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Small system corrections to thermal field theory and pQCD energy loss

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The ominous absence of partonic energy loss in small colliding systems is forcing the heavy-ion community to sharpen its theoretical tools. In particular, all the main forms of pQCD energy loss depend on the assumption that the brick of QGP is large, but it is clear that any droplet of QGP that may be created in high multiplicity $p/d + A$ or peripheral AA collisions cannot be much larger than the mean free path, $\lambda_{mfp}^{\rm QCD} \sim 1$ fm. We present an illuminating and exhaustive numerical analysis of the recent extension of DGLV energy loss to all separation distances, and show a need for stronger theoretical control over the nature of the medium at early times and short separation distances. Prompted by this demand for an understanding of the small system corrections to medium properties that are traditionally computed in an infinite medium, we then present a thermal field theoretical calculation of the thermodynamic properties of a toy model. We consider a single, massless, scalar field and impose Dirichlet boundary conditions in order to investigate the qualitative effect of a boundary on the properties of the medium, finding significant deviations from the standard Stefan-Boltzmann results, even at relatively large L.

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