Energy loss in small-system Quark Gluon Plasmas

Coleridge Faraday*

W. A. Horowitz†

Department of Physics, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa

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Abstract

Quark Gluon Plasma (QGP) is a fascinating substance formed in heavy ion collisions at RHIC and the LHC, and in the first microseconds after the Big Bang. There is a wealth of evidence for QGP formation in the collision of two heavy ions ($A + A$)—including final state energy loss of high-p_T jets—and there are tantalising pointers to QGP formation in proton + heavy ion ($p + A$) collisions. We present first results for light and heavy flavour high-p_T hadron suppression from a short path length corrected perturbative energy loss model in $p + p$, $p + A$, and $A + A$ collisions at the LHC. We find that in $p+A$ collisons the short path length corrections lead to a prediction of final state energy *gain* relative to the vacuum—in contrast with the usual energy *loss* in $A+A$ collisions—qualitatively consistent with data. We further systematically check the consistency of the assumptions (such as collinearity, softness, and large formation time) made in the derivation of radiative energy loss, with the final numerical model. We find that the large formation time approximation breaks down at modest to high momenta $p_T \gtrsim 30$ GeV. Comparison to data at higher momenta thus requires a rederivation of GLV, DGLV, and short path length correction results; with the large formation time assumption relaxed. We also show that the usual elastic energy loss treatment vastly overpredicts the suppression in small systems; thus, small path length corrections to elastic energy loss are required for quantitative comparison to data in small systems.

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*frdcol002@myuct.ac.za (speaker, first author)
†wa.horowitz@uct.ac.za

References

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