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Data-Driven Predictions for Small System Energy Loss

We present novel predictions for the heavy- and light-flavor nuclear modification factor R_{AB} in small systems from a pQCD-based energy loss model, constrained by a comprehensive statistical analysis of central heavy-ion suppression data. Our large-system-constrained results are validated by their consistency with the light-flavor photon-normalized $R_{AB} \sim 0.75$ measured in central $d + \mathrm{Au}$ collisions by PHENIX; however, they are inconsistent with the $R_{AB} \sim 1.2$ measured in central $p + \mathrm{Pb}$ collisions by ATLAS. We show that, independent of a variety of energy loss models, one expects similar suppression in central $p/d + A$ collisions as for peripheral $A + A$ collisions, underscoring the challenges in interpreting the measured enhancement in central $p + A$ collisions. To better understand the theory expectation, we account for several theoretical uncertainties, resulting in a 50% uncertainty in the extracted value of the jet transport coefficient $\hat{q}$ and highlighting concerns about the reliability of using hard probes to measure quark-gluon plasma properties. We further show that using both heavy- and light-flavor observables to constrain the model can significantly decrease the impact of these uncertainties. Finally, we present predictions for heavy- and light-flavor R_{AB} in minimum bias and central collisions of $p + \mathrm{Pb}$, $p/d/^3\mathrm{He} + \mathrm{Au}$, and $\mathrm{O} + \mathrm{O}$, and discuss the implications of our statistical analysis on the scale at which the coupling runs.

Category

Theory

Collaboration (if applicable)

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