

Comment on “Quantum Opacity, the RHIC HBT Puzzle, and the Chiral Phase Transition”

In a recent Letter, Cramer, Miller, Wu and Yoon [1] (CMWY) presented a model based on a relativistic quantum mechanical treatment of opacity and refractive effects on momentum correlations between pairs of identical particles and particle transverse momentum (p_T) spectra. The values of the ten model parameters were obtained from a simultaneous fit to the HBT radii and pion p_T spectra measured for central Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. CMWY conclude from the fitted values of their model parameters that the data are consistent with the emission of pions from a dense medium in which chiral symmetry has been restored. In addition, the authors provide predictions of the momentum dependence of the HBT radii and pion p_T spectra in the region below 200 MeV/c. However, the authors chose not to compare their model predictions with the published experimental data for pion yields at very low p_T obtained using the PHOBOS detector at RHIC. The purpose of this Comment is to make the comparison of the CMWY model predictions with the PHOBOS data.

The PHOBOS experiment has a unique capability of measuring charged particles down to very low p_T . The results [2] reach p_T as low as 30 MeV/c for charged pions, and cover the region where the CMWY model predicted notable structure in the pion p_T spectrum. The published model predictions are shown as a dashed curve in Fig. 1. However, in the original paper [1] there was an error in the representation of the STAR pion momentum spectra [3], consequently leading to the extraction of incorrect values of the model parameters. As a result, the dashed curve, shown in Fig. 1, disagrees with the STAR data at higher p_T . This mistake was pointed out to CMWY by the authors of this comment and, as a result, a new set of model predictions for the spectral behavior at very low transverse momenta was generated [4]. The corrected model predictions, shown by a dotted curve in Fig. 1, differ significantly from those published in [1]. More recently, an alternative fit was performed in which the pion momentum distribution used in the fit was modified “to remove from the spectrum those pions that did not participate in the Bose-Einstein symmetrization” [4]. The results from this version of the fit are shown as the solid curve in Fig. 1. It is clear that the predicted yield at low p_T is very sensitive to the values of the parameters and the details of the model.

The low-transverse momentum charged pion yields, measured by PHOBOS [2], are overlaid on the model curves in Fig. 1. Since our analysis of particle production in this momentum region does not allow for separation of positive and negative pions, the invariant p_T yields measured for charged pions are divided by 2. It should be noted that our results correspond to the 15% most

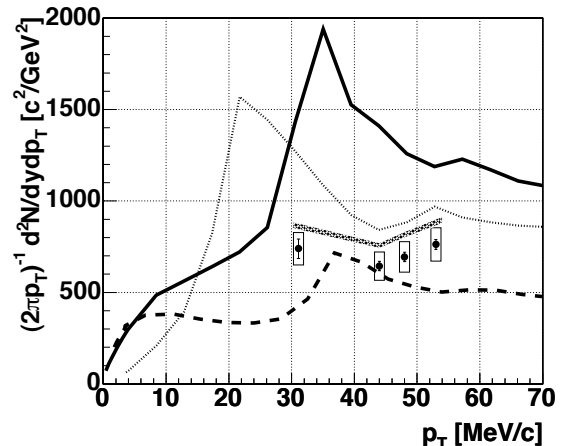


FIG. 1: p_T spectra of charged pions. Points show PHOBOS published data for $(\pi^+ + \pi^-)/2$ yields measured in the 15% most central Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. Bars denote statistical errors and the boxes correspond to 90% C.L. systematic uncertainties. The crossed curve shows the extent to which the yield is expected to increase (15-20%) for a more central event selection in the data. Other curves show results of the CMWY model calculations with the dashed curve representing the published results [1]. The dotted and solid curves represent more recent model predictions [4]. See text for more details.

central Au+Au collisions. The centrality of the predictions is not clearly specified, but we infer from the data shown that they are for the 5% most central collisions. The number of pions per event is expected to be higher for more central data. Thus, imposing a more stringent centrality selection leads to yields higher than those measured by PHOBOS. One can roughly estimate the size of this increase from the p_T spectra measured by PHENIX at higher p_T for centrality bins of 0-5% and 0-15% [5] or from the centrality dependence of the p_T integrated charged particle $dN/d\eta$ yields measured by PHOBOS [6]. Both estimates give scaling factors in a range from 15 to 20%. Interpolation of the STAR published data at higher p_T [3] for centrality bins of 0-10% and 0-20% suggests a similar increase. Multiplying our measured points by factors of 1.15 to 1.20 gives the thick crossed curve shown in Fig. 1.

It is clear that it would be best to test models, such as those discussed here, in a range of centralities. This requires more central data, which will be provided by PHOBOS, as well as model calculations for less central collisions. We conclude that the low p_T pion yields uniquely measured by PHOBOS provide valuable information for evaluating models of the dense medium created in heavy ion collisions at RHIC energies.

PHOBOS Collaboration:

B.B.Back¹, M.D.Baker², M.Ballintijn⁴, D.S.Barton², R.R.Betts⁶, A.A.Bickley⁷, R.Bindel⁷, A.Budzanowski³, W.Busza⁴, A.Carroll², M.P.Decowski⁴, E.García⁶,

N.George^{1,2}, K.Gulbrandsen⁴, S.Gushue², C.Halliwell⁶,
 J.Hamblen⁸, G.A.Heintzelman², C.Henderson⁴,
 D.J.Hofman⁶, R.S.Hollis⁶, R.Hołyński³, B.Holzman²,
 A.Iordanova⁶, E.Johnson⁸, J.L.Kane⁴, J.Katzy^{4,6},
 N.Khan⁸, W.Kucewicz⁶, P.Kulinich⁴, C.M.Kuo⁵,
 W.T.Lin⁵, S.Manly⁸, D.McLeod⁶, A.C.Mignerey⁷,
 R.Nouicer⁶, A.Olszewski³, R.Pak², I.C.Park⁸,
 H.Pernegger⁴, C.Reed⁴, L.P.Remsberg², M.Reuter⁶,
 C.Roland⁴, G.Roland⁴, L.Rosenberg⁴, J.Sagerer⁶,
 P.Sarin⁴, P.Sawicki³, W.Skulski⁸, S.G.Steadman⁴,
 P.Steinberg², G.S.F.Stephans⁴, A.Sukhanov², J.-
 L.Tang⁵, A.Trzupek³, C.Vale⁴, G.J.van Nieuwenhuizen⁴,
 R.Verdier⁴, F.L.H.Wolfs⁸, B.Wosiek³, K.Woźniak³,
 A.H.Wuosmaa¹, B.Wysłouch⁴

¹ Argonne National Laboratory, Argonne, IL 60439

² Brookhaven National Laboratory, Upton, NY 11973

³ Institute of Nuclear Physics PAN, Kraków, Poland

⁴ Massachusetts Institute of Technology, Cambridge, MA 02139

⁵ National Central University, Chung-Li, Taiwan

⁶ University of Illinois at Chicago, Chicago, IL 60607

⁷ University of Maryland, College Park, MD 20742

⁸ University of Rochester, Rochester, NY 14627

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