A puzzle in the direct photon production *

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Recent measurements of direct photon spectra and their v_2 in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV by the PHENIX Collaboration [1] stimulated a new wave of interest for real photons, since the thermal QGP photons were expected to dominate the spectra. But the experimental observation that the elliptic flow $v_2(p_T)$ of direct photons is comparable to that of the pions was in contrast to the theoretical expectations. The photons produced in the QGP are not expected to show a considerable flow, because they are dominated by the emission in the initial phase before the elliptic flow fully develops. None of the theoretical models could describe simultaneously the photon spectra and v_2, which is known as the "direct photon puzzle".

Our results for the direct photon p_T-spectra and v_2 [2] are shown in comparison to the PHENIX data in the Figure below. We model the evolution of heavy-ion collisions by using the microscopic non-equilibrium transport approach Parton-Hadron-String Dynamics (PHSD), which describes the initial hard scatterings, string formation, creation of the strongly-interacting quark-gluon plasma as well as dynamical hadronization and the subsequent interactions in the expanding hadronic phase. The photons from QGP give up to 50% of the direct photon yield below 2 GeV/c, but a sizable contribution stems from hadronic sources such as meson-meson (mm) and meson-Baryon (mB) bremsstrahlung. The contribution from binary mm and VN reactions is minor compared to the partonic and bremsstrahlung channels. The hadron bremsstrahlung photons carry large v_2 of the order of the pion v_2, which leads to the direct photon v_2 in agreement with the data within the systematical uncertainties. The PHENIX Collaboration found also that the midrapidity 'thermal' photon yield scales with the number of participants as $dN/dy \sim N_{part}^{\alpha}$ with $\alpha = 1.48 \pm 0.08$. Our predictions gave $\alpha = 1.5$ dues to the dominance of the mm and mB contribution, while the QGP channels scale with $\alpha = 1.7$. Thus, according to the present PHSD results the mm and mB bremsstrahlung turn out to be an important source of direct photons, which contributes towards the resolution of the puzzle.

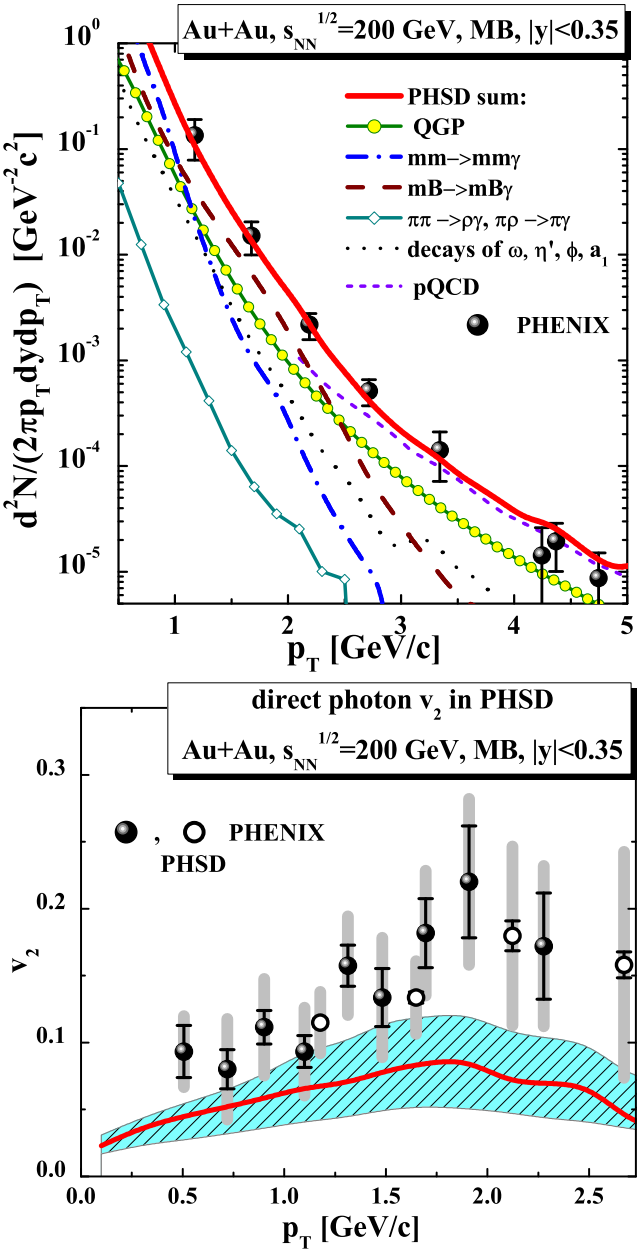

Figure 1: The spectra (up) and elliptic flow (down) for the direct photons produced in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. Our results within the PHSD approach [2] are given by the red solid lines. The PHENIX data (symbols) are from [1].

References

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[2] O. Linnyk et al, Phys. Rev. C88 (2013) 034904; O. Linnyk et al, Phys. Rev. C89 (2014) 034908; O. Linnyk et al, to be published in Phys. Rev. C (2015)

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