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Next-To-Leading Order QCD Corrections for Transversely Polarized PP and anti-PP Collisions

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NEXT-TO-LEADING ORDER QCD CORRECTIONS FOR TRANSVERSELY POLARIZED PP AND $\bar{P}P$ COLLISIONS

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We present a calculation of the next-to-leading order QCD corrections to the partonic cross sections contributing to single-inclusive high-p_T hadron production in collisions of transversely polarized hadrons. We use a recently proposed projection technique and give some predictions for the double spin asymmetry A_{TT}^{π} for the proposed experiments at RHIC and at the GSI.

1. Introduction

The leading-twist partonic structure of a spin-$\frac{1}{2}$ hadron is given in terms of the unpolarized parton distribution functions $f(x, Q^2)$, the helicity distributions $\Delta f(x, Q^2)$, and the transversity distributions $\delta f(x, Q^2)$. Transversity describes the number density of a parton with the same transverse polarization as the nucleon, minus the number density for opposite polarization. Among the various parton distributions, the $\delta f(x, Q^2)$ are the ones about which we have the least knowledge. They are at present the focus of much experimental activity. Transversity will be probed by double-transverse spin asymmetries in transversely polarized pp collisions at the BNL Relativistic Heavy Ion Collider (RHIC) [1]. The most promising reaction is the Drell-Yan process, which offers the largest spin asymmetries, but whose

in a covariant way. The projector

$$F(p, s_a, s_b) = \frac{s}{\pi t u} \left[2\,(p \cdot s_a)\,(p \cdot s_b) \; + \; \frac{tu}{s}\,(s_a \cdot s_b) \right] \tag{2}$$

reduces to $\cos(2\Phi)/\pi$ in the center-of-mass frame of the initial hadrons. Here p is the momentum of the observed particle in the final state and the s_i are the initial transverse spin vectors. The squared matrix element for the partonic process is multiplied with this projector and integrated over the full azimuthal phase space. Integrations of terms involving the product of the transverse spin vectors with the final-state momenta can be performed using a tensor decomposition. After this step, no scalar products involving the s_i are left in the squared matrix element. For the remainder of the phase space integrations, one can now use techniques familiar from the unpolarized and longitudinally polarized cases. This method is particularly convenient at NLO, where one uses dimensional regularization and the phase space integrations are performed in $n \neq 4$ dimensions.

3. Application to single-inclusive hadroproduction : phenomenological results

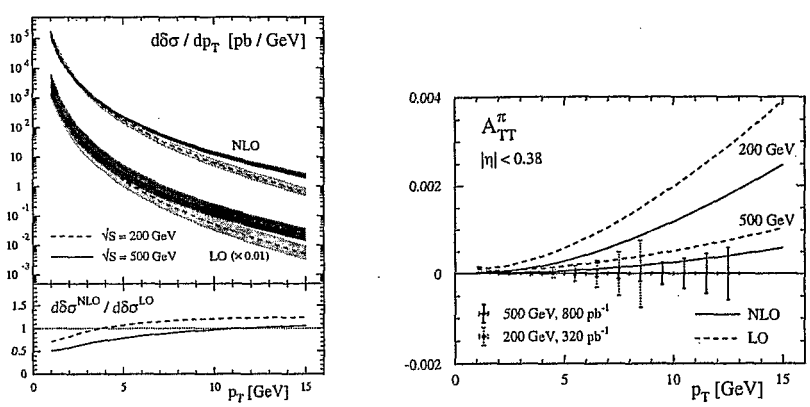

Figure 1. Predictions for the transversely polarized single-inclusive pion production cross sections at LO and NLO at RHIC (left), and for the transverse double-spin asymmetry $A_{TT}^{\pi^0}$ (right). The shaded bands represent the range of predictions when the scale μ is varied in the range $p_T \leq \mu \leq 4p_T$. The lower panel on the left shows the ratios of the NLO and LO results (the 'K-factors').

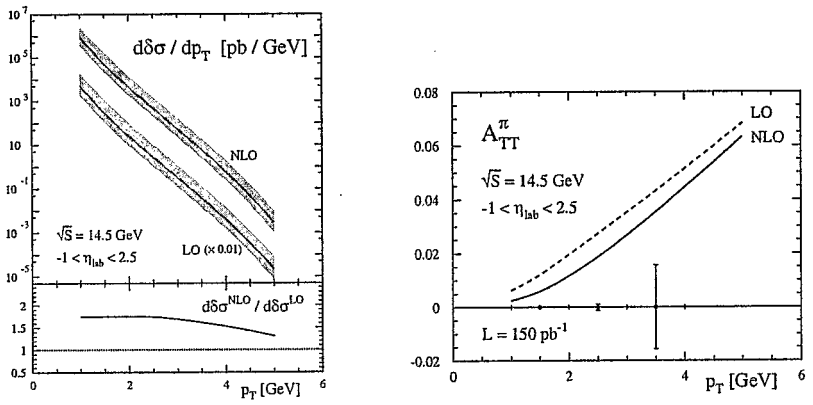

Figure 2. LO and NLO predictions for the cross section (left) and the transverse spin asymmetry $A_{TT}^{\pi^0}$ (right) for single-inclusive pion production in $\bar{p}p$ collisions at the GSI. The shaded bands represent the range of predictions if the scale μ is varied in the range $p_T \leq \mu \leq 4p_T$. The lower panel (left) shows the ratios of the NLO and LO results (the 'K-factors').

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