PROCEEDINGS OF SCIENCE

Nonphotonic electrons at RHIC within the k_t-factorization approach

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We discuss production of so-called nonphotonic electrons in proton-proton scattering at BNL RHIC. The distributions of charm and bottom quarks/antiquarks are calculated in the framework of the k_t-factorization approach. For this calculation we use Kwieciński unintegrated parton distributions. The hadronization of heavy quarks is done by means of Peterson et al. fragmentation function. The semileptonic decay functions are found by fitting recent semileptonic data obtained by the CLEO and BABAR collaborations. In the next step of our analysis, we have calculated the kinematical correlations between charged leptons from semileptonic decays of open charm/bottom as well as leptons produced in the Drell-Yan mechanism. In both cases, we get good description of the PHENIX and STAR data.

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1. Introduction

Recently the PHENIX and STAR collaborations have measured transverse momentum distribution of nonphotonic electrons [1]. It is believed that the dominant contribution to the nonphotonic electrons/positrons comes from the semileptonic decays of charm and beauty mesons. These processes have three subsequent stages. The whole procedure of electron/positron production can be written in the following schematic way:

$$\frac{d\sigma^e}{dyd^2p} = \frac{d\sigma^Q}{dyd^2p} \otimes D_{Q\to h} \otimes f_{h\to e} \; , \tag{1.1}$$

where the symbol $\otimes$ denotes a generic convolution. The first term is responsible for production of heavy quarks/antiquarks. Next step is the process of formation of heavy mesons and the last ingredient describes semileptonic decays of heavy mesons to electrons/positrons.

2. Formalism and Results

The inclusive production of heavy quark/antiquark can be calculated in the framework of the k_t-factorization [2]. In this approach transverse momenta of initial partons are included and emission of gluons is encoded in so-called unintegrated gluon (parton) distributions. In the leading-order approximation within the k_t-factorization approach the differential cross section for the $Q\overline{Q}$ or Drell-Yan process can be written as:

$$\frac{d\sigma}{dy_1 dy_2 d^2p_{1,t} d^2p_{2,t}} = \sum_{i,j} \int \frac{d^2\kappa_{1,t}}{\pi}\frac{d^2\kappa_{2,t}}{\pi}\frac{1}{16\pi^2(x_1x_2s)^2}\,\overline{|\mathcal{M}_{ij}|^2}$$
$$\delta^2\left(\vec{\kappa}_{1,t}+\vec{\kappa}_{2,t}-\vec{p}_{1,t}-\vec{p}_{2,t}\right)\,\mathcal{F}_i(x_1,\kappa_{1,t}^2)\,\mathcal{F}_j(x_2,\kappa_{2,t}^2)\;, \tag{2.1}$$

where $\mathcal{F}_i(x_1,\kappa_{1,t}^2)$ and $\mathcal{F}_j(x_2,\kappa_{2,t}^2)$ are the unintegrated gluon (parton) distributions (UPDFs).

There are two types of the LO $2\to 2$ subprocesses which contribute to heavy quarks production, $gg\to Q\overline{Q}$ and $q\overline{q}\to Q\overline{Q}$. The first mechanism dominates at large energies and the second one near the threshold. At relatively low RHIC energies rather intermediate x-values become relevant so the Kwiecinski UPDFs seem applicable in this case [3].

The hadronization of heavy quarks is usually done with the help of fragmentation functions. The inclusive distributions of hadrons can be obtained through a convolution of inclusive distributions of heavy quarks/antiquarks and Q $\to$ h fragmentation functions. The Peterson fragmentation functions are often used in this context [4].

Recently the CLEO and BABAR collaborations have measured very precisely the spectrum of electrons/positrons coming from the weak decays of D and B mesons, respectively [5]. These functions can in principle be calculated. This introduces, however, some model uncertainties and requires inclusion of all final state channels explicitly. An alternative is to use proper experimental input which after renormalizing to experimental branching fractions can be use to generate electrons/positrons in a Monte Carlo approach.

Better statistics at present and future colliders give a new possibility to study not only inclusive distributions but also correlations between outgoing particles. The k_t-factorization method is very useful to study correlations between produced leptons. In this part of our calculations we take

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under consideration not only leptons from open charm/bottom decays but also leptons produced in Drell-Yan proccess.

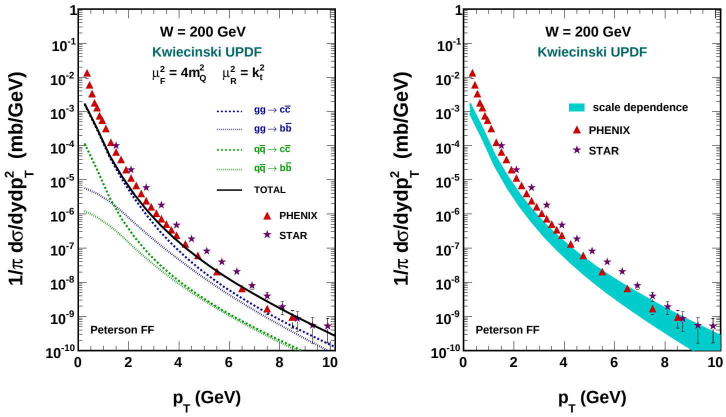

Figure 1: Transverse momentum distributions of leptons (left panel) and factorization and renormalization uncertainty band of the $Q\overline{Q}$ contribution (right panel)

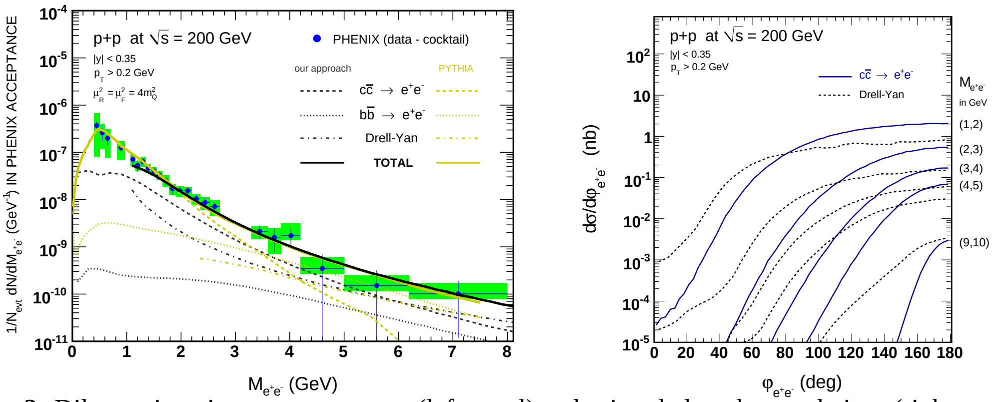

Figure 2: Dilepton invariant mass spectrum (left panel) and azimuthal angle correlations (right panel)

3. Conclusions

We have calculated distributions in rapidity and transverse momentum of single electrons as well as kinematical correlations between outgoing leptons. We get good description of the recent PHENIX and STAR data. More details can be found in our original papers [6].

References

[1] A. Adare et al. (PHENIX collaboration), Phys. Rev. Lett. **97** (2006) 252002,
B.I. Abelev et al. (STAR collaboration), Phys. Rev. Lett. **98** (2007) 192301.

[2] S. Catani, M. Ciafaloni and F. Hautmann, Nucl. Phys. **366** (1991) 135.

[3] J. Kwieciński, Acta Phys. Polon. **B33** (2002) 1809.

[4] C. Peterson, D. Schlatter, I. Schmitt, P.M. Zerwas, Phys. Rev. **D27** (1983) 105.

[5] N.E. Adam, et al. (CLEO collaboration), Phys. Rev. Lett. **97** (2006) 251801.
B. Aubert, et al. (BABAR collaboration), Phys. Rev. **D69** (2004) 111104(R).

[6] M. Łuszczak, R. Maciuła, A. Szczurek, Phys. Rev. **D79** (2009) 034009,
G. Ślipek, A. Szczurek, Phys. Rev. **D78** (2008) 114007.