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$\eta - \eta'$ Photoproduction and the Axial Isoscalar Neutral Current Coupling

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ABSTRACT

We show that coherent η and η' photoproduction by means of the Primakoff Effect on the proton depends on the strange component of the neutral axial current coupling. We construct polarization asymmetries that are sensitive to this coupling through the $\gamma - Z$ interference. The η' is not a Goldstone boson of a spontaneously broken chiral symmetry, but a phenomenological analysis of the η and η' production through chiral perturbation theory allows to calculate the observables of interest. The polarized proton or polarized photon asymmetries are predicted to be close to 10^{-4} for $-q^2 \sim 0.1 - 0.5$ GeV^2.

1 Introduction

The flavour content of the nucleon has been experimentally tested and confronted with effective theories on the nucleon structure all over the past 20-30 years. So far, a rather consistent picture of the up and down content of the nucleon has emerged from both low and high energy experiments, whereas predictions from the quark-type models, Skyrme-inspired models and the quark-parton model have been extensively tested. However, a deep understanding of the nucleon structure starting from the believed strong interaction theory, namely QCD, is still lacking. The relation of the quark-type models to low energy QCD is obscure, and the Skyrme-type effective theories have little evolved since the fundamental papers of their revival in the '80.

An open window to new phenomena related to the flavour content of the nucleon started since the EMC and SLAC deep inelastic scattering experiments [1]. From the results of these, the common wisdom of the (naive) spin structure of the proton has given rise to a lively debate. Data from experiments, when combined with the analysis of semileptonic baryon decays and the quark-parton model, give the polarized quark moments Δq ($q = u, d, s$) in the proton. The flavour singlet part of these first moments is found to be anomalously small, leading to the so called 'spin crisis'. Moreover, the strange polarization quark moment is predicted to be of the same order of magnitude of the up and down ones.

Another probe of the proton flavour content is provided by the weak neutral axial current. This current certainly receives contributions from the up and down quarks, and the previously mentioned experiments that lead to the 'spin crisis' raise the question on the strange content of the proton and neutron. So the following question imposes: is it possible to have a strange flavour contribution comparable with the up and down ones? In other words, is it possible to have an isoscalar neutral axial current coupling comparable with the isovector one? This is the question to which we address to in this paper.

Our aim is to construct observables sensitive to the axial isoscalar coupling of the proton. This can be searched for [2] in elastic neutrino-proton scattering or electroweak nuclear processes. In Ref.[3] we have demonstrated that the polarized Primakoff Effect is adequate to achieve this purpose. In this process there exists a neutral weak current contribution through the $\gamma - Z - \pi^0$ vertex. This contribution is suppressed by the factor $G_F Q^2/\alpha$, relative to the pure electromagnetic one, and one has to look for parity-violating asymmetries in order to disentangle it. The P-odd observables are induced by the weak- electromagnetic interference for polarized photon or polarized proton. The parity violating asymmetries for polarized photon or polarized proton Primakoff Effect (π^0 photoproduction) filter the couplings so as to leave the proton neutral *axial* coupling only. However, in that case, in addition to the suppression factor $G_F Q^2/\alpha$, the anomaly cancellation condition in the standard theory forces the vector coupling of the electron to come into the game, and another suppression factor appears in the asymmetries. One could have naïvely expected a higher value because only u and d quarks vector-couplings (v^u and v^d) to Z are needed in the calculus. But the anomaly cancellation imposes $N_c(Q_u v^u - Q_d v^d) = Q_e v^e$, and one ends up with the small factor v^e in the asymmetries. In the same way, assuming exact flavour-$SU(3)$ symmetry, in the case of coherent photoproduction of the other flavour-neutral pseudoscalar meson in the octet, the η, the same suppression factor is present. We would like to think of the possibility to avoid this suppression by considering the coherent photoproduction of η'. What about the η'? Mostly identified with the singlet component of the flavour $U(3)$ meson nonet, it is not a Goldstone boson for any of the symmetries of QCD, and in the zero quark mass limit the axial $U(1)$ anomaly prevents its mass to vanish. So a similar analysis to the one we developed in Ref.[3] is not possible for the η' meson.

In this paper we extend the above mentioned results so as to include the η and η' photoproduction as a probe of the isoscalar axial coupling. The absence of the anomaly cancellation suppression factor already mentioned allows to obtain two orders of magnitude enhanced asymmetries, thus reducing the need of statistics by four orders of magnitude. The paper is organized as follows: in section (2) the theoretical basis of our computation is established; in section (3) the announced observables are constructed, and in section (4) we present the numerical estimates and discussion of the results.

2 η, η' and the Primakoff Effect

The spin-dependent structure function $g_1(x, Q^2)$ of the proton, as determined by the EMC-experiment together with previous SLAC data for electron scattering, and the analysis of semileptonic baryon decays give the polarized quark moments Δq ($q = u, d, s$) in the proton:

$$\begin{aligned} \Delta u &= 0.78 \pm 0.06 \\ \Delta d &= -0.47 \pm 0.06 \\ \Delta s &= 0.19 \pm 0.06 \end{aligned} \tag{1}$$

In particular, the flavour singlet part of this first moment is found to be anomalously small, leading to the so called 'spin crisis'. Another by-product of this analysis is that an unexpected large strange quark moment is obtained.

Another probe of the flavour content of the proton is provided by the weak neutral axial current, for which the operator is

$$J_\lambda^{A,Z} = \overline{\Psi}_u \gamma_\lambda \gamma_5 \Psi_u - \overline{\Psi}_d \gamma_\lambda \gamma_5 \Psi_d - \overline{\Psi}_s \gamma_\lambda \gamma_5 \Psi_s \tag{2}$$

For elastic low Q^2 neutral current processes, the weak neutral axial quark current for definite flavour gives the coupling constant for the corresponding axial current of the proton

$$< p|\overline{\Psi}_q \gamma_\lambda \gamma_5 \Psi_q|p > \stackrel{Q^2 \to 0}{\longrightarrow} G_A^q \, \overline{p} \gamma_\lambda \gamma_5 p \tag{3}$$

Therefore, from the combination Eq.(2) for quark neutral weak axial current, the proton coupling can be inferred:

$$G_A = \Delta u - \Delta d - \Delta s = 1.44 \pm 0.06$$

when the already mentioned analysis is used. In this way we are assuming that, although in a different theoretical frame, we have an *a priori* estimate for the coupling constant

G_A of the proton and for the flavour couplings G_A^q. We will use the values inferred in this way as a guess to compute the observables we construct in the next section.

In terms of nucleonic isospin, these experiments predict that, in addition to the well known isovector axial coupling

$$g_A = \Delta u - \Delta d = 1.254 \pm 0.006 \qquad (4)$$

an isoscalar axial coupling f_A, such that

$$f_A = -\Delta s = -0.19 \pm 0.06 \qquad (5)$$

does exist.

In this paper we present an extended analysis of the proposal we have made in Ref.[3], for which the neutral vector coupling of the proton is filtered and only G_A is left in the observables. The Primakoff Effect [4] corresponds to the coherent photoproduction of π^0 by the nuclear Coulomb field. This process is mediated by the axial anomaly [5] for the vector-vector-axial current, and the π^0 field is implemented using the PCAC hypothesis. The parity violating asymmetries in the Primakoff Effect for polarized photons or polarized protons are the appropriate observables. In precise terms, the two parity violating asymmetries for circularly polarized photons or longitudinally polarized protons are proportional to G_A, as a result of the interference of the weak axial neutral current amplitude with the electromagnetic one, through the magnetic form factor G_M or the electric form factor G_E of the proton, respectively. For more details we refer to Ref.[3] and references quoted there. This type of analysis is not possible for the η'. As it is not a Goldstone boson there is no legitimate PCAC hypothesis for the η'. A different approach is needed.

If the u, d and s quarks were all massless, the low energy hadron spectrum would consist of a massless $U(3)$ octet of Goldstone bosons plus a massive singlet, due to the $U(1)$ axial anomaly. With non vanishing quark masses the octet becomes massive. $U(3)$ breaking also causes the singlet η_0 to mix with the η_8 producing the physical eigenstates η and η' to be

$$|\eta\rangle = \cos\theta \; |\eta_8\rangle - \sin\theta \, |\eta_0\rangle \quad , \quad |\eta'\rangle = \sin\theta \; |\eta_8\rangle + \cos\theta \, |\eta_0\rangle \qquad (6)$$

where no mixing with other $I = 0$ pseudoscalar states is present in the isospin limit. Equation (6) shows that one can expect the suppression factor, coming from the anomaly cancellation already discussed, not to be dominant when considering observables related to η and η' photoproduction. This factor certainly appears in the η_8 photoproduction, but not in the η_0 one. As the physical η has a component along the η_0 and if the mixing angle is not too small, this component can prevent the expected values for the observables to be suppressed. We will verify that, in fact, this is the case.

The decay amplitude of a pseudoscalar meson to two photons can be parametrized as

$$\mathcal{M}(P_i \longrightarrow \gamma(q')\,\gamma^*(q)) = \frac{\alpha}{2\pi \overline{F}_i}\, c_i\, \epsilon^{\mu\nu\alpha\beta}\, \varepsilon^*_\mu\, \varepsilon'^*_\nu\, q_\alpha q'_\beta\, (1 + b_i\, q^2) \tag{7}$$

where $P_i = (\pi^0, \eta_8, \eta_0)$ and $c_i = (1, \sqrt{\frac{1}{3}}, 2\sqrt{\frac{2}{3}})$. We allow one of the two photons $\gamma^*(q)$ to be off shell; $q^2 = 0$ when the two photons are on shell. The slope parameter b_i gives the leading order term in a q^2-expansion when one photon is off shell. The axial anomaly plus PCAC predicts $\overline{F}_\pi = F_\pi$, with a good fit to the π^0 decay rate. A powerful theoretical approach to implement these symmetry features is to refer to the Wess-Zumino-Witten effective lagrangean [6]. Anomalous processes are described by this lagrangean. One loop corrections at low energies from chiral perturbation theory predict [7]

$$\overline{F}_{\eta_8} \simeq 1.3\; F_\pi \qquad\qquad \overline{F}_{\eta_0} \simeq 1.1\; F_\pi \tag{8}$$

while $\theta \simeq -20^o$. Assuming that nonet symmetry gives a good description of the singlet except for its mass which gets an extra term, we have that for low energy the above formulas are valid. This argument is supported [8] by large N_c arguments that show that, in despite of the axial anomaly present in the Ward identity for the singlet current, in that limit the η_0-analogous is a Goldstone boson. When one of the two photons is not on shell, the slope parameter b_i has, in principle, to be included in the above analysis. This has been measured [9] in the processes $\gamma\gamma^* \longrightarrow P_i$ in electron-positron collision and in $\eta \longrightarrow \gamma\mu^+\mu^-$. These measurements are for rather large values of $-q^2$ and a extrapolation to small values of q^2 is needed. As we are interested only in low q^2 (*i.e.* $|b_i q^2| < 1$), where the coherent cross section is appreciable, we neglect this term in

Eq.(7). The amplitude for the $\gamma - \gamma^* - \eta$ and $\gamma - \gamma^* - \eta'$ vertex is then:

$$\mathcal{M}(\eta\,(\eta') \longrightarrow \gamma\gamma^*) = \frac{\alpha}{2\pi F_{\eta\,(\eta')}}\;\epsilon^{\mu\nu\alpha\beta}\;\varepsilon^*_\mu\;\varepsilon'^*_\nu\;q_\alpha q'_\beta \tag{9}$$

where the η and η' decay constants are

$$F_\eta = \left(\frac{1}{\sqrt{3}}\frac{\cos\theta}{\overline{F}_{\eta_8}} - 2\sqrt{\frac{2}{3}}\frac{\sin\theta}{\overline{F}_{\eta_0}}\right)^{-1} \quad , \quad F_{\eta'} = \left(\frac{1}{\sqrt{3}}\frac{\sin\theta}{\overline{F}_{\eta_8}} + 2\sqrt{\frac{2}{3}}\frac{\cos\theta}{\overline{F}_{\eta_0}}\right)^{-1} \tag{10}$$

So we have a way to compute the polarized Primakoff Effect for the η and η'. From now onwards, we proceed along the same method as in Ref.[3]. In the η (η') Primakoff production there exists the conventional electromagnetic contribution plus a neutral weak current contribution through the $\gamma - Z - \eta$ (η') vertex. In the case of π^0 the $\gamma - Z$ anomaly is proportional to

$$D^{\gamma Z}_\pi = \frac{N_c}{s_w c_w} Tr\left[\left\{Q^{em}, V^Z\right\}\frac{\lambda_3}{2}\right] = \frac{1 - 4\sin^2\theta_W}{4\sin\theta_W\cos\theta_W} \tag{11}$$

giving a suppression factor proportional to the neutral vector coupling v^e of the electron. Taking into account the mixing given in Eq.(6), the corresponding coefficients for the η and η' are

$$D^{\gamma Z}_\eta = \cos\theta\; D^{\gamma Z}_{\eta_8} - \sin\theta\; D^{\gamma Z}_{\eta_0} \quad , \quad D^{\gamma Z}_{\eta'} = \sin\theta\; D^{\gamma Z}_{\eta_8} + \cos\theta\; D^{\gamma Z}_{\eta_0} \tag{12}$$

where

$$D^{\gamma Z}_{\eta_0} = \frac{2\,(1 - 2\sin^2\theta_W)}{\sqrt{3}\sin\theta_W\cos\theta_W} \quad , \quad D^{\gamma Z}_{\eta_8} = \frac{1 - 4\sin^2\theta_W}{4\sqrt{3}\sin\theta_W\cos\theta_W} \tag{13}$$

and the suppression factor for the η_8 is seen in the last coefficient. Finally we get

$$D^{\gamma Z}_\eta = \frac{1}{\sqrt{3}\sin\theta_W\cos\theta_W}\left(-\sin^2\theta_W\,(\cos\theta - 4\sin\theta) - 2\sin\theta + \frac{\cos\theta}{4}\right) \tag{14}$$

and

$$D^{\gamma Z}_{\eta'} = \frac{1}{\sqrt{3}\sin\theta_W\cos\theta_W}\left(-\sin^2\theta_W\,(\sin\theta + 4\cos\theta) + 2\cos\theta + \frac{\sin\theta}{4}\right) \tag{15}$$

3 Polarization Observables

One has to look for parity-violating asymmetries in order to disentangle the Z-exchange contribution. Parity-violating observables will be induced by the weak-electromagnetic interference for polarized photons or polarized protons. The parity-violating interference automatically selects the weak neutral *axial* current of the proton, with coupling G_A.

For the processes $\gamma(k)\, p \longrightarrow \eta\, p'$ and $\gamma(k)\, p \longrightarrow \eta'\, p'$ all the observable quantities of interest are obtained, at lowest order, from the electromagnetic and weak amplitudes:

$$T_\gamma = \frac{ie^3}{2\sqrt{2}\pi^2 F_{\eta'} q^2}\, \epsilon_{\mu\,\nu\,\alpha\,\beta}\, \epsilon^\mu(k) < p'|J^\nu_{e.m.}|p > k^\alpha q^\beta$$

$$T_Z = -\frac{ie}{2\pi^2 F_{\eta\,(\eta')}} D^{\gamma Z}_{\eta\,(\eta')}\, G_F\ \sin\theta_W \cos\theta_W\ \epsilon_{\mu\,\nu\,\alpha\,\beta}\, \epsilon^\mu(k)\ < p'|J^\nu_{A,Z}|p > k^\alpha q^\beta \quad (16)$$

where k, p' and p are the four-momenta for the incident photon and the final and initial proton respectively, and $q = p' - p$. The Lorentz decomposition of the matrix elements is

$$< p'|J^\nu_{e.m.}|p >= \overline{u}(p') \left[\gamma^\nu F_1(q^2) + i\sigma^{\nu\mu}\frac{q_\mu}{2M} F_2(q^2)\right] u(p)$$

$$< p'|J^\nu_{A,Z}|p >= G_A(q^2)\, \overline{u}(p')\gamma^\nu\gamma_5 u(p) + G_P(q^2)\, \overline{u}(p') q^\nu \gamma^5 u(p) \quad (17)$$

We notice that the pseudoscalar form factor G_P of $< p'|J^\nu_{A,Z}|p >$ will be omitted in the following. This is so because it exactly cancels in the T_Z amplitude when contracted with the anomalous $\gamma - Z - \eta\,(\eta')$ vertex, as seen in Eq.(16), in such a way that we do not have to postulate any extra hypothesis related to this rather unknown form factor: it just disappears from the amplitude in these processes.

For the parity-violating observables we are interested in, the squared amplitude $|T|^2$ is given, at leading order and at low energies, by the electromagnetic term plus the electromagnetic-weak interference, that can be written in the following way:

$$|T|^2 = 8\pi\alpha\ \left(\frac{\alpha}{\pi F_{\eta\,(\eta')}}\right)^2 L^{\nu\mu} \left\{W^{e.m.}_{\nu\mu} - \sin\theta_W\ \cos\theta_W\ D^{\gamma Z}_{\eta\,(\eta')}\ \frac{G_F}{\sqrt{2}\,\pi}\frac{q^2}{\alpha} W^I_{\nu\mu}\right\} \quad (18)$$

In order to clarify the discussion, let us decompose each tensor in Eq.(18) in two pieces with definite properties:

$$L^{\nu\mu} = L^{\nu\mu}_S + iL^{\nu\mu}_A(h) \quad (19)$$

$$W^{e.m.}_{\nu\mu} = W^{e.m.}_{\nu\mu,S} + iW^{e.m.}_{\nu\mu,A}(s) \tag{20}$$

$$W^{I}_{\nu\mu} = iW^{I}_{\nu\mu,A} + W^{I}_{\nu\mu}(s) \tag{21}$$

Let us summarize the properties of the different tensors in the above expressions. The non-baryonic tensor $L^{\nu\mu}$ is a common factor to Eq.(18). $L^{\nu\mu}_S$ is real, symmetric and independent of the photon helicity h, whereas $iL^{\nu\mu}_A$ is imaginary, antisymmetric and linear in h. The two pieces of the electromagnetic $\gamma-\gamma$ tensor $W^{e.m}_{\nu\mu}$ for the proton have the following characteristics: $W^{e.m.}_{\nu\mu,S}$ is real, symmetric and independent of the proton polarization s; and $iW^{e.m.}_{\nu\mu,A}(s)$, on the contrary, is imaginary, antisymmetric and linear in s. The interference $\gamma - Z$ tensor $W^{I}_{\nu\mu}$ for the proton has the following structure: $iW^{I}_{\nu\mu,A}$ is imaginary, antisymmetric and independent of the proton polarization s and, as we will see, in our case it is given by the axial-magnetic interference; finally $W^{I}_{\nu\mu}(s)$ is real and linear in s.

For elastic proton scattering and in the laboratory frame, all of them can be explicitly computed using Eqs.(16,17), and the result is:

$$L^{\nu\mu}_S = \frac{1}{2}\left[(k^\nu q^\mu + k^\mu q^\nu)(kq) - k^\nu k^\mu q^2 - g^{\nu\mu}(kq)^2\right] \tag{22}$$

$$L^{\nu\mu}_A(h) = -\frac{h}{2}\,\epsilon^{\nu\mu\alpha\beta}\;k_\alpha\,q_\beta\;(kq) \tag{23}$$

$$W^{e.m.}_{\nu\mu,S} = G_M^2(q^2 g_{\nu\mu} - q_\nu q_\mu) + (2p_\nu + q_\nu)(2p_\mu + q_\mu)\frac{G_E^2 - \frac{q^2}{4M^2}G_M^2}{1 - \frac{q^2}{4M^2}} \tag{24}$$

$$W^{e.m.}_{\nu\mu,A}(s) = \epsilon_{\nu\mu\alpha\beta}q^\alpha\left[G_M G_E\;(2M)s^\beta + \frac{(qs)}{M\left(1 - \frac{q^2}{4M^2}\right)}\,G_M(G_M - G_E)\,p^\beta\right] \tag{25}$$

$$W^{I}_{\nu\mu,A} = -2\,G_A\,G_M\;\epsilon_{\nu\mu\alpha\beta}\,q^\alpha p^\beta \tag{26}$$

$$\begin{aligned} W^{I}_{\nu\mu}(s) \;&=\; 2M\,G_A\times \\ &\left[G_M\left(g_{\nu\mu}(sq) - s_\nu q_\mu\right) - (2p_\nu + q_\nu)\left(G_E s_\mu + \frac{G_M - G_E}{1 - \frac{q^2}{4M^2}}\,\frac{(sq)}{2M^2}p_\mu\right)\right] \end{aligned} \tag{27}$$

where G_E and G_M are the two Sachs form factors of the proton:

$$G_E = F_1 + \frac{q^2}{4M^2} F_2 \qquad\qquad G_M = F_1 + F_2 \tag{28}$$

We see that the contraction $L^{\nu\mu} W^{e.m.}_{\nu\mu}$ cannot induce *separate* linear terms in h or s. As our aim is the extraction of G_A in $W^I_{\nu\mu}$, one can first get the information from the sector

$$L^{\nu\mu}_A(h)\, W^I_{\nu\mu,A}\ ,$$

by considering, in the laboratory frame, the difference of cross sections for different photon helicity and for unpolarized proton

$$\begin{aligned}\frac{d\sigma(h=+)}{dq^2} - \frac{d\sigma(h=-)}{dq^2} \quad &= \quad \frac{\alpha^2}{16\pi^3 F^2_{\eta\,(\eta')}}\, D^{\gamma Z}_{\eta\,(\eta')}\, \frac{G_F \sin\theta_W \cos\theta_W}{ME} \times \\ & \quad G_A G_M \left(1 - \frac{q^2 - m^2_{\eta\,(\eta')}}{4ME}\right)(q^2 - m^2_{\eta\,(\eta')})\end{aligned} \tag{29}$$

where E is the photon energy. The associated parity-violating observable for circularly polarized photons corresponds to the following asymmetry:

$$A^\gamma \equiv \frac{d\sigma(h=+) - d\sigma(h=-)}{d\sigma(h=+) + d\sigma(h=-)} \tag{30}$$

From Eqs.(22,27) one can build a second parity-violating observable from

$$L^{\nu\mu}_S\, W^I_{\nu\mu}(s)\ ,$$

which corresponds to the differences of cross sections for different proton polarizations and for unpolarized photons

$$\begin{aligned}&\frac{d\sigma(s=+)}{dq^2} - \frac{d\sigma(s=-)}{dq^2} = \frac{\alpha^2}{8\pi^3 F^2_{\eta\,(\eta')}}\, D^{\gamma Z}_{\eta\,(\eta')} G_F \sqrt{2} \sin\theta_W \cos\theta_W\, \frac{1}{1 - \frac{q^2}{4M^2}}\, \frac{1}{q^2} \ \times \\ &G_A \left[G_E \left(1 + \frac{q^2 - m^2_{\eta\,(\eta')}}{4ME}\right)\left(q^2 + q^2 \frac{q^2 - m^2_{\eta\,(\eta')}}{2EM} + \frac{(q^2 - m^2_{\eta\,(\eta')})^2}{4E^2}\right) - \right. \\ &\left. \frac{G_M}{4}\left(\frac{q^2 - m^2_{\eta\,(\eta')}}{EM} + \frac{q^2}{M^2}\right)\left(q^2 + \frac{q^2 - m^2_{\eta\,(\eta')}}{2E}\left(\frac{q^2}{M} + q^2 \frac{q^2 - m^2_{\eta\,(\eta')}}{4M^2 E} - \frac{q^2 - m^2_{\eta\,(\eta')}}{2E}\right)\right)\right]\end{aligned} \tag{31}$$

The corresponding asymmetry for longitudinally polarized protons is then given by

$$A^p \equiv \frac{d\sigma(s=+) - d\sigma(s=-)}{d\sigma(s=+) + d\sigma(s=-)} \tag{32}$$

In the next section the numerical estimate for these two asymmetries A^γ and A^p is given. The above formulas Eq.(29) and Eq.(31) show that our aim is achieved: both asymmetries are proportional to the coupling G_A. Besides, the suppression factor v^e is not the leading term in $D^{\gamma Z}_{\eta\,(\eta')}$, as it was in $D^{\gamma Z}_{\pi}$.

4 Numerical Estimates and Conclusions

For the value of G_A suggested by the EMC-experiment we show in Figure 1 the expected results of the two asymmetries A^γ and A^p as functions of $-q^2$ from 0.1 to 0.5 GeV^2, for various incident energies, and for η and η' photoproduction. We also show the cross

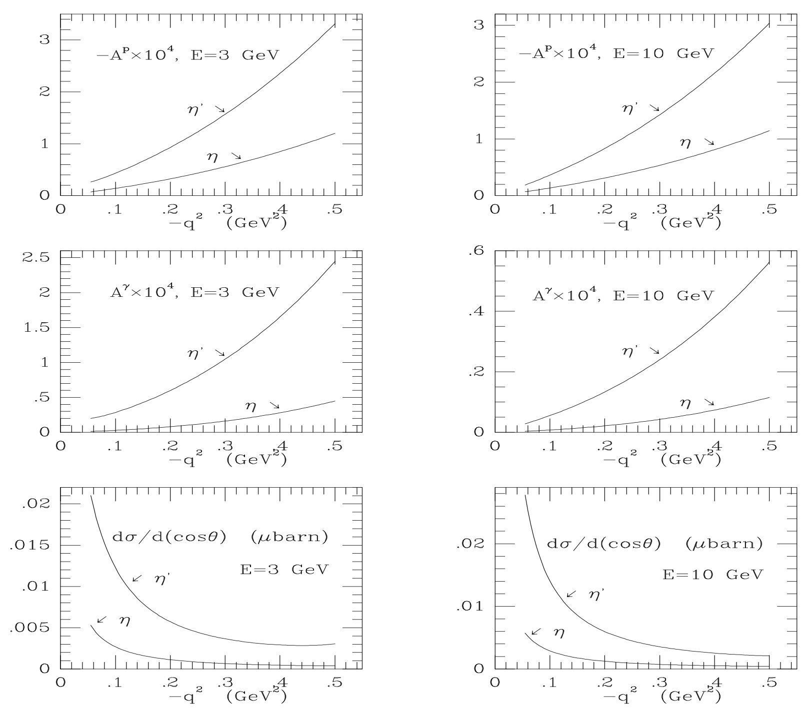

Figure 1: η and η' polarized Primakoff Effect. Cross sections and asymmetries for polarized photon and proton for photon energies 3 GeV and 10 GeV.

sections for the considered processes. The predictions for the asymmetries are two orders of magnitude bigger than the ones we have previously obtained in [3] for the π^0. The minimum number of events needed to be sensitive to these asymmetries is thus reduced by two or three orders of magnitude. In the case of the η this enhancement is due to the combined effect of a large enough mixing angle that allows the η_0 component in Eq.(6) to play a leading role in the observables so that an amplification is produced in the anomaly factor: $D_\eta^{\gamma Z} \simeq 12.4\, D_\pi^{\gamma Z}$. For η' the enhancement is mostly due to the fact that the η_0 is the leading component in Eq.(6) and the anomaly factor is $D_{\eta'}^{\gamma Z} \simeq 32.3\, D_\pi^{\gamma Z}$.

We calculate parity violating asymmetries for polarized photon Eq.(30) or polarized proton Eq.(32) in the η and η' Primakoff Effect. They filter the couplings of the proton so as to leave the weak neutral *axial* coupling G_A in the observables, and the contribution coming from the pseudoscalar form factor G_P is exactly zero. These asymmetries, due to the interference between γ- and Z-exchanges, are mediated by the $\gamma - Z - \eta\, (\eta')$ anomaly. Thus the suppression factor due to the anomaly cancellation condition, that appears in the asymmetries for π^0 and η_8 photoproduction, is avoided. The η and η' are implemented as a mixing of the $|\eta_8\rangle$ and $|\eta_0\rangle$ $U(3)$ states, whereas the vertex is calculated in chiral perturbation theory. When the value of G_A as determined by the EMC-experiment is used, the predictions for the asymmetries are of order 10^{-4}.

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