The baryon octet magnetic moments to all orders in flavor breaking; an application to the problem of the strangeness in the nucleon

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Abstract. Using the general QCD parametrization (GP) we display the magnetic moments of the octet baryons including all flavor breaking terms to any order. The hierarchy of the GP parameters allows to estimate a parameter $g_0$ related to the quark loops contribution of the proton magnetic moment; its magnitude is predicted to be inside a comparatively small interval including the value given recently by Leinweber et al. from a lattice QCD calculation.

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1. Introduction

The $s\bar{s}$ contribution $\mu_p^s = -\frac{1}{3}G_M^s(0)$ to the proton magnetic moment (compare, for the experimental situation, Refs.[1, 2]) has been the object of many QCD calculations leading to a variety of results. A list of references is found in the table 3 of the review of Beck-McKeown [3] and also in recent papers by Leinweber et al. [4]. Although, as we shall see, our results are compatible with the most recent ones of Leinweber et al. [4], it is known that QCD (either in the chiral or in the lattice approaches) has produced in the course of the years a variety of predictions for $G_M^s(0)$, differing in magnitude by a factor larger than 10 (and also differing in sign).

To treat this problem we use here the general QCD parametrization (GP) ([6]-[9]) of the magnetic moments of the baryons, including (for the first time) terms of all orders in flavor breaking. Exploiting a dynamical property of the GP, its “hierarchy” of the parameters [10], we can estimate the order of magnitude of a parameter $g_0$ related to a part of the $s$ quark loops contribution of the proton magnetic moment ($g_0$ is $-3O_N$).
in the notation of Ref.[4]). The value of $g_0$ is predicted inside a rather narrow interval that includes the value obtained by Leinweber et al. [4] by a lattice QCD calculation.

2. The general QCD parametrization of the magnetic moments

Consider the operator

$$M = \frac{1}{2} \int d^3 r \, (r \times j(r))$$

(1)

where the current

$$j_\mu(x) = e\bar{q}(x)Q\gamma_\mu q(x)$$

(2)

is expressed in terms of the quark $(u,d,s)$ fields $q(x)$ and of a charge-diagonal flavor matrix $Q$. The GP parametrizes (compare [6] and [8]-see there in particular footnote 14) the expectation value of $M$ (Eq.(1)) on the exact eigenstate $|\psi_B\rangle$ of the QCD Hamiltonian for the baryon $B$ at rest as:

$$\langle \psi_B | M | \psi_B \rangle = \langle \Phi_B | V^\dagger M V | \Phi_B \rangle = \langle W_B | \sum_\nu g_\nu G_\nu(\sigma,f) | W_B \rangle \equiv \langle W_B | G(\sigma,f) | W_B \rangle$$

(3)

The symbols in the above equations were used repeatedly in previous work ([6]-dm962), but, for convenience, we recall part of them again: Thus $|\Phi_B\rangle$ is an auxiliary three quarks-no gluon state -having simple properties (e.g. $L = 0$); $V$ is a QCD unitary transformation leading from the auxiliary state $|\Phi_B\rangle$ to the exact QCD eigenstate $|\psi_B\rangle$ ($|\psi_B\rangle = V|\Phi_B\rangle$). In Eq.(3) the space coordinates are eliminated in the second step, as described in [6]; the $G_\nu$'s are operators, linear in the matrix $Q$, depending only on the spin $\sigma$ and flavor $f$ of three quarks; $|W_B\rangle$ are the usual spin(1/2)-flavor octet states (with spin up); the $g_\nu$'s are parameters independent of $Q$, the same for the magnetic moments ($Q = Q^\gamma = Diag[2/3, -1/3, -1/3]$) and the $Z$-moments ($Q = Q^Z \propto Diag[1 - (8/3)\sin^2\theta_W, -1 + (4/3)\sin^2\theta_W, -1 + (4/3)\sin^2\theta_W]$).

Recently [12], applying the GP to this problem, we related the key formula of Beck-McKeown [3] for $\mu_p^\sigma = -(1/3)G_M^\sigma$, to the quark loops corresponding to the $Z$-trace terms. Note: In our notation the negative charge of $s$ is not included in the definition of $G_M^s(0)$. 
In the limit of exact $SU(3)$ ($m_u = m_d = m_s$) $G(\sigma, f)$ is the sum of only three possible operators. Writing: $G_1 = \sum_i Q_i \sigma_i$, $G_3 = \sum_{i\neq k} Q_i \sigma_k$, it is:

$$G(\sigma, f) = g_1 G_1 + g_3 G_3 + \hat{g}_0 Tr[Q] \sum_i \sigma_i \quad (4)$$

In $G_1$, $G_3$ the index $i$ on $Q_i$ arises from the $\gamma$ (or $Z$) being attached to a quark line with that index. The meaning of a quark line and its index in the exact state $|\psi_B\rangle$ is illustrated in the fig.1 of Ref.\[10\].

The Trace terms (e.g. the last term in Eq.(1) and others to appear in the following sections) can be due only to quark loops; each loop is connected to the other quark lines by gluons; because the quark loops associated to Trace terms including a charge must have on their contour an incoming $\gamma$ (or $Z$), the number of gluons connecting these loops to the other quark lines must be at least three, due to color conservation and the Furry theorem (see, e.g., Sect.4 of \[11\]). From Eq.(4), the contribution to the proton magnetic moment from the $s$-quarks would be $(-1/3)\hat{g}_0$, but, in the e.m. case, this $s$ quark contribution is cancelled by those of the $u$ and $d$ quark loops, due to

$$Tr[Q^\gamma] = 0 \quad (5)$$

The symmetry breaking due to the heavier mass of $s$ (we work here assuming charge symmetry $m_u = m_d \equiv m$) is represented in the GP by terms containing an $s$ projector $P^s = Diag[0, 0, 1]$ or the product of two such projectors with different indices (products of more than two $P^s$ with different indices do not contribute to matrix elements with octet states). Below we list all possible $P^s$ structures.

### 3. Flavor breaking in the GP

#### i) Terms with one $P^s$

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3We recall that in the figure just cited the boxes describe the effect of the transformation $V$ in Eq.(3) on the three quarks in $|\Phi_B\rangle$. A quark line may zigzag inside the box as much as one likes, due to emission and reabsorption of gluons; also each box contains quark loops and gluon lines connected in all possible ways consistent with the prescriptions of QCD.

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The terms with one $P^s$ to be considered in this subsection were often indicated in the past as first order flavor breaking; but it was underlined since the beginning \cite{6} that, because $P^s_i \equiv (P^s_i)^n$ for any $n$, such terms contained also contributions of higher order in flavor breaking ($\Delta m/m_s \equiv (m_s - m)/m_s$).

There are five operators with one indexed $P^s$ (see \cite{6,8}): They are:

\begin{align*}
G_2 &= \sum_i Q_i P^s_i \sigma_i ; \\
G_4 &= \sum_{i \neq k} Q_i P^s_i \sigma_k ; \\
G_5 &= \sum_{i \neq k} Q_k P^s_i \sigma_i ; \\
G_6 &= \sum_{i \neq k} Q_i P^s_k \sigma_i ; \\
G_7 &= \sum_{i \neq j \neq k} Q_i P^s_j \sigma_k .
\end{align*}

Of course they act only on the strange baryons. There is also a Trace term containing one $P^s$ (that acts, clearly, also on $p$ and $n$):

\begin{equation}
G_0 = g_0 \text{Tr}[Q P^s] \sum \sigma_i \tag{6}
\end{equation}

The magnetic moments $\mu_B$ for the octet baryons $B$ are:

\begin{equation}
\mu_B = \langle \psi_B | (M)_z | \psi_B \rangle = \langle W_B | \sum_{\nu=0}^7 g_\nu (G_\nu)_z | W_B \rangle \tag{7}
\end{equation}

In Eqs.\(6,7\) $g_0$ is associated to the flavor breaking $s$-quark contribution to the proton moment, so that

\begin{equation}
G^s_M(0) = \hat{g}_0 + g_0 \tag{8}
\end{equation}

(multiplied by $-1/3$) is the whole $s$-contribution to $\mu_p$ that one is measuring in the $\gamma-Z$ interference experiments \cite{1,2}.

At this stage one has 8 parameters and 8 data for the octet (7 magnetic moments plus the $\Sigma\Lambda$ transition moment) but the expectation values of the $G_\nu$'s ($\nu = 0, \ldots, 7$) in the $|W_B\rangle$'s are not independent (see the identity in Eq.\(8\) of \cite{9}). Thus \cite{12} it is impossible to derive the strangeness content of the nucleon only from the octet-baryons magnetic moments without exploiting some additional property of QCD.

We now list the flavor breaking structures with 2 (or more) $P^s$.

ii) Terms with two (or more) $P^s$
To proceed we consider the following flavor breaking structures with two \( P^s \) (they act only on \( \Xi^0 \) and \( \Xi^- \)):

\[
G_{7b} = \sum_{i \neq k} Q_i P^s_i P^s_k \sigma_i \quad G_{7c} = \sum_{i \neq k} Q_i P^s_i P^s_k \sigma_k
\]

\[
G_8 = \sum_{i \neq j \neq k (i > k)} Q_i P^s_i P^s_k \sigma_i \quad G_9 = \sum_{i \neq j \neq k} Q_i P^s_i P^s_k \sigma_k \quad G_{10} = \sum_{i \neq j \neq k} Q_i P^s_i P^s_k \sigma_j
\]

We have also 4 Trace structures of higher order:

\[
G^0_6 = Tr[Q P^s] \sum_i P^s_i \sigma_i \quad G^b_6 = Tr[Q P^s] \sum_{i \neq k} P^s_i \sigma_k
\]

\[
G^c_6 = Tr[Q P^s] \sum_{i \neq k} P^s_i P^s_k \sigma_k \quad G^0_6 = Tr[Q P^s] \sum_{i \neq j \neq k (i > j)} P^s_i P^s_j \sigma_k
\]

Using Eq. (3) with \( Q = Q^* \), one gets the magnetic moments as linear combinations of the parameters \( g_{\nu} \)'s. Because the 9 parameters multiplying the structures in Eqs. (9) (11) intervene only in a few combinations, it is convenient to define:

\[
\begin{align*}
g_\Xi & = \frac{2}{5} (-2g_{7b} - 2g_{7c} - g_8 + 4g_9 + g_{10}) \\
g_0^\Lambda & = g_0 + g_0^\Lambda \\
g_0^\Sigma & = g_0 - g_0^\Sigma/3 + 4g_0^\Sigma/3 \\
g_0^\Xi & = g_0 + 4g_0^\Sigma/3 + 2g_0^\Xi/3 + 4g_0^\Xi/3 - g_0^\Xi/3
\end{align*}
\]

We get finally (compare Eq. (12)) the magnetic moments to all orders in flavor breaking (in Eq. (12), the baryon symbol indicates the magnetic moment). The contributions of the \( 1P^s \) terms (see, e.g. [9]) are obtained by omitting in (12) \( g_8, g_9 \) and the terms with \( g_\Xi, g_0^\Lambda, g_0^\Sigma, g_0^\Xi \) defined in the Eq. (11) above:

\[
\begin{align*}
p & = g_1 - g_0/3 \\
n & = -(2/3)(g_1 - g_3) - g_0/3 \\
\Lambda & = -(1/3)(g_1 - g_3 + g_2 - g_5) - g_0^\Lambda/3 \\
\Sigma^+ & = g_1 + (1/9)(g_2 - 4g_4 - 4g_5 + 8g_6 + 8g_7) - g_0^\Sigma/3 \\
\Sigma^- & = -(1/3)(g_1 + 2g_3) + (1/9)(g_2 - 4g_4 + 2g_5 - 4g_6 - 4g_7) - g_0^\Sigma/3 \\
\Xi^0 & = -(2/3)(g_1 - g_3) + (2/9)(-2g_2 + 2g_5 - 4g_6 + 5g_7) + g_\Xi - g_0^\Xi/3 \\
\Xi^- & = -(1/3)(g_1 + 2g_3) + (2/9)(-2g_2 - 4g_4 - 4g_6 - 7g_7 + 3/2g_8 - 6g_9) + g_\Xi - g_0^\Xi/3 \\
\mu(\Sigma \Lambda) & = -\frac{1}{\sqrt{3}}(g_1 - g_3 + g_6 - g_7)
\end{align*}
\]

\(^4\)On using \( Q_i P^s_i = -(1/3)P^s_i \) and \( Tr[Q P^s] = -(1/3) \) many operators in (9) (10) reduce to the same, or to some already considered (e.g. \( G_6^0 \equiv G_2 \)). One may ask why these structures are listed separately; the reason is that they correspond to different QCD diagrams; only displaying them separately, the order of magnitude of their parameters can be estimated by the “hierarchy” - see Sect.4.
From Eqs. (11,12) one gets Eq. (13), also QCD exact to all orders in flavor breaking. Note that \( \mu(\Sigma \Lambda) \) can have an imaginary part \([6]\); in principle this might contribute, via other terms, to the \( \Sigma^0 \rightarrow \gamma \Lambda \) decay rate. But, because all open \( \Sigma^0 \rightarrow \Lambda \) channels are \( \gamma \) channels, such terms would imply additional \( \gamma \)'s and are therefore negligible.

\[
\sqrt{3} \mu(\Sigma \Lambda) = n - (3/2)\Lambda - (\Sigma^+ + \Sigma^-)/4 + \Xi^0 - g_\Xi + (4/9)g_0^c - (1/9)g_0^d \tag{13}
\]

The Eq. (13) (barring the higher order parameters \( g_\Xi, g_0^c, g_0^d \)) is the Okubo relation \([13]\).

From the previous formulas one can calculate the contribution of each specific flavor \( f = (u, d, s) \) to the baryon magnetic moments and compare the resulting equations with Eqs. (4,5) of Ref. [4], obtained exactly from QCD by Leinweber et al. using only \( u, d \) charge symmetry.\(^5\) The contribution of the flavor \( f \) to the magnetic moment of \( B \) (except for the loops and to be still multiplied by the charges) is indicated as \( f^B \) similarly to Ref. [4]. In the GP treatment \( u^p, u^n, \) etc. are calculated as follows: Replace the matrix \( Q \) in Eq. (2) with \( P^f \). We then obtain for \( u^p, u^n, \) etc. the results:\(^6\)

\[
\begin{align*}
  u^p &= (4/3)g_1 + (2/3)g_3 \\
  u^n &= (-1/3)g_1 + (4/3)g_3 \\
  u^{\Sigma^+} &= (4/3)g_1 + (2/3)g_3 + (-2/3)g_5 + (4/3)g_6 + (4/3)g_7 \\
  u^{\Xi^0} &= (-1/3)g_1 + (4/3)g_3 + (4/3)g_5 + (-2/3)g_6 + (4/3)g_7 + (-1/3)g_8 + (4/3)g_9
\end{align*}
\]

We easily find using Eqs. (12,14) the relations:

\[
\begin{align*}
  u^{\Sigma^+} &= \Sigma^+ - \Sigma^- & u^{\Xi^0} &= \Xi^0 - \Xi^- \\
  u^p &= 2p + n + g_0 & u^n &= p + 2n + g_0
\end{align*}
\]

that are exact consequences of QCD (plus \( u, d \) charge symmetry) since the GP displays and takes into account all the operators \( G_\nu \) compatible with QCD. Because of the en-

\(^5\) Charge symmetry for \( u \) and \( d \) has always been part of our general QCD parametrization, although, of course, in some cases - e.g. for the explanation of the extraordinary level of precision of the Coleman-Glashow e.m. baryon mass formula \([14]\) - its applicability was examined in detail (see Sect. 4 of \([14]\)).

\(^6\) To obtain (referring to the \( u \) quarks) the full contribution \( \mu_B^u \) to the magnetic moment of baryon \( B \), one must add to \( u^B \) the loop contributions - for the proton simply \( g_0^c \) and multiply the result by the \( u \)-charge \( Q_u \) (for \( p \) and \( n \) see the Eqs. (20,21) of Ref. [12]).
tirely different derivation, it is expected and satisfactory that Eqs. (15,16) lead to the same equations and therefore to the same constraint (fig. 2 of [4]) between the ratios $u^p/u^\Sigma$ and $u^n/u^\Xi$ as those of [4]. This is seen by inserting in Eqs. (16) the expression (17) for $g_0$. To summarize: Because Eqs. (15,16) follow exactly from QCD plus charge symmetry, the general parametrization developed above -that includes exactly all possible terms consistent with QCD, plus charge symmetry- must lead necessarily to the above equations. Note, by the way, that some papers (e.g. [15]) misinterpreted the GP as some model “a little more sophisticated than the simplest constituent quark model”.

The connection of our $g_0, \hat{g}_0$ (Eqs. (4,6,8)) with the symbols in [4] is:

$$g_0 = -3O_N = -G_M^a(0)(1 - i R_d^a)/i R_d^a$$

$$i R_d^a = 1 + g_0/\hat{g}_0$$

4. The hierarchy of the coefficients in the general QCD parametrization

Everything, so far, is an exact consequence of QCD (plus $u,d$ charge symmetry). Now we turn to the determination of $g_0$. As already noted [12] its value cannot be determined from the magnetic moments only. One has to exploit a dynamical property of QCD, “the hierarchy of the parameters”, as anticipated at the end of Sect.1. The “hierarchy” is an empirical property, noted long ago [10] and used in past work (e.g. [16,14]); below we recall only its main points. Although the hierarchy was discussed in detail in the references cited above, for convenience we will recall briefly (at the end of this section) how it works in the first case to which it was applied (the extension of the Gell Mann-Okubo mass formula to second order flavor breaking).

It is a fact that the coefficients $g_\nu$ of the various structures (the “parameters”) are seen to decrease with increasing complexity of the structure. This was first seen in the GP of the $8+10$ baryon masses, but applies generally. It appears from the previous...
analysis that each baryon property (e.g. the magnetic moments) is QCD parametrized as a sum of structures each being a sum of terms having a maximum of three different indices (as an example, see the structure $G_8 = \sum_{i \neq j \neq k (j > k)} Q_i P_j^s P_k^s \sigma^i$); these indices are appended to a quark charge, or to a $P^s$ or to a $\sigma$ in the term under consideration. If the rules of Ref.\[10\] are adopted to normalize univocally the sums, the coefficients of the various structures - that is the parameters $g_\nu$ - decrease in a well defined way with the number of different indices present in the terms being summed and, of course, also with the number of $P^s$ (flavor breaking) factors in the structure. Each factor $P^s_i$ produces a reduction $7 \approx 1/3$ and each pair of indices produces a reduction -as discussed in \[8\] - by a factor from 0.2 to 0.37 (see the footnote 16 of \[8\]). This “pair of indices” reduction is due to the exchange of a gluon between two quark lines and applies to baryons or mesons composed of quarks $u,d,s$. In the calculations performed so far (e.g.\[16, 14, 18\]) this hierarchy of the coefficients was used to show why certain formulas (the Gell Mann-Okubo baryon mass formula, or the Coleman-Glashow or the Gal-Scheck formulas) work so well. Observe that to do this -that is to show that the terms neglected were indeed negligible- any choice of the “pair of indices” reduction factor given above (from 0.2 to 0.37) was equivalent; we selected 0.3 or 0.33 in the above evaluations for convenience (the same factor as that due to $P^s$); however, since below we are going to use the hierarchy to estimate the order of magnitude of $g_0$, we will consider the whole interval 0.2 to 0.37 mentioned above.

To exemplify the above presentation we will summarize the main points of the first application of the GP \[16\] to the baryon masses. In the general parametrization the masses of the eight lowest octet + decuplet baryons can be expressed in terms of 8 parameters (the e.m. mass differences are neglected). The known values of the

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7Of course the reduction, for the magnetic moments, is relative to $g_1 \approx 2.8$.

8Incidentally these reduction factors explain why the naive NRQM, based essentially on terms with few indices, works reasonably; to understand this fact on the basis of QCD was precisely the aim of the GP (see also \[19\]).
masses allow to calculate all the above parameters; one can check that the parameters multiplying the two more complicated structures (sums over 3 indices-containing 2 or 3 $P^s$) are negligible. Neglecting them one finds a new relation between the masses which generalizes the Gell Mann-Okubo formula including to a very good approximation the contribution of the $2P^s$ terms.

5. Estimating $g_0$

For the baryon octet magnetic moments at the $1P^s$ level it has been seen repeatedly that the hierarchy for the $g_{\nu}$ ($\nu = 1...7$) applies fairly well except for the ratio $p/n$. It is well known that for the ratio $p/n$ the hierarchy does not work; indeed the extraordinary smallness of $(p/n + 3/2)$ is accidental; therefore one cannot determine the order of magnitude of $g_0$ from the $p,n$ system alone. (For this compare [10] and the second paper in [8]; see also [20].)

Leaving aside $g_3$, there is however a way to estimate the order of magnitude of $g_0$ from Eqs.(12); indeed from them one derives the relation (19) (again, of course, an exact QCD equation):

$$g_0 = -\frac{5}{4}p - \frac{7}{4}n + \frac{\sqrt{3}}{2} \mu(\Sigma\Lambda) + \frac{1}{2} (\Sigma^+ - \Sigma^-) + \frac{1}{4} (\Xi^0 - \Xi^-) - \frac{3}{2} g_7 + \frac{1}{12} g_8 - \frac{1}{3} g_9$$

(19)

Inserting experimental values in Eq.(19) one obtains (in nuclear magnetons):

$$g_0 = 0.13 \pm 0.07 - \frac{3}{2} g_7 + \frac{1}{12} g_8 - \frac{1}{3} g_9$$

(20)

where the error comes essentially from $|\mu(\Sigma\Lambda)| = 1.61 \pm 0.08$ (the sign of $\mu(\Sigma\Lambda)$ is negative, as can be seen from Eq.(13))

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9 Actually the $M1$ transition $\Delta \rightarrow p + \gamma$ allows to understand, via the hierarchy applied to the whole octet-decuplet system, the smallness of $g_3$ ; compare the Sects. V, VI -see the Eq.(22)- in [8].

10 Neglecting $g_8$ and $g_9$, one gets from (20) $\tilde{g}_7 \equiv g_7 + (2/3)g_9 \simeq 0.09 \pm 0.04$ instead of $\tilde{g}_7 \simeq 0.16$, the value given in the 2nd paper in [8]. This is because, to determine $g_7$, we now used $\mu(\Sigma\Lambda) = -1.61 \pm 0.08$ deduced from its experimental value $|\mu(\Sigma\Lambda)| = 1.61 \pm 0.08$. (Instead in [6],[8] the $1P^\prime$ calculation was used giving $\mu(\Sigma\Lambda) = -1.48 \pm 0.04\mu_N$). A new measurement of $\mu(\Sigma\Lambda)$ would be of interest; the present value is the result of a Primakoff effect determination [21] dating back to 1986.
In (20) $g_8$ and $g_9$ are parameters associated to a structure with three indices plus two $P^*$ operators; they are both expected to be of order 0.03. Thus $| (g_8/12) - (g_9/3) | \leq 0.01$. So the contributions of $g_8$ and $g_9$ can only affect negligibly the already large uncertainty in the first term of Eq.(20). Instead, the parameter $g_7$ is associated to a structure with three indices plus one $P^*$; its contribution cannot be neglected. Depending on the choice of the gluon exchange reduction factors in the hierarchy (from 0.2 to 0.37), one expects

$$0.036 \leq |g_7| \leq 0.13$$

(21)

We thus obtain from Eq.(20), if $g_7$ is negative: $0.18 \pm 0.07 \leq g_0 \leq 0.33 \pm 0.07$ and, if $g_7$ is positive: $-0.07 \pm 0.07 \leq g_0 \leq +0.08 \pm 0.07$. Altogether:

$$-0.07 \pm 0.07 \leq g_0 \leq 0.33 \pm 0.07$$

(22)

This interval includes $g_0 = 0.28 \pm 0.07$, the value that can be extracted from Fig.2 and Eqs.(11) of Ref.[4]. As a matter of fact the environment dependance of the $u$-quark magnetic moment as reflected by $u^n/u^{\Xi^0}$, discussed in [4] and re-derived above using the GP with charge symmetry - Eqs.(15,16)- suggests to stay in the region of positive $g_0$, so that the interval to be considered reduces to:

$$0 \leq g_0 \leq 0.33 \pm 0.07$$

(23)

Because $u^n/u^{\Xi^0} = (g_0 + 2n + p)/(\Xi^0 - \Xi^-)$ its value is $\approx 1.2$ for $g_0 = 0.33$ and $\approx 1.7$ for $g_0 = 0$. As to $u^p/u^{\Sigma^+} = (g_0 + 2p + n)/(\Sigma^+ - \Sigma^-)$ its values are $\approx 1.1$ for $g_0 = 0.33$ and $\approx 1.0$ for $g_0 = 0$.

6. Conclusion

The main point of this paper has been to show that in $G^*_M(0) = g_0 + \hat{g}_0$ one can evaluate $g_0$ by performing a complete general QCD parametrization of the baryon
octet magnetic moments and exploiting the GP “hierarchy of parameters”. The point of interest is that by the simple general QCD parametrization one obtains a value (compare Eq.(23)) compatible with the value $(0.28 \pm 0.07)$ obtained in Ref.[4].

Of course $G_M^s(0)$ is the sum of $g_0$ and $\hat{g}_0$ (Eq.(8)), where $\hat{g}_0$ is related to $^1R_d^s$ of Ref.[4] by Eq.(18) $^1R_d^s = 1 + g_0/\hat{g}_0$. Even if $^1R_d^s$ had a value two times larger than that $0.139 \pm 0.042$ of Ref.[4]-as it seems possible- the value of $\mu_p^s$ would stay in the region of very small values (that is at the limit of the present experimental possibilities) recently indicated by HAPPEX (compare the HAPPEX JLAB report 2006 in Ref.[2]) and its experimental determination (especially at $Q^2 = 0$) would remain extremely difficult.

[Note added, march 1, 2007] Recently the results of the HAPPEX collaboration have been published [22] confirming the above indications. While of course we refer to [22] for any detail, we note only that the authors state that the experiments will continue at values of $Q^2$ higher than the present one $\approx 0.1 \text{GeV}^2$. At such low values of $Q^2$ the results (in the words of the authors) “leave little room for observable nucleon strangeness dynamics”.

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