of x a_0 becomes negative (–0.06). We want to stress once more that our fits lead to the substantial antiquark contribution in the measured region of x and rather small gluon contribution.

When we use the quantities calculated in the measured region and extend them to the full x region using asymptotic Regge behaviour for small x we get $\Delta u = 0.86$ ($\Delta u_v = 0.59$, $2\Delta\bar{u} = 0.27$), $\Delta d = -0.51$ ($\Delta d_v = -0.58$, $2\Delta\bar{d} = 0.07$), $\Delta s = -0.14$, $a_0 = 0.21$, $\Delta G = 0.04$, $a_3 = 1.37$. We have used $x^{-\alpha}$ behaviour for small x (with $-0.25 \leq \alpha \leq 0.25$) and the quantities do not depend strongly on a specific value of α. For the values given above $\alpha = 0$ was used.

Now, we shall calculate Γ^p, Γ^n and Γ^d in the measured region for $Q^2 = 5$ GeV^2 and compare them with the quantities given by the experimental groups. We get in the region between $x = 0.003$ and $x = 0.8$ (covered by the data) $\Gamma_1^p = 0.132 \pm 0.006$, $\Gamma_1^n = -0.051 \pm 0.007$ and $\Gamma_1^d = 0.037 \pm 0.006$. The experimental group SMC presents [23] the following values in such region (for $Q^2 = 5$ GeV^2):

$$\begin{aligned} \Gamma_1^p &= 0.130 \pm 0.007\,, \\ \Gamma_1^n &= -0.054 \pm 0.009\,, \\ \Gamma_1^d &= 0.036 \pm 0.005\,. \end{aligned} \tag{12}$$

One can see that our results are in good agreement with experimental values.

In Fig. 1 we present (as an example) our fit to the non averaged data in comparison with measured (averaged over Q^2) g_1/F_1 for new proton (HERMES) and deuteron (E155) data. The curves are obtained by joining the calculated values of asymmetries corresponding to actual values of x and Q^2 for measured data points. The curves are not fitted but the difference in fitted asymmetries for averaged and non-averaged data are very small. For asymmetries the curves with Q^2 evolution taken into account and evolution completely neglected do not differ very much so we do not present them.

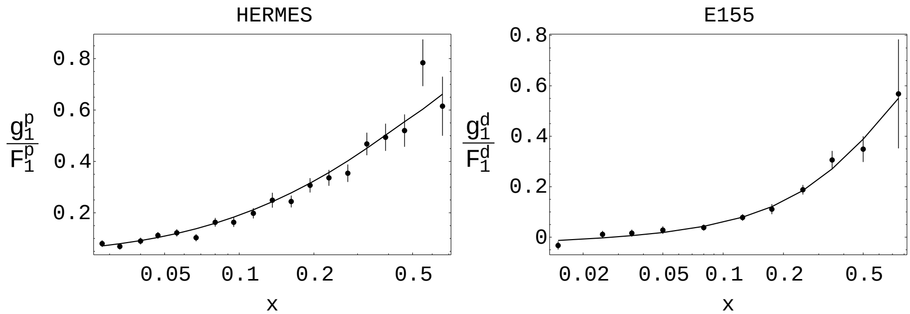

Fig. 1. The comparison of our predictions for $g_1^N(x,Q^2)/F_1^N(x,Q^2)$ *versus* x from the basic fit with HERMES proton and E155 deuteron averaged data.

In Figs. 2 and 3 we show the comparison of our predictions for g_1 from the basic fit with the measured averaged values for proton, deuteron and neutron data. The values of g_1 were calculated from the fitted spin asymmetries for the values of x and Q^2 measured for averaged data points in different experiments and then joined together. The agreement is good and shows consistency of assumptions we made. On the other hand the spread of experimental points is still substantial. Polarised quark distributions for up and down valence quarks as well as non strange, strange quarks and gluons for $Q^2 = 1$ GeV^2 are presented in figure 4. Dashed curves represent the $+$ and $-$ components for different parton densities. The solid curves correspond to the difference of $+$ and $-$ components, the sums of components (not shown) correspond to nonpolarised parton distributions. We see that especially polarised gluon distribution function is really tiny and does not resemble the distribution function for unpolarised case. We would like to stress that our procedure to get a parametrisation of polarised distributions enables one to show $+$ and $-$ components of such densities and not only their difference, as is the case in other determinations of parton polarisations.

The gluon distribution is also quite different from the gluon distribution (given in [34]) used to estimate $\Delta G/G$ in COMPASS experiment planned at CERN [35]. For $x = 0.1$ (at $Q^2 = 1\,\mathrm{GeV}^2$) we have $\Delta G/G = 0.01$ and this is below a planned experimental resolution.

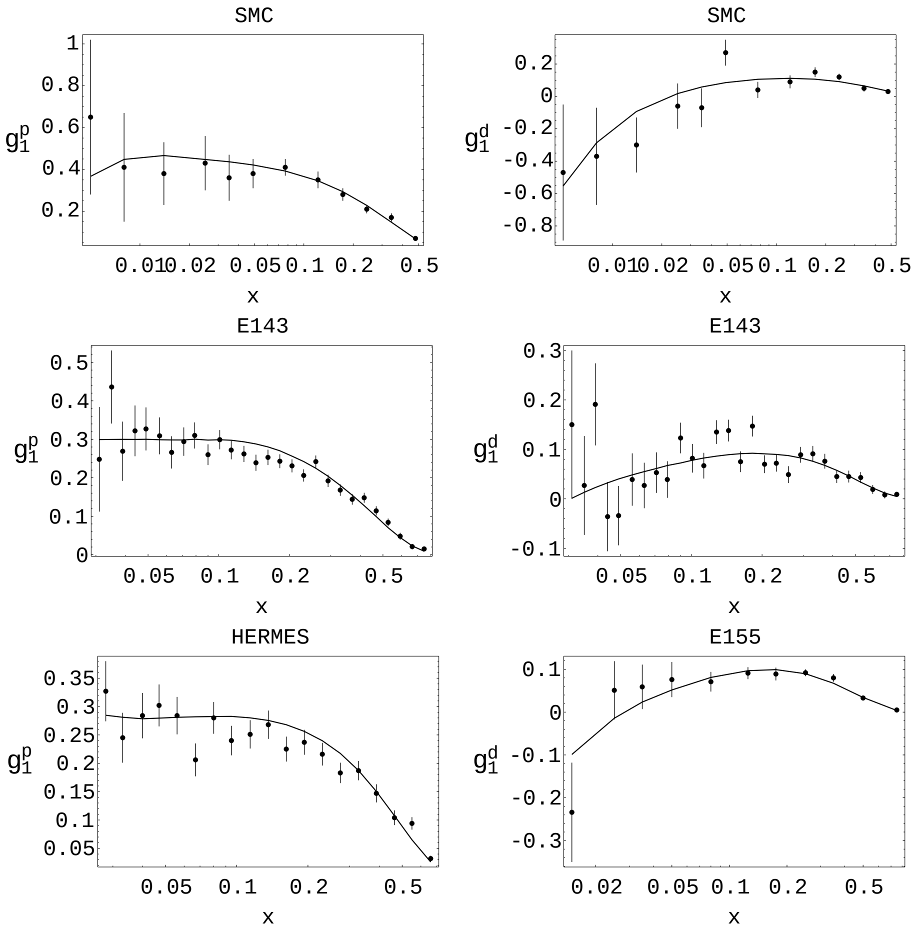

Fig. 2. The comparison of our predictions for $g_1^N(x,Q^2)$ *versus* x with the measured structure functions in experiments on proton target: SMC, E143, HERMES and on deuteron target SMC, E143 and E155.

In our fit the value of a_8 is fixed by adding experimental point on this quantity. When we relax the condition for $a_8 = 0.58$ we get $\chi^2 = 340.8$, so χ^2 practically does not change. We get the fit with the parameters not very different from our basic fit but with $\Delta s = 0.01$ and very small $a_8 = 0.03$ far from the value obtained from low energy experiments. It seems that Δs is not well determined from the data on spin asymmetries alone but that does not influences strongly the values of non strange quark and gluon parameters.

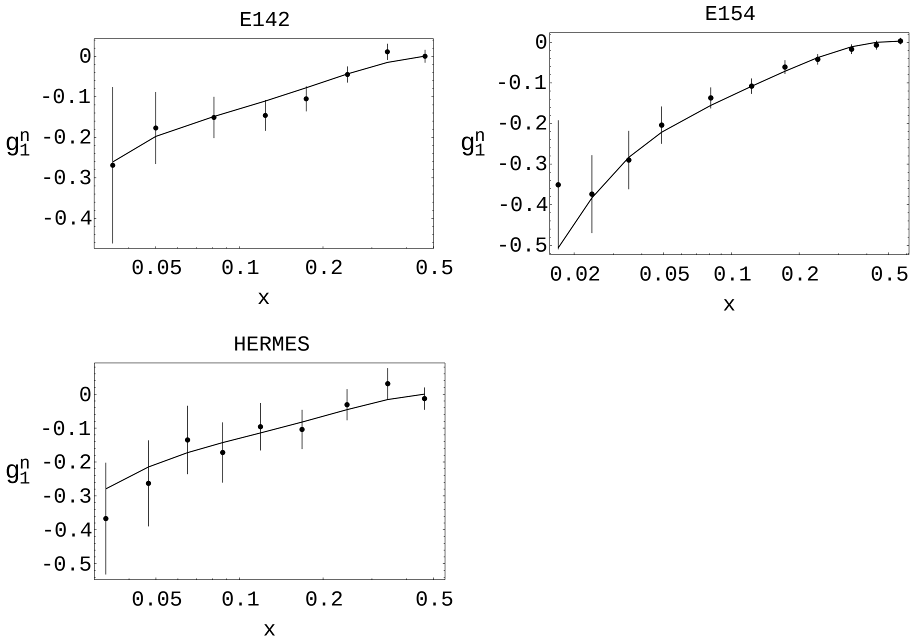

Fig. 3. The comparison of our predictions for $g_1^n(x,Q^2)$ *versus* x calculated from the basic fit with the measured structure functions in E142, E154 and HERMES experiments.

We have also repeated the fit with the specific assumption for the sea contribution namely: $\Delta\bar{u} = \Delta\bar{d} = 2\Delta\bar{s}$, the assumption that follows directly from MRST unpolarised fit with the additional experimental point for a_8. The χ^2 value increases significantly and per degree of freedom one gets a number $\chi^2/N_{\rm DF} = \frac{353.2}{418-9} = 0.86$ which is worse than in our basic fit. In this case we have $\Delta u = 0.80$ ($\Delta u_v = 0.87$, $2\Delta\bar{u} = -0.07$), $\Delta d = -0.61$ ($\Delta d_v = -0.40$, $2\Delta\bar{d} = -0.21$), $\Delta s = -0.07$, $a_0 = 0.11$, $\Delta G = 0.07$ and $a_8 = 0.33$. The quantity Δs must be negative in order to get experimental value for a_8 and because of our assumption $\Delta\bar{u} = \Delta\bar{d} = 2\Delta\bar{s}$ we obtain negative values of non strange sea for up and down quarks. The values of $\Delta u = \Delta u_v + 2\Delta\bar{u}$ and $\Delta d = \Delta d_v + 2\Delta\bar{d}$ do not change significantly (however, Δu_v and Δd_v change). Also ΔG does not change and is small. With the assumption concerning non-strange and strange sea and additional experimental point on a_8 we get $a_8 = 0.33$ and high χ^2 value. Part of the increase in χ^2 comes from that deviation from the experimental value. On the other hand we want to stress that without the experimental point corresponding to a_8 we get $\chi^2 = 340.8$ and reproduce the basic solution with relaxed a_8 value. Drawing the conclusions from the discussion of the above assumption (very

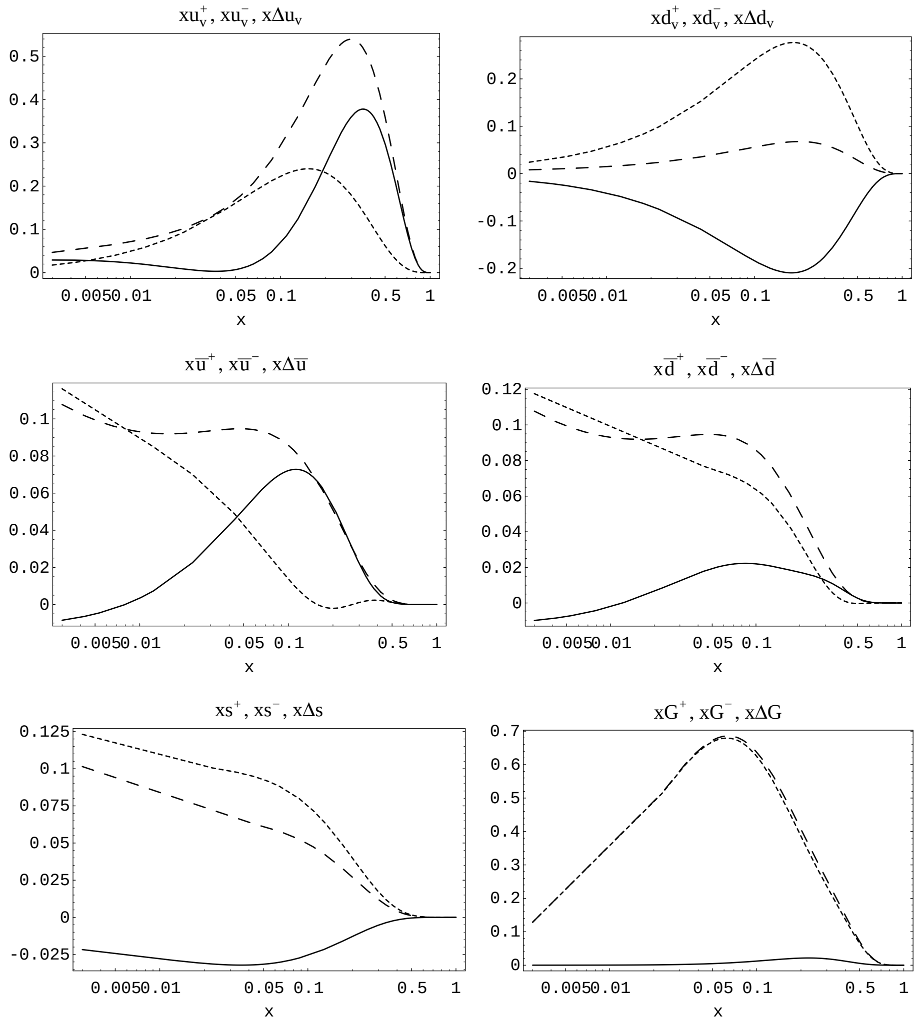

Fig. 4. Our predictions for spin densities *versus* x for quark and gluons at $Q^2 = 1\,\mathrm{GeV}^2$. We present distributions for valence u quark, valence d quark, sea $\bar{u}$ antiquark, sea $\bar{d}$ antiquark, sea s quark and gluons. For each figure we have densities for partons polarised along ($xq^+(x), xG^+(x)$ — dashed lines) and opposite ($xq^-(x), xG^-(x)$ — dotted lines) to the helicity of parent proton as well as total polarization of such partons (*i.e.* the differences of above mentioned quantities — solid lines).

natural from the point of view of MRST parametrisation) and having in mind that the value of Δs is important in determination of a_0 we decided to use additional free parameters for strange sea contribution in order to determine it (with additional point for a_8) from the fit to experimental data.

As in [1] we look on consequences of eliminating the most singular terms in polarised distributions ($\Delta u_v(x)$ and $\Delta M(x)$). For comparison we have investigated the model when in polarised densities these singular contributions are absent. In this case Δu_v and ΔM are $\sqrt{x}$ less singular than in our basic fit. For such a fit we get $\chi^2/N_{\rm DF} = \frac{356.6}{418-8} = 0.87$, *i.e.* significantly higher than in our basic fit. We get in this case: $\Delta u = 0.77$ ($\Delta u_v = 0.57$, $2\Delta\bar{u} = 0.20$), $\Delta d = -0.38$ ($\Delta d_v = -0.63$, $2\Delta\bar{d} = 0.25$), $\Delta s = -0.10$, $a_0 = 0.28$, $\Delta G = 0.22$. In such fit the integrated quantities taken over the whole range of $0 \leq x \leq 1$ and in the truncated one ($0.003 \leq x \leq 1$) differ very little. The quantity ΔG is positive and different from zero. So it is possible to get the fit with practically no change of integrated quantities in the region between $x = 0$ and $x = 0.003$ but with significantly higher χ^2 value. For Q^2=1 GeV^2 we have $\Gamma_1^p = 0.122$ and $\Gamma_1^n = -0.041$.

Now, let us consider the fit when, instead of 417 points for different x and Q^2 values, one uses only 160 data points (with the averaged Q^2 values for the same x). We get $\chi^2/N_{\rm DF} = \frac{118.3}{161-10} = 0.78$. This fit is very good, better than our basic fit. The integrated values for quark and gluon densities are: $\Delta u = 0.79$ ($\Delta u_v = 0.65$, $2\Delta\bar{u} = 0.14$), $\Delta d = -0.66$ ($\Delta d_v = -0.60$, $2\Delta\bar{d} = -0.06$), $\Delta s = -0.22$, $a_0 = -0.09$, $\Delta G = 0.31$ and $a_3 = 1.45$. We see that averaging over Q^2 and different numbers of data points leads to very similar fit. The values for integrated valence densities and non-strange sea contribution are only a bit changed (the same is also true for integrated quantities in the region $0.003 \leq x \leq 1$) and the only difference is in integrated gluon density. We get a little bit higher value for $\Delta G = 0.31 \pm 0.28$. Similar value was also obtained by other group [23]. For $x = 0.1$ at $Q^2 = 1\,{\rm GeV}^2$ $\Delta G/G = 0.08$ and is slightly above a planned experimental resolution in COMPASS.

For completeness we will also present fits neglecting evolution of parton densities with Q^2 (formulas from the simple parton model). We get for non averaged data sample $\chi^2/N_{\rm DF} = \frac{349.9}{418-9} = 0.86$ (bigger than in our basic fit: $\chi^2/N_{\rm DF} = 0.84$): $\Delta u = 0.66$ ($\Delta u_v = 0.56$, $2\Delta\bar{u} = 0.10$), $\Delta d = -0.49$ ($\Delta d_v = -0.49$, $2\Delta\bar{d} = 0.0$), $\Delta s = -0.20$, $a_0 = -0.03$, $a_3 = 1.14$, $\Gamma_1^p = 0.108$, Γ_1^n = -0.082. For averaged data points we get $\chi^2/N_{\rm DF} = \frac{125.4}{161-9} = 0.83$ (this number should be compared with $\chi^2/N_{\rm DF} = 0.78$, the corresponding quantity from the NLO fit) and we have: $\Delta u = 0.66$ ($\Delta u_v = 0.58$, $2\Delta\bar{u} = 0.08$), $\Delta d = -0.48$ ($\Delta d_v = -0.48$, $2\Delta\bar{d} = 0.0$), $\Delta s = -0.20$, $a_0 = -0.03$. Hence, χ^2 per degree of freedom is smaller in the case of averaged sample. We see that both fits give very similar results. It means that the averaging of data does not influence the fit when we do not take Q^2 evolution into account (the differences are also very small in the $0.003 \leq x \leq 1$ region).

It has been pointed out [22] (and discussed in [1]) that the positivity conditions could be restrictive and influence the contribution of polarised gluons. We have also made a fit to experimental data without such assumption for polarised partons. The χ^2 value does not changed much $\chi^2/N_{\rm DF}=\frac{340.7}{418-10}$ $=0.84$ and we get $\Delta u=0.84$ ($\Delta u_v=0.72$, $2\Delta\bar{u}=0.12$), $\Delta d=-0.74$ ($\Delta d_v=-0.50$, $2\Delta\bar{d}=-0.24$), $\Delta s=-0.24$, $a_0=-0.13$, $a_3=1.57$, $\Delta G=0.02$. The results are a little bit different but the value of ΔG is not influenced by the positivity conditions. The same is also true in the case of averaged data. It seems that our positivity conditions are not very restrictive.

We have made fits for two samples of data with averaged Q^2 values and with non averaged ones (adding deuteron data from E155 and proton data from HERMES experiments) leading to very similar results with the substantial antiquark contributions in the measured region of x. The integrated gluon contribution comes out small. The best fits (measured by χ^2 per degree of freedom) we have for zero (for non averaged data points) or rather small ($\Delta G=0.31$ for averaged data) gluon polarisation. The value of a_3 was not fixed in the fit and comes out higher in comparison with experimental value. In order to compare with Ref. [1] and to discuss different assumptions we have also repeated fits in models without fixing a_8 value, with modified sea contribution and models with less singular behaviour for valence u quark and sea contribution as well as models neglecting Q^2 dependence of parton densities or with relaxed positivity conditions. The different parametrisation, additional experimental points and modified value of R have not changed much the results of the fits. The experimental accuracy still must be improved and probably additional experiments are needed in order to make more precise statements about polarised parton densities.

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