NUCLEON SPIN STRUCTURE AND LARGE p_T PROCESSES AT pp COLLIDERS [a]

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QCD motivated polarized parton distributions, evolved directly in x-space, are used to predict rates for prompt photon production at RHIC centre of mass energies. Various scenarios for the polarized gluon distributions are considered and compared, and the possibility of using large p_T processes in polarized pp collision experiments to choose between them is analyzed.

1 Introduction

In a recent paper [1] we proposed three new parametrizations for the spin dependent parton distributions for the proton. Our distributions, which are available in both leading order (LO) and next-to-leading order (NLO), were evolved directly in x-space. In [1] we presented details of the models used to obtain the input distributions and compared the evolved structure functions with the available data.

All currently available data on the nucleon spin structure come from deep inelastic scattering experiments, and therefore do not contain direct information on individual parton distributions such as the gluon, $\Delta G(x, Q^2)$ or strange sea, $\Delta s(x, Q^2)$, for example. It is expected that such detailed information will come from other experiments such as those proposed at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven or HERA-$\vec{N}$ in Hamburg.

One of the main programs at RHIC will be to determine the size and the shape of the polarized parton distributions which, at the moment, suffer from significant model dependence, especially in the gluon contribution, ΔG, but also the sea quark distributions.

In this paper we use our evolved parton distributions to predict cross sections for direct photon production at RHIC cms energies. Details of the evolution of the parton distributions and predictions for prompt photon production can be found in [2].

The prompt photon cross section promises to be one of the most useful for measuring ΔG at RHIC and HERA-$\vec{\mathrm{N}}$ since it is dominated by the subprocess $qg \to \gamma q$. Contributions to the prompt photon cross section are usually separated into two classes in both LO and NLO. There are the so-called direct

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processes where the photon is produced directly in the hard scattering. In addition there are the fragmentation contributions where the photon is produced via bremsstrahlung off a final state quark or gluon.

2 Results

In this paper we present results for the inclusive prompt photon cross section at RHIC energies without taking any possible isolation cuts into account. As shown in [3], isolation cuts do not have a significant effect on the asymmetries which are the quantities in which we are mainly interested here.

Figure 1 shows our various parametrizations of the polarized gluon distributions at $Q^2 = 100$ GeV^2. The GSA [4] parametrization is included for comparison. Our polarized gluon distributions are smaller than GSA, which affects the ratio of quark to gluon contributions at small x. This in turn will modify the relative contributions to direct γ production. (See figure 3).

Figure 2 shows the asymmetries, A_{LL}, as predicted using the various parametrizations at $\sqrt{s} = 200$ GeV. The asymmetries differ significantly confirming sensitivity to ΔG. They differ from GSA most significantly at the largest p_T values ($> 40\, GeV$), where RHIC is at the p_T limit. However, measurement of this asymmetry should be able to distinguish between small and large polarized gluon distributions at large p_T.

Figure 3 confirms that the qg scattering process dominates the direct γ cross section at the p_T values where the cross section is largest. The second most important process $q\bar{q}$ scattering only becomes significant at very large p_T values.

3 Conclusions

The new NLO GGR parametrizations of the polarized parton distributions were used to predict asymmetries for direct photon production at RHIC energies. The three scenarios considered give different predictions which will be distinguishable with reasonably good statistics in the measurements.

References

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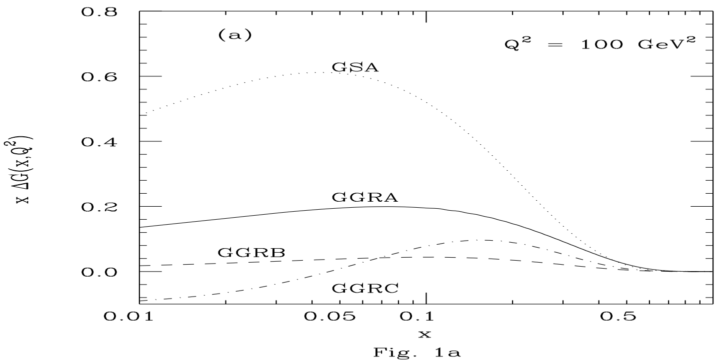

Figure 1: The GGR polarized gluon distributions compared to GSA.

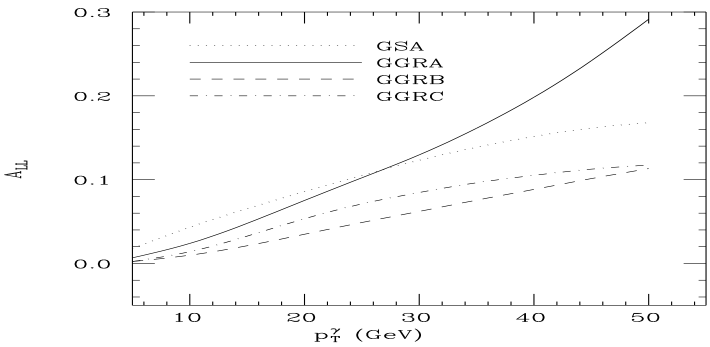

Figure 2: Asymmetries for direct γ production.

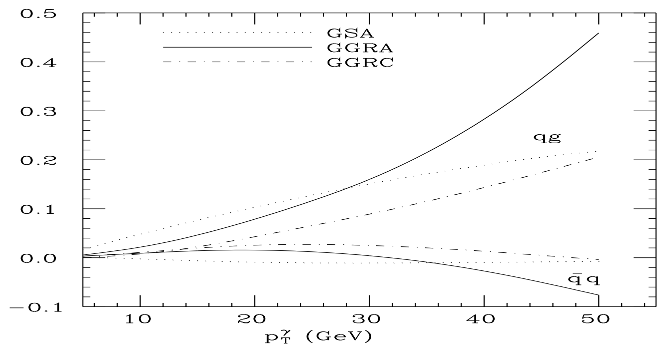

Figure 3: Asymmetries showing qg and $q\bar{q}$ contributions.