Studies of transversity distributions at RHIC

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ABSTRACT

We explain our studies on transversity distributions. First, Q^2 evolution for the transversity distributions is discussed. It is given by a single integrodifferential equation without coupling to the gluon distribution. Dividing the variables x and Q^2 into small steps, we solve the integrodifferential equation by the Euler method in the variable Q^2 and by the Simpson method in the variable x. We provide a FORTRAN program for the Q^2 evolution and devolution of the transversity distribution $\Delta_T q$. Using the program, we show the LO and NLO evolution results of the valence-quark distribution $\Delta_T u_v + \Delta_T d_v$ and the singlet distribution $\sum_i(\Delta_T q_i + \Delta_T \bar{q}_i)$. Because the evolution results are very different from the longitudinal ones, the measurement of the transversity distributions could be an important test of perturbative QCD. Next, we consider a flavor asymmetry distribution $\Delta_T \bar{u} - \Delta_T \bar{d}$. There is a finite contribution to $\Delta_T \bar{u} - \Delta_T \bar{d}$ in perturbative QCD; however, it is rather a small effect. If a significant amount of the flavor asymmetry is found by future experiments, it is likely due to a nonperturbative mechanism. Using a theoretical model, in particular the Pauli blocking model, for explaining the unpolarized asymmetry $\bar{u} - \bar{d}$, we show the flavor asymmetric transversity distribution $\Delta_T \bar{u}(x) - \Delta_T \bar{d}(x)$. Then, we discuss its Q^2 dependence and its effects on the spin asymmetries at RHIC.

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References

- Phys. Rev. D56 (1997) 2504.
- Comput. Phys. Commun. 108 (1998) 38.
- hep-ph/9712410, in press.
- research in progress.

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RHIC-Spin, BNL

DGLAP evolution equation for transversity distributions

"nonsinglet type"

$$\frac{\partial}{\partial(\ln Q^2)} \Delta_T q\,(x,Q^2) = \frac{\alpha_s}{2\pi} \int_x^1 \frac{dy}{y} \Delta_T P\left(\frac{x}{y}\right) \Delta_T q\,(y,Q^2)$$

Numerical solution

$x \longrightarrow$ divided into $2N_x$ steps

$t = \ln Q^2 \longrightarrow$ divided into N_t steps

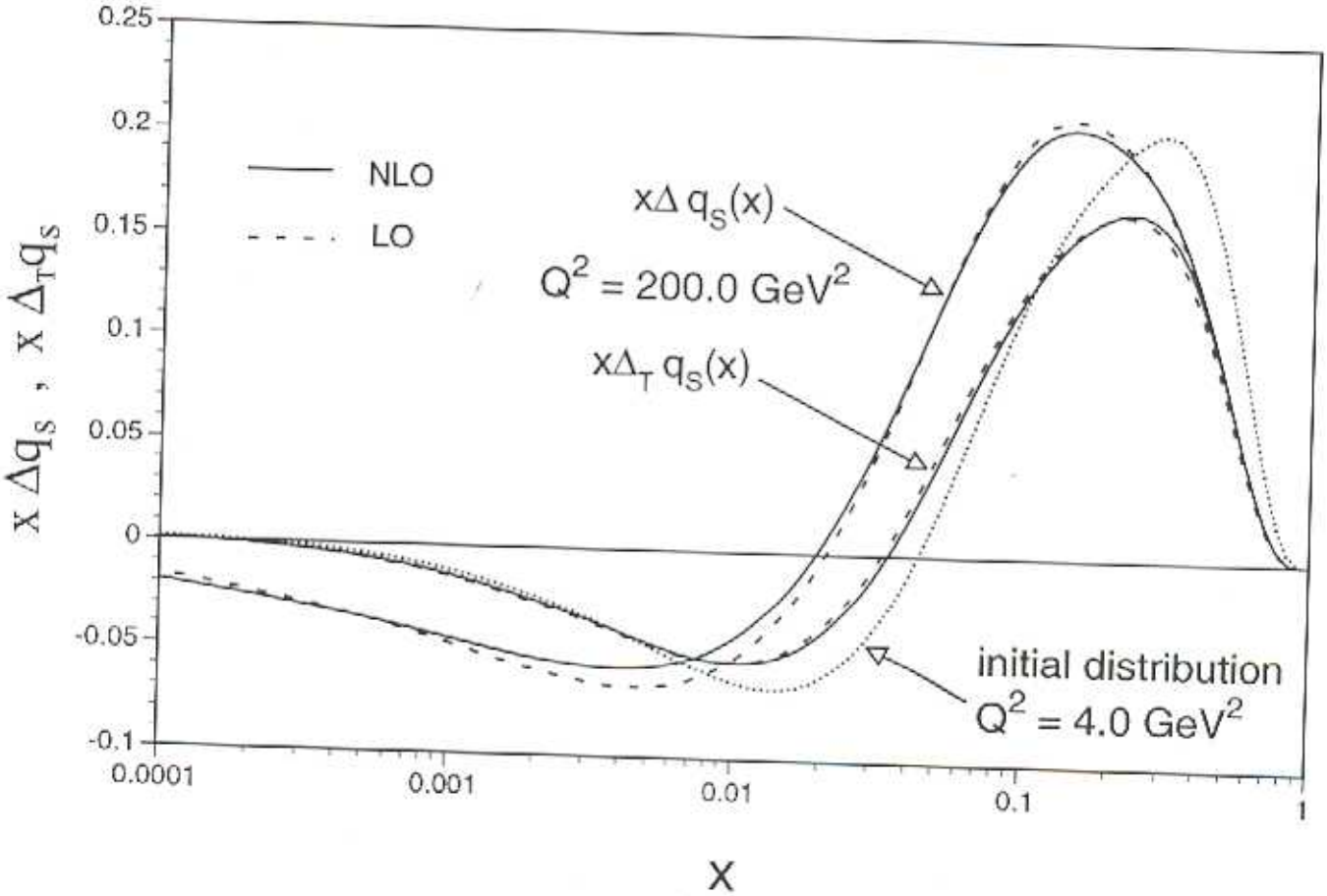
$$\frac{\partial}{\partial t} f(x,t) \quad \Rightarrow \quad \frac{f(x_i, t_{j+1}) - f(x_i, t_j)}{\delta t}$$

$$\int dz\, f(z) \quad \Rightarrow \quad \sum_{k=2,4,\ldots}^{2Nx} \frac{\delta z}{3} \left[f(z_{k-1} + 4\, f(z_k) + f(z_{k+1}) \right]$$

see hep-ph/9712410

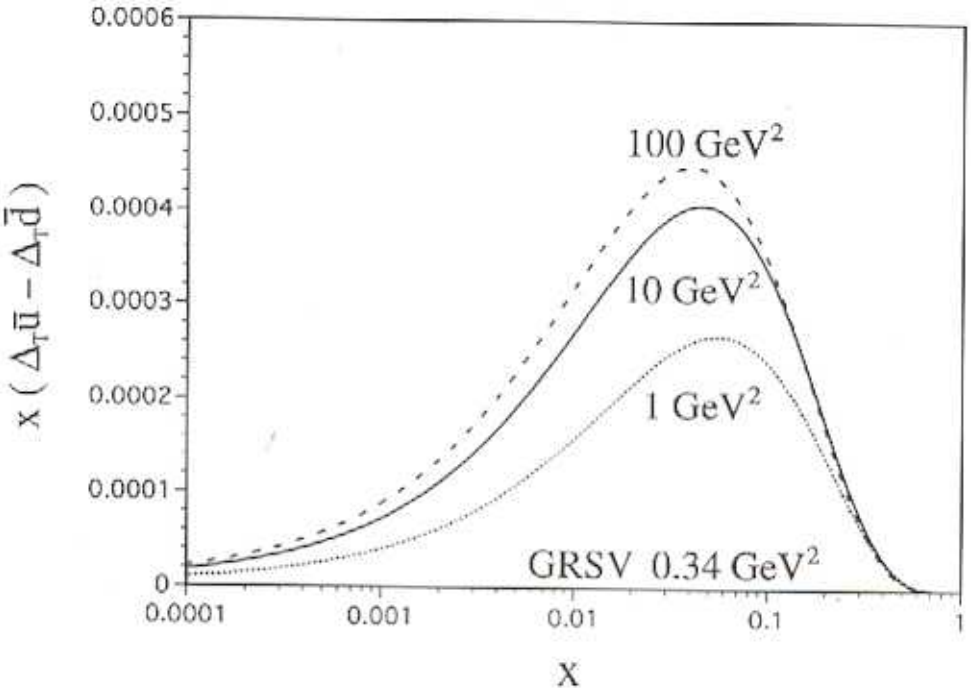
Our evolution program could be obtained upon email request.

Q^2 evolution of longitudinally polarized and transversity distributions

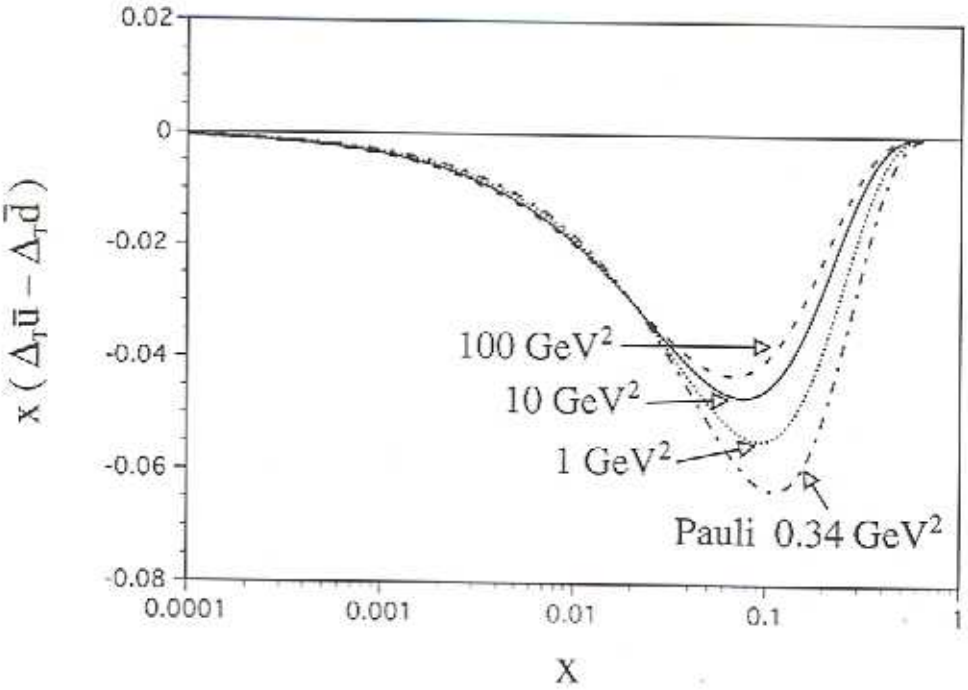
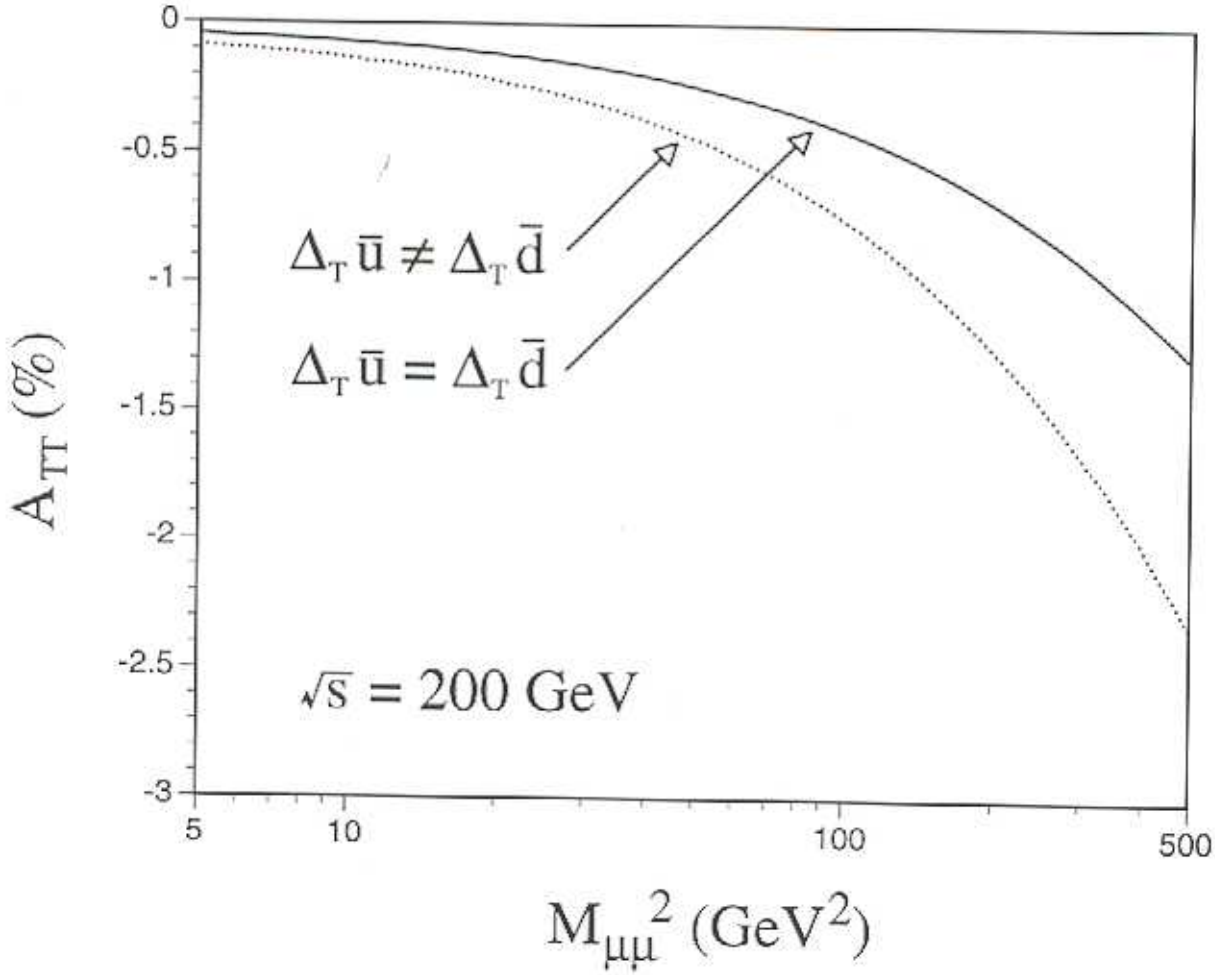


Q^2 dependence of $\Delta_T\bar{u} - \Delta_T\bar{d}$

initial $(\Delta_T\bar{u} - \Delta_T\bar{d})_{GRSV} = 0$ at Q^2=0.34 GeV^2



initial $(\Delta_T\bar{u} - \Delta_T\bar{d})_{Pauli} \neq 0$ at Q^2=0.34 GeV^2



Transverse spin asymmetry