J/ψ in *p*+*p*, *p*+Al, *p*+Au, and ^{3}He+Au Collisions with PHENIX

Krista Smith, for the PHENIX Collaboration

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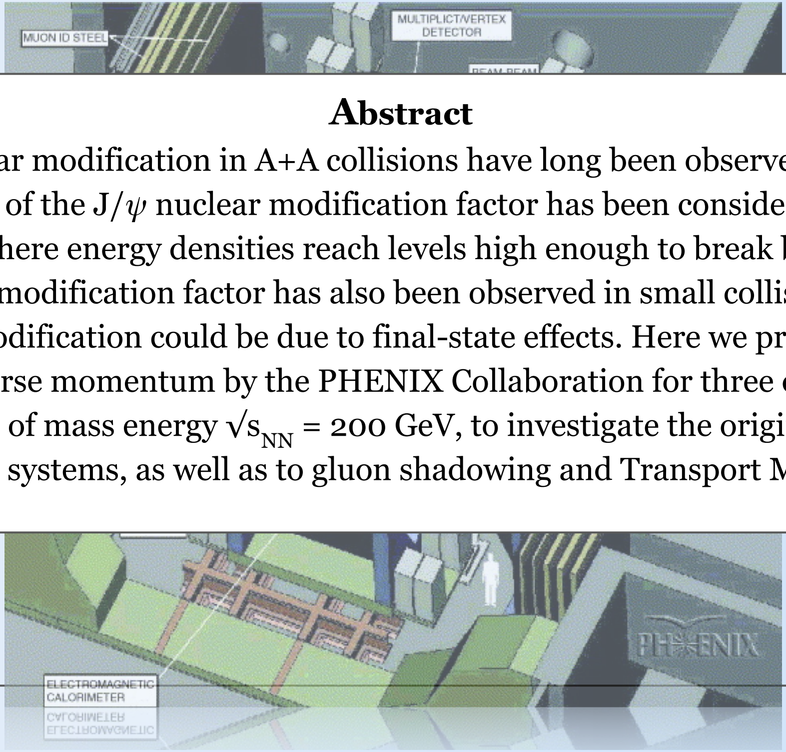
13-17 June 2022 Busan, Republic of Korea



Abstract

Final-state effects on J/ψ nuclear modification in A+A collisions have long been observed in heavy-ion physics at RHIC and LHC energies. Suppression of the J/ψ nuclear modification factor has been considered a signature of quarkonia dissociation in large systems, where energy densities reach levels high enough to break bound $c\bar{c}$ states. However, suppression of the J/ψ nuclear modification factor has also been observed in small collision systems, prompting questions about whether the modification could be due to final-state effects. Here we present J/ψ measurements as a function of rapidity and transverse momentum by the PHENIX Collaboration for three different systems: *p*+Al, *p*+Au, and ^{3}He+Au collisions at center of mass energy $\sqrt{s_{NN}}$ = 200 GeV, to investigate the origin of this suppression. Results are compared between collision systems, as well as to gluon shadowing and Transport Model predictions.

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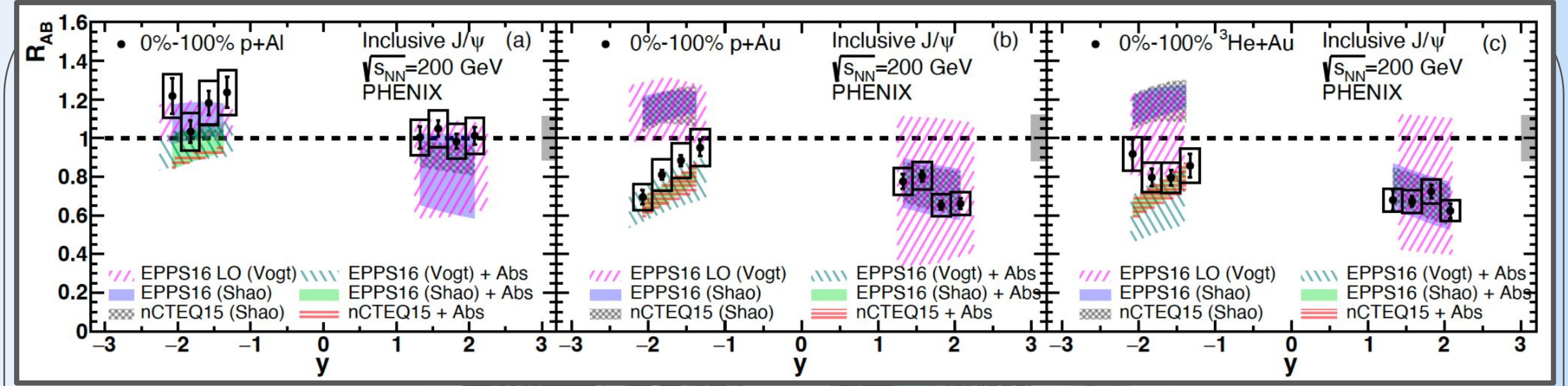

J/ψ nuclear modification is shown as a function of rapidity in *p*+Al, *p*+Au, and ^{3}He+Au collisions, and compared to EPPS16 and nCTEQ15 shadowing predictions. The calculations describe the data very well at forward rapidity for all three systems, and for *p*+Al at backward rapidity. An estimate for the effect of nuclear shadowing was folded into the shadowing predictions at backward rapidity (+ *Abs*), which describes the *p*+Au and ^{3}He+Au suppression reasonably well.

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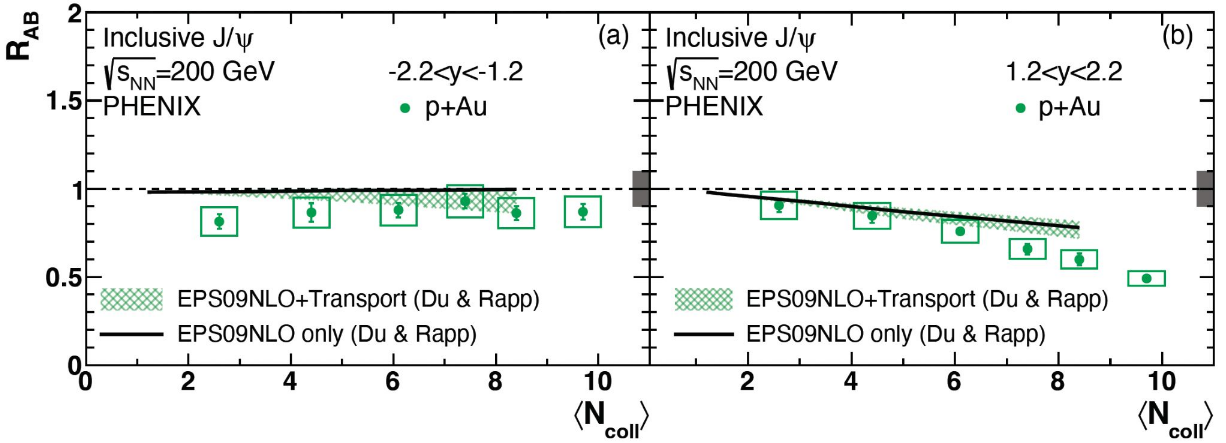

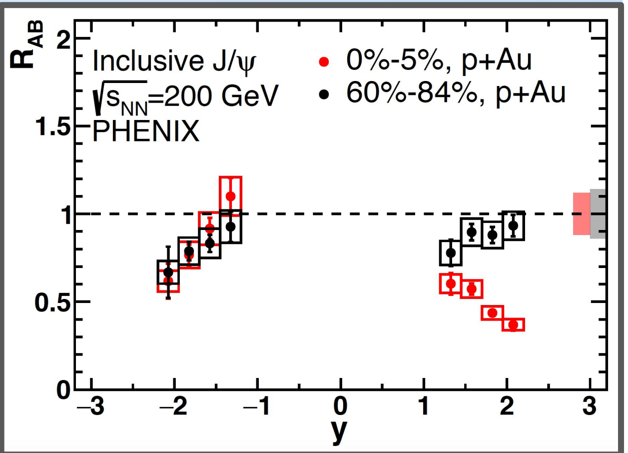

Left: J/ψ nuclear modification as a function of centrality in p+Au collisions compared to Transport Model predictions. The theory calculation shows both the CNM baseline and the effect of the transport model. At forward rapidity, the Transport Model is dominated by gluon shadowing, where EPS09 nPDF predictions tend to underestimate the suppression. Because nuclear absorption is important at backward rapidity, the weak centrality dependence is likely due to a trade-off between anti-shadowing and nuclear absorption. Right: We see consistent behavior of strong gluon shadowing at forward rapidity in 0-5% vs. 60-84% collisions, and similar modification between centralities at backward rapidity.

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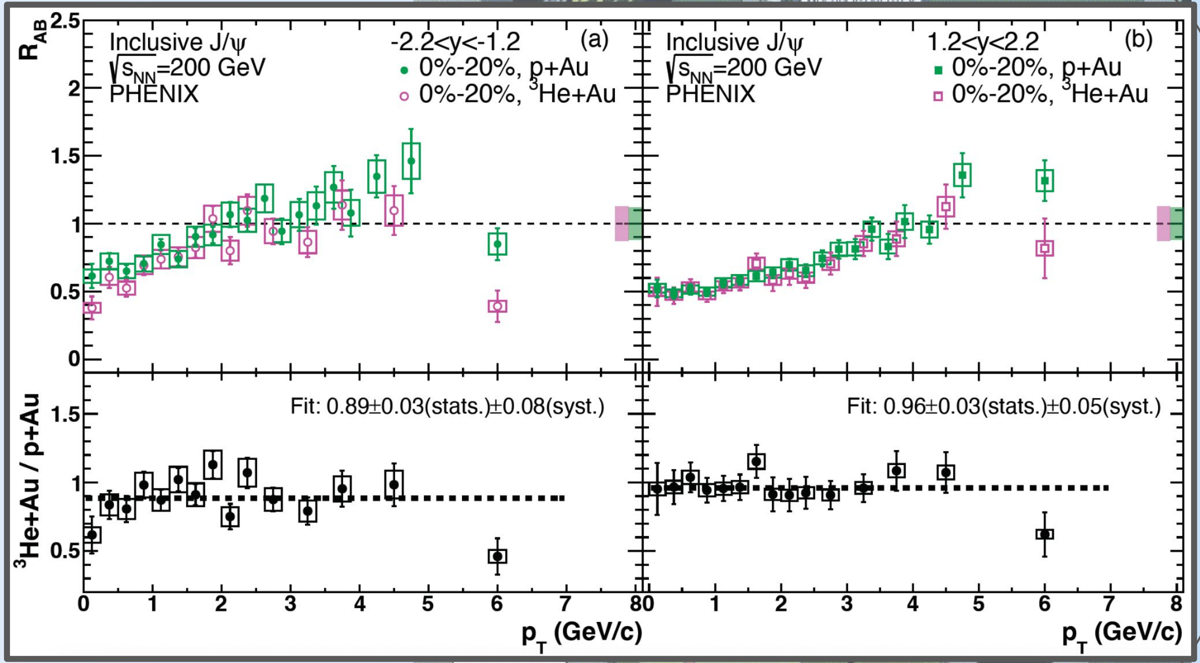
J/ψ modification as a function of p_T in ^{3}He+Au is compared with that in *p*+Au. At forward rapidity, the ratio R_{3HeAu}/R_{pAu} = 0.96±0.03±0.05 is consistent with unity, as expected if shadowing is the dominant contribution. At backward rapidity, where final state effects are expected to be largest, the ratio is R_{3HeAu}/R_{pAu} = 0.89±0.03±0.08. The results are consistent with J/ψ production being reduced for the ^{3}He projectile, with the backward rapidity ratio having a probability of 90% of being less than unity.



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Summary

At forward rapidity, the J/ψ nuclear modification in all three *p*+Al, *p*+Au, and ^{3}He+Au systems is well described by shadowing-only models from Shao et al. At backward rapidity, theoretical models including the cold nuclear matter effects of gluon anti-shadowing describe the *p*+Al data well. However, the *p*+Au and ^{3}He+Au data are only described at backward rapidity if nuclear absorption is added to the models.

As a function of centrality, the J/ψ nuclear modification in *p*+Au collisions shows very strong suppression at forward rapidity, where R_{pAu} reaches almost 0.50 in the 0-5% centrality range. At backward rapidity, we see competing effects between anti-shadowing and nuclear absorption. The data is well described by the Transport Model predictions, which consider both CNM effects. Consistent behavior is seen in J/ψ R_{pAu} measurements as a function of rapidity.

Lastly, the ratio in the most central collisions at forward rapidity is consistent with unity and does not support final state effects. At backward rapidity, the ratio of R_{3HeAu}/R_{pAu} has a 90% probability of being less than 1, allowing for a small final state effect for ^{3}He+Au over *p*+Au, although it is not definitive.

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