

Probing quark compositeness at hadronic colliders : the case of polarized beams

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Abstract

A new handed interaction between constituents of quarks could be at the origin of some small parity violating effects in one-jet inclusive production. Within a few years, the Relativistic Heavy Ion Collider (RHIC) will be used as a polarized proton-proton collider. In this context, we analyse the possibilities of disentangling some new parity violating effects from the standard spin asymmetries which are expected due to the Standard Model QCD-Weak interference. We also explore the possibilities of placing some more stringent limits on the quark compositeness scale Λ thanks to measurements of such spin asymmetries.

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1 Introduction

The idea of compositeness has been introduced in the hope of solving some of the problems left unanswered by the Standard Model (SM). In particular, considering the difficulties for explaining the family pattern of quarks and leptons, it was natural to speculate about the existence of an underlying substructure. However, no "standard" model of quarks and leptons subconstituents (preons or whatever) has emerged so far. In phenomenological studies one usually assumes that these subconstituents could interact by means of a new "contact" interaction which is normalized to a certain compositeness scale Λ . Then, one can describe the residual interaction between quarks and/or leptons by using an effective lagrangian, an approach which is valid at energies below the compositeness scale.

The HERA $e - p$ collider is now deeply probing the presence of such an anomalous term in electron-quark scattering. However, hadronic colliders only would allow to reveal a new contact interaction belonging purely to the quark sector.

Following [1], we write the lowest dimensional current-current interaction with a four fermion contact term under the form :

$$\mathcal{L}_{qqqq} = \epsilon \frac{g^2}{8\Lambda_{qqqq}^2} \bar{\Psi}\gamma_\mu(1 - \eta\gamma_5)\Psi.\bar{\Psi}\gamma^\mu(1 - \eta\gamma_5)\Psi \quad (1)$$

where Ψ is a quark doublet, ϵ is a sign and η can take the values ± 1 or 0 . g is a new strong coupling constant normalized usually to $g^2(\Lambda_{qqqq}) = 4\pi$.

Working at Fermilab at the Tevatron $\bar{p} - p$ collider with $\sqrt{s} = 1.8$ TeV, the CDF collaboration has published some bounds on the scale Λ_{qqqq} (denoted shortly Λ from now). The strategy consisted in searching for an excess of events (compared to the QCD prediction at leading order) in the inclusive one-jet cross section [2] and in the dijet invariant mass spectrum [3]. The former gives the best limit published today : $\Lambda > 1.4$ TeV [4].

The expression (eq. 1) is rather general. In particular, there is no reason to assume that the new interaction is a parity conserving (PC) one. On the contrary, it has been advocated for some time [1, 5] that parity violation (PV) could be present ($\eta \neq 0$).

It is then tempting to propose the search for an effect which is absent in strong processes, like the production of jets, as long as these processes are solely described in the framework of QCD which is a parity conserving theory.

It is well-known, from deep-inelastic scattering (DIS) experiments and from experiments at e^+e^- colliders, that the measurement of some spin asymmetries, either in the final or in the initial state, gives a direct way to pin down a PV interaction.

In the context of hadronic colliders, the huge hadronic background makes it very difficult to measure the helicity state of a produced particle. Then, it is mandatory to use polarized hadronic *beams* to build a spin asymmetry.

Hadronic spin physics has been confined for a long time to fixed polarized target experiments but it is now under good way to reach the truly high energy domain. Indeed, stimulated by the puzzling results obtained these last years from polarized DIS experiments [6], the RHIC Spin Collaboration (RSC) [7] has recently proposed to run the Brookhaven Relativistic Heavy Ion Collider (RHIC) in the pp mode, with longitudinally (or transversely) polarized beams. The degree of polarization of the beam will be as high as 70%, with a high luminosity at a center-of-mass energy up to 500 GeV. This proposal have been approved recently and a very complete program of measurements of (PV or PC) spin asymmetries will be performed (see ref. [8] ; for reviews on spin physics at future hadronic colliders one can consult refs. [9, 10]).

In a first step, the RSC will focus on the PC double spin asymmetry A_{LL} in jet production, direct photon production and other hadronic processes governed by QCD. For an inclusive process like $p_a p_b \hat{c} + X$, where c is either a jet or a well-defined particle, A_{LL} is defined as (in obvious notations, the signs \pm refer to the helicities of the colliding protons) :

$$A_{LL} = \frac{d\sigma_{a(+)b(+)} - d\sigma_{a(+)b(-)}}{d\sigma_{a(+)b(+)} + d\sigma_{a(+)b(-)}} \quad (2)$$

On the other hand, large Standard PV effects should be obtained in the direct production of the W and Z gauge bosons [9, 11]. To build a PV asymmetry one single polarized beam is sufficient $A_{LR} = (d\sigma_{a(-)b} - d\sigma_{a(+)b}) / (d\sigma_{a(-)b} + d\sigma_{a(+)b})$.

One can also define a double helicity PV asymmetry :

$$A_{LL}^{PV} = \frac{d\sigma_{a(-)b(-)} - d\sigma_{a(+)b(+)}}{d\sigma_{a(-)b(-)} + d\sigma_{a(+)b(+)}} \quad (3)$$

A whole set of measurements of the large Standard PC and PV asymmetries should allow to isolate with very good precision the polarized distribution functions of the various partons (quarks and gluons) in a polarized proton (see refs. [11, 12, 13]) and, in the meantime, to perform some polarization tests of the Standard Model. Note that transversely polarized beams, whose great interest has been emphasized [8] will be also available at RHIC.

In this letter we focus on the production of a single jet in polarized pp collisions at RHIC with $\sqrt{s} = 500$ GeV. From now $d\sigma$ means

$$d\sigma \equiv \frac{d^2\sigma}{dp_T dy} \text{ at } y = 0 \quad (4)$$

where p_T is the jet transverse momentum and y its rapidity.

We will concentrate on a high p_T region where quark-quark elastic scattering is the dominant process and where an effect due to compositeness has some chance to be observed. At RHIC it corresponds to the region $60 < p_T < 120$ GeV/c.

The interest of using a PV spin asymmetry to reveal a new effective handed interaction between quarks has been already noticed in the literature [9, 11, 14]. It is however valuable to explore this issue in more details.

First, QCD-Electroweak boson exchange interference terms [15, 16] which are indeed present, not only in the vicinity of the W and Z "Jacobian peaks", but also at high p_T , have been essentially neglected up to now [9, 11]. It is mandatory to take these terms into account to set definitive conclusions about the origin of any PV effect which should be observed in this context. The calculations described below take into account all the (lowest order) relevant terms : QCD + Electroweak(EW) + Contact Terms (CT) which are to be added coherently.

The second point is more technical : various choices of polarized distribution functions of quarks and antiquarks in a polarized proton are now available, in particular those which have been updated according to the latest polarized DIS results. Also, at a variance with previous works, we will concentrate on the asymmetry A_{LL}^{PV} from which the largest PV effects should be seen.

2 Parity violating subprocesses for the one-jet inclusive production

The expression of $d\sigma$, eq.(4) is given by the well-known formula:

$$d\sigma = \sum_{ij} \frac{2p_T}{1 + \delta_{ij}} \int_{x_{min}}^1 dx_a \left(\frac{x_a x_b}{x_a - p_T/\sqrt{s}} \right) \left[f_i^{(a)}(x_a, Q^2) f_j^{(b)}(x_b, Q^2) \frac{d\hat{\sigma}(i, j)}{d\hat{t}}(\hat{s}, \hat{t}, \hat{u}) + (i \leftrightarrow j) \right] \quad (5)$$

where the sum runs over all the various partons.

For consistency, we will follow the CDF analysis, restricting to leading order terms. For the scale Q^2 , we have taken $Q^2 = p_T^2$ after having checked that changing this value between $p_T^2/4$ and $4.p_T^2$ has a very small influence on our results on A_{LL}^{PV} .

The helicity dependent cross section is given by ($h_{a,b}$ refers to the helicities of the protons and $\lambda_{1,2}$ to those of the partons) :

$$d\sigma^{h_a, h_b} = \sum_{ij} \frac{2p_T}{1 + \delta_{ij}} \sum_{1,2} \int_{x_{min}}^1 dx_a \left(\frac{x_a x_b}{x_a - p_T/\sqrt{s}} \right) \left[f_{i, \lambda_1}^{(h_a)}(x_a) f_{j, \lambda_2}^{(h_b)}(x_b) \frac{d\hat{\sigma}^{\lambda_1, \lambda_2}}{d\hat{t}}(i, j) + (i \leftrightarrow j) \right] \quad (6)$$

where we have dropped out the scale dependance for simplicity. Following the notations of ref.[11] we have :

$$\frac{d\hat{\sigma}^{\lambda_1, \lambda_2}}{d\hat{t}}(i, j) = \frac{\pi}{\hat{s}^2} \sum_{\alpha, \beta} T_{\alpha, \beta}^{\lambda_1, \lambda_2}(i, j) \quad (7)$$

$T_{\alpha, \beta}^{\lambda_1, \lambda_2}(i, j)$ denoting the matrix element squared with α boson and β boson exchanges, or with one exchange process replaced by a contact interaction.

If one ignores the contribution of the antiquarks, which is marginal in our p_T range, and restricts to the main channels $q_i q_i \bar{q}_i q_i$ and $q_i q_j \bar{q}_i q_j$ ($i \neq j$) one gets in short :

$$A_{LL}^{PV} \cdot d\sigma \simeq \sum_{ij} \sum_{\alpha,\beta} \int \left(T_{\alpha,\beta}^{--}(i,j) - T_{\alpha,\beta}^{++}(i,j) \right) \left[q_i(x_a) \Delta q_j(x_b) + \Delta q_i(x_a) q_j(x_b) + (i \leftrightarrow j) \right] \quad (8)$$

where we have introduced as usual the polarized quark distributions : $\Delta q_i(x, Q^2) = q_{i+} - q_{i-}$, $q_{i\pm}(x, Q^2)$ being the distributions of the polarized quark of flavor i , either with helicity parallel (+) or antiparallel (-) to the parent proton helicity. In eq.(8), $d\sigma$ is given by eq.(5). Concerning the QCD contribution to $d\sigma$, we take also into account the antiquarks as also $q(\bar{q})g$ and gg scattering although these subprocesses are not dominant in the high p_T region we consider.

2.1 Standard QCD-Electroweak interference effects

Concerning the influence of QCD-EW interference terms on A_{LR} or A_{LL}^{PV} , in the high p_T regime we are concerned with, only some estimates can be found in the literature [14] since previous authors focused mainly on the $p_T \sim M_{W,Z}/2$ region which is dominated by the s-channel W and Z resonance contributions [16].

We give in Fig.1 the asymmetry A_{LL}^{PV} in one-jet production at RHIC which is expected from purely QCD-EW interference terms. The correct expressions for the $T_{\alpha,\beta}$'s can be found in ref. [11]. It can be checked that 90% of the effect comes both from the interference terms T_{gZ} between the gluon and Z exchange graphs (identical quarks) and from the terms T_{gW} (quarks of different flavors).

We have used various sets of polarized distributions, some quite old, like BRST [9], CN1 [17] or CN2 [18], and some recent ones which give better fits to the new polarized DIS data : BS [19] and GS.a,b,c labelled according to ref. [20]. Note that when some distributions, like GS.a or b or c, differ by the shape of the polarized gluonic contribution, they give essentially the same values for A_{LL}^{PV} . Since BS and GS distributions provide two extreme cases we will keep only these latter in the following.

The rise of A_{LL}^{PV} with p_T is due to the increasing importance of quark-quark scattering relatively to other terms involving gluons. A_{LL}^{PV} remains small (at most 4% at $p_T = 100$ GeV/c) but it is measurable with the sensitivity available at RHIC (see below).

2.2 Interference between Contact and Standard amplitudes

One has to consider (schematically) all the terms appearing in $|QCD + EW + CT|^2$. Since we restrict to values of Λ above the CDF bound, the squared terms $|CT|^2$ involving $1/\Lambda^4$ are negligible at RHIC except for some unreasonable values of p_T . Any effect should come from CT+Standard interference terms.

One can find in ref. [10] all the helicity dependent $|QCD+CT|^2$ terms for the scattering of all kinds of quarks and antiquarks. As long as quarks are concerned, only identical

quarks give a contact amplitude interfering with the one gluon exchange amplitude:

$$T_{g.CT}^{\lambda_1, \lambda_2}(i, i) = \frac{8}{9} \alpha_s \frac{\epsilon}{\Lambda^2} (1 - \eta \lambda_1)(1 - \eta \lambda_2) \left(\frac{\hat{s}^2}{\hat{t}} + \frac{\hat{s}^2}{\hat{u}} \right) \quad (9)$$

On the other hand, we have found that the interference terms between Electroweak and Contact amplitudes cannot be ignored although they are not the source of the main effect. In this case, identical quarks as well as quarks of different flavors are involved. We have :

- for $q_i q_i \hat{q}_i q_i$:

$$T_{Z.CT}^{\lambda_1, \lambda_2}(i, i) = \frac{4\alpha_Z}{3} \frac{\epsilon}{\Lambda^2} \left[(1 - \lambda_1)(1 - \lambda_2) C_L^2(1 + \eta) + (1 + \lambda_1)(1 + \lambda_2) C_R^2(1 - \eta) \right] \left(\frac{\hat{s}^2}{\hat{t}_Z} + \frac{\hat{s}^2}{\hat{u}_Z} \right) \quad (10)$$

where $\alpha_Z = \alpha / \sin^2 \theta_W \cos^2 \theta_W$, $C_{R[L]} = -e_i \sin^2 \theta_W [T_{q_i}^3 - e_i \sin^2 \theta_W]$ for a quark of charge e_i and $\hat{t}_Z[\hat{u}_Z] = \hat{t}[\hat{u}] - M_Z^2$. $T_{\gamma.CT}^{\lambda_1, \lambda_2}(i, i)$ can be obtained from eq.(10) by changing $\alpha_Z \hat{\alpha} \cdot e_i^2$, $C_{L,R} \hat{1}$ and $\hat{t}_Z[\hat{u}_Z] \hat{t}[\hat{u}]$.

- for $q_i q_j \hat{q}_i q_j$ $i \neq j$:

$$T_{Z.CT}^{\lambda_1, \lambda_2}(i, j) = \alpha_Z \frac{\epsilon}{\Lambda^2} \left[(1 - \lambda_1)(1 - \lambda_2) C_L^i C_L^j (1 + \eta) + (1 + \lambda_1)(1 + \lambda_2) C_R^i C_R^j (1 - \eta) \right] \frac{\hat{s}^2}{\hat{t}_Z} \quad (11)$$

$T_{\gamma.CT}^{\lambda_1, \lambda_2}(i, j)$ being obtained from eq.(11) by changing $\alpha_Z \hat{\alpha} e_i e_j$, $\forall C \hat{1}$ and $\hat{t}_Z \hat{t}$,

and also

$$T_{W.CT}^{\lambda_1, \lambda_2}(i, j) = \frac{\alpha_W}{6} \frac{\epsilon}{\Lambda^2} |V_{ij}^{CKM}|^2 \left[(1 - \lambda_1)(1 - \lambda_2)(1 + \eta) \right] \frac{\hat{s}^2}{\hat{u}_W} \quad (12)$$

where $\alpha_W = \alpha / \sin^2 \theta_W$ and $\hat{u}_W = \hat{u} - M_W^2$.

In the actual calculations we have added all the terms, involving quarks or antiquarks, dominant or not.

3 Discussion and results

At RHIC, a very important parameter is the high luminosity which increases with the energy, reaching $\mathcal{L} = 2.10^{32} \text{ cm}^{-2} \cdot \text{s}^{-1}$ at $\sqrt{s} = 500 \text{ GeV}$. These figures yield an integrated luminosity $L_1 = \int \mathcal{L} dt = 800 \text{ pb}^{-1}$ in a few months running. In the following, we will call L_2 the luminosity giving four times this sample of events. We have integrated over a p_T bin of 10 GeV/c which is typical of a CDF like detector [2] in this p_T range.

This high luminosity will allow some very small statistical uncertainties on a spin asymmetry like A_{LL}^{PV} [8]. This uncertainty is given by :

$$\Delta A = \frac{1}{\mathcal{P}^2} \frac{2}{(N_{++} + N_{--})^2} \sqrt{N_{++} N_{--} (N_{++} + N_{--})} \quad (13)$$

where $N_{++}(N_{--})$ is the expected number of events in the helicity configuration $++$ ($--$) and $\mathcal{P} = 0.7$ is the degree of polarization of one beam. ΔA is roughly equal to $2/\sqrt{(N_{++} + N_{--})}$. One gets $\Delta A = \pm 0.01(0.005)$ with $N_{++} + N_{--} \sim 40000(170000)$ events. These figures are not unrealistic, even at high p_T , thanks to the high integrated luminosities L_1 or L_2 .

We present in Fig. 2 the results of our complete calculation for A_{LL}^{PV} , including all terms, for $\Lambda = 1.4$ TeV (that is the present CDF bound). The expected Standard asymmetry is shown for comparison. The parameter governing the sign of A_{LL}^{PV} is the sign of the product $\epsilon.\eta$. As can be seen from eq.(9), which gives the main effect, since \hat{t} and \hat{u} are negative, $\epsilon = -1$ ($+1$) corresponds to constructive (destructive) interference. We have chosen the BS parametrization for illustration. One can see that, at RHIC, even with the integrated luminosity L_1 , it is very easy to separate the Standard from the Non-Standard cases. With GS distributions, the magnitudes of the asymmetries are reduced but the effect is still spectacular.

For $\Lambda = 2$ TeV (Fig. 3), with L_2 there is still a 4σ difference (2σ with L_1) between the Standard and Non-Standard asymmetries, especially at values of p_T above 80 GeV/c. The small positive value of A_{LL}^{PV} for $\epsilon.\eta = +1$ at low p_T is due to the influence of the QCD-EW and CT-EW interference terms.

In Fig. 4 we display again A_{LL}^{PV} with $\Lambda = 2$ TeV, but now calculated using the two extreme choices, BS and GS distributions. The clearest result is that, in spite of the present uncertainty due to the imperfect knowledge of the polarized quark distributions, a value for A_{LL}^{PV} close to zero at large p_T is the sign of the presence of Non-Standard physics (namely either a left-handed contact interaction with destructive interference or a right-handed one with constructive interference). Indeed, with L_2 , the two close BS and GS curves stand at 3σ from the smaller QCD-EW asymmetry which corresponds to the GS parametrization. The situation is less spectacular in the case where $\epsilon.\eta = -1$ but it is still interesting.

Finally, we have tried to determine if the information from the measurement of A_{LL}^{PV} could compete with the bounds on Λ one could reach in the future at the Tevatron (with unpolarized beams). Following the strategy of refs. [1, 21], we have calculated $d\sigma(\text{QCD}+\text{CT})$ in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV using MRS [22] distributions and demanding a 100% deviation from the QCD prediction at large p_T (with at least 10 QCD events). Our crude estimate gives amazingly exactly the same result as the published sophisticated CDF study ($\Lambda > 1.4$ TeV with $4.2 pb^{-1}$ of integrated luminosity). With an integrated luminosity of $100 pb^{-1}$ we expect a limit of $\Lambda > 2$ TeV at the Tevatron. We give in Table 1 the 95% C.L. limits on Λ which should be obtained at RHIC from the measurement of A_{LL}^{PV} .

Λ	$\epsilon.\eta = -1$	$\epsilon.\eta = +1$
L_1	BS : 2200	2070
	GS : 1950	1900
L_2	BS : 3050	3010
	GS : 2710	2670

Table 1: Limits on Λ (in GeV) from the measurement of A_{LL}^{PV} at RHIC with the integrated luminosities L_1 and L_2 , according to BS and GS polarized distributions.

4 Conclusion

It has been stressed for some time that polarization at hadronic colliders should improve their potential capabilities [9, 10], in particular in the search for New Physics if the energy is as large as the LHC energy (see e.g. [23]). We have seen here that, in spite of the lower energy, the RHIC collider, running in the pp mode, could compete with the Tevatron, thanks to the polarization and also to the high luminosity which turned out to be the key factor for our analysis. The high statistics which should be available could allow to disentangle a Non-Standard A_{LL}^{PV} due to compositeness from the Standard asymmetry due to QCD-EW interference, provided Λ lies in the 2 - 3 TeV range. Needless to recall that, if such a signal is observed, then a unique information could be obtained on the chirality structure of the new contact interaction from the determination of the sign of the product $\epsilon.\eta$.

It is true that the present imperfect knowledge of the polarized quark distributions still induces some uncertainties. It has to be stressed however that our wisdom on this subject will change drastically in the near future, thanks to new polarized DIS experiments (the experiment HERMES at HERA [24] is presently running) and to the RHIC Spin Collaboration program itself.

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References

- [1] E. Eichten, K.Lane and M. Peskin, Phys. Rev. Lett.. **50**, 811 (1983), E. Eichten, et al., Rev. Mod. Phys. **56** (1984) 579.
- [2] F. Abe et al., Phys. Rev. Lett. **68**, 1104 (1992).
- [3] F. Abe et al., Phys. Rev. Lett. **71**, 2542 (1993).
- [4] L. Montanet et al. (Particle Data group) , Phys. Rev. **D50**, 1173 (1994).
- [5] C.H. Albright et al. in *Proceedings of the Summer Study on the Design and Utilization of the SSC* (Snowmass 1984), eds. R. Donaldson and J. Morfin (APS New York 1985), p. 27 ; S.L. Adler in *Physics of the SSC* (Snowmass 1986) eds. R. Donaldson and J. Marx (APS New York 1986), p. 292.
- [6] J. Ashman et al., Phys. Lett. **B206**,364 (1988); Nucl. Phys. **B328**, 1 (1989); B. Adeva et al. , Phys. Lett. **B302**, 533 (1993) ; D. Adams et al. Phys. Lett. **B329**, 399 (1994) ; P.L. Anthony et al. , Phys. Rev. Lett. **71**, 959 (1993) ; K. Abe et al. Phys. Rev. Lett. **74**, 346 (1995).
- [7] RHIC Spin Collaboration (RSC), Letter of intent, April 1991 and RSC (STAR/PHENIX) letter of intent update, August 1992.
- [8] G. Bunce et al., *Polarized protons at RHIC*, Particle World, **3**, 1 (1992).
- [9] C. Bourrely, J. Soffer, F.M. Renard and P. Taxil, Phys. Reports,**177**, 319 (1989).
- [10] P.Taxil, Riv. Nuovo Cimento, Vol. 16, No. 11 (1993).
- [11] C. Bourrely, J. Ph. Guillet and J. Soffer, Nucl. Phys. **B361**, 72 (1991).
- [12] M.A Doncheski, F Halzen, C.S. Kim and M.L. Stong, Phys.Rev.**D49**, 3261 (1994).
- [13] C. Bourrely, and J. Soffer, Nucl. Phys. **B423**, 329 (1994).
- [14] M. Tannenbaum, in *Polarized Collider Workshop*, J. Collins, S.F. Heppelmann and R.W. Robinett eds, AIP Conf. Proceedings **223**, AIP, New York, 1990, p. 201.
- [15] M. Abud, R. Gatto and C.A. Savoy, Ann. Phys. (NY) **122**, 219 (1979) ; U. Baur, E.W.N. Glover and A.D. Martin, Phys. Lett. **B232**, 519 (1989).
- [16] F.E. Paige, T.L. Trueman and T.N. Tudron, Phys. Rev. **D19**, 935 (1979) ; J. Ranft and G. Ranft, Nucl. Phys. **B165**, 395 (1980).
- [17] P. Chiappetta and G. Nardulli, Zeit. Phys. **C51**, 435 (1991).
- [18] P. Chiappetta, P. Colangelo, J.Ph. Guillet and G. Nardulli, Zeit. Phys. **C59**, 629 (1993).

- [19] C. Bourrely, and J. Soffer, Nucl. Phys. **B445**, 341 (1995).
- [20] T. Gehrmann and W.J. Stirling, Zeit. f. Phys. **C65**, 461 (1995).
- [21] P. Chiappetta and M. Perrottet, Phys. Lett. **B253** 489 (1991) ; see also *Proc. LHC Aachen Workshop*, Vol. II, G. Jarlskog and D. Rein eds., CERN Report CERN 90-10, p. 685 (1990).
- [22] A.D. Martin, R.G. Roberts and W.J. Stirling Phys. Rev. **D50**, 6734 (1994).
- [23] A. Fiandrino and P. Taxil, Phys.Rev. **D44**, 3490 (1991) and Phys. Lett. **B293**, 242 (1992) ; R. Casalbuoni et al. Phys. Lett. **B279**, 397 (1992).
- [24] HERMES collaboration, DESY Report, DESY-PRC 93/06, Hamburg 1993.

Figure captions

Fig. 1 A_{LL}^{PV} for one-jet inclusive production from QCD-EW interference only, versus p_T , with RHIC parameters (see Section 3) : pp collisions, $\sqrt{s} = 500$ GeV, integrated luminosities L_1 (large error bars) and L_2 (small error bars), according to various choices of polarized distributions : BS (plain curve), BRST (dotted), CN1 and CN2 (dot-dashed), GSa,b,c (dashed curves).

Fig. 2 A_{LL}^{PV} versus p_T for $\Lambda = 1.4$ TeV. $\epsilon.\eta = -1$ (dashed curve) ; $\epsilon.\eta = +1$ (dot-dashed curve), and pure QCD-EW interference (plain curve). The calculations are performed with BS distributions and the RHIC parameters are the same as in Fig. 1

Fig. 3 Same as Fig. 2 for $\Lambda = 2$ TeV.

Fig. 4 A_{LL}^{PV} versus p_T at RHIC with $\Lambda = 2$ TeV for BS (plain curves) and GS (dot-dashed curves) polarized distributions. The error bars correspond to the luminosity L_2 .