Nuclear Modification Factors in d+Au and Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV ⋆

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Abstract

BRAHMS has measured the identified charged hadron production at different rapidities in Au+Au and d+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV. The centrality and rapidity dependence of nuclear modification factors R_{AuAu} and R_{dAu} provides a better way to study how the dense medium is distributed in the longitudinal direction.

Key words: Particle production, Nuclear modification factor, Suppression, Forward rapidity
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1. Introduction

High p_T suppression has been observed in central Au+Au collisions at RHIC energy (200 GeV) [2] and may be interpreted as a consequence of the energy loss due to the hard scattering process, as partons traverse through the hot and dense medium. Since there is no hot and dense final state medium in d+Au collisions, suppression effects due to nuclear shadowing and/or gluon saturation are expected only at larger rapidity in d+Au collisions. BRAHMS [1] has reported the transverse momentum dependence of the nuclear modification factors R_{dAu} and R_{AuAu} of charged hadrons and showed a high p_T suppression at forward rapidity [3,4]. The nuclear modification factors of identifed particles in central Au+Au collisions at both $y = 0$ and $\eta = 2.2$ show a suppression for pions but not for protons at intermediate p_T [5]. Studying nuclear modification factors of various particle species in Au+Au and d+Au collisions as a function of centrality

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and rapidity provides information to understand the extend of the hot medium in the longitudinal direction.

2. Results

The nuclear medium effects on hadron production are quantified by the use of nuclear modification factors, which are defined as R_{AA} or R_{CP}. R_{AA} gives the deviation in yields from A+A collisions relative to the scaled yields from nucleon-nucleon collisions. R_{CP} can provide similar information based on the relative yield in central(C) and peripheral(P) collisions scaled by the mean number of binary collisions, but does not depend on the reference nucleon-nucleon system. The nuclear modification factor R_{AA} and R_{CP} as a function of p_T for the most central Au+Au collisions (0-10%) at η = 0, 0.8, 2.6, 3.0 and 3.6 are shown in Figure 1. The high p_T suppression persists over a wide range in pseudorapidity for the most central Au+Au collisions. At all pseudorapidities, R_{AuAu} reaches a maximum value of 0.6 - 0.8 at $p_T \sim 2$ GeV/c, following a decrease at higher p_T. R_{CP} shows a roughly constant suppression, when goes from midrapidity to forward rapidity. The observed behavior of nuclear modification factors seems to be consistent with the jet surface emission picture [6].

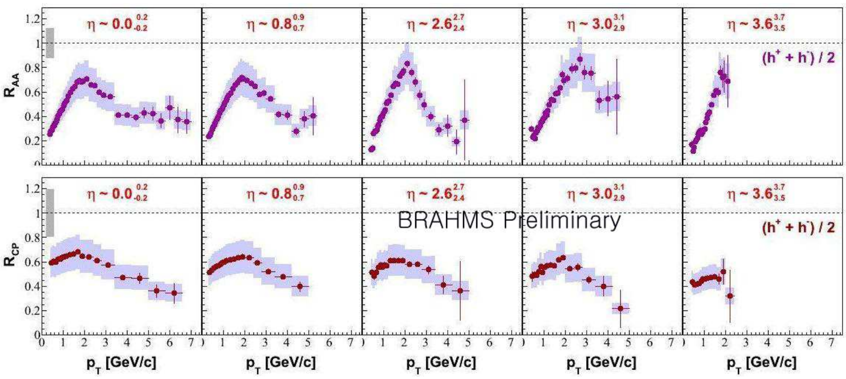

Fig. 1. Nuclear modification factor R_{AA} at different η for the most central collisions (0-10% centrality), and R_{CP} for charged hadrons in Au+Au collisions at $\sqrt{s_{NN}}$=200 GeV for pseudorapidities η=0, 0.8, 2.6, 3.0, 3.6 as a function of p_T. The systematic uncertainties are shown as the shaded boxes around the data points. The shaded bands at $R_{AA}(R_{CP}) = 1$show the systematic uncertainty in the number of binary collisions.

High p_T suppression shows a particle species dependence. Nuclear modification factors for identified charged hadrons, $\pi^{\pm}$, p, and $\bar{p}$, in 0-10% central Au+Au collisions are presented in Figure 2. R_{AuAu} for both positive and negative mesons exhibit suppression at all measured rapidities, and a very similar behavior at y $\sim$ 0 and y $\sim$ 3.1. The R_{AuAu} for protons and antiprotons show an enhancement in the intermediate p_T ranges, and no significant difference between midrapidity and forward rapidity. These observations might be related to in-medium parton recombination processes, which favor the production of baryons over mesons in the intermediate p_T region [7,8].

Figure 3 shows the centrality dependence of R_{dAu} for charged pions, kaons and protons in d+Au collisions at midrapidity and forward rapidity. There is a difference of R_{dAu} in

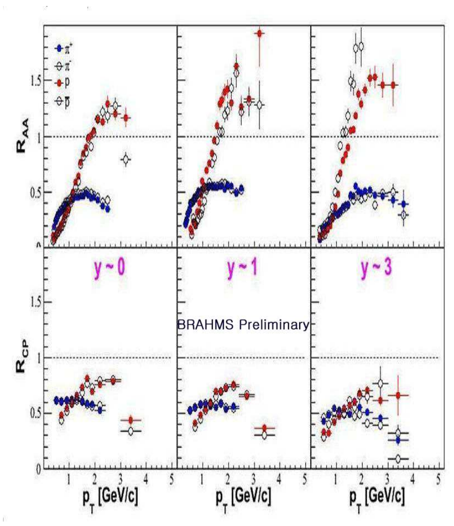

Fig. 2. Nuclear modification factor R_{AuAu} for $\pi^{\pm}$, p and $\bar{p}$ at different rapidity for 0-10% centrality bin. Error bars are statistical. The dotted lines indicate the expectation of binary scaling.

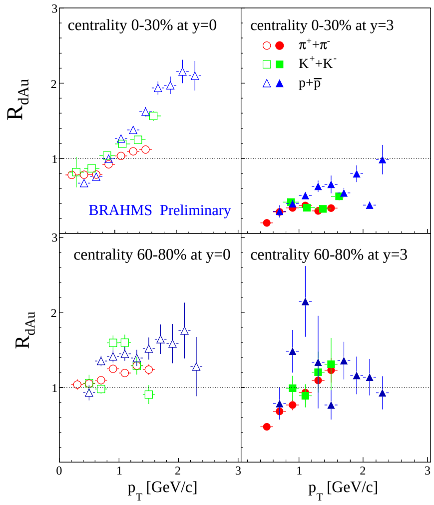

Fig. 3. Nuclear modification factor R_{dAu} for identified charged hadrons at rapidity $y = 0$ and $y = 3$. Top panel shows 0-30% centrality bin, and bottom one shows 60-80% centrality bin. Only statistical error bars are shown.

central and peripheral collisions. No suppression was seen at midrapidity $y = 0$ for all species in both central and peripheral collisions, while at forward rapidity $y = 3$, R_{dAu} for identified charged particles are suppressed for central collisions.

3. Summary

BRAHMS has measured the rapidity dependence of nuclear modification factors in Au+Au and d+Au collisions at $\sqrt{s_{NN}} = 200$ GeV. For charged hadrons, R_{AuAu} and R_{CP} in Au+Au collisions show very little variation with rapidity, and a suppression of R_{AuAu} extends to the most forward rapidity, $\eta \sim 3.6$. The observed rapidity independence in Au+Au collisions might indicate the presence of a longitudinally extended hot and dense partonic medium. R_{AuAu} for identified charged hadrons shows a different meson/baryon dependence at both rapidities, and R_{dAu} for heavier hadrons is larger than that for lighter ones at midrapidity. At forward rapidity in d+Au collisions, suppression is observed in central collisions.

4. Acknowledgments

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