DREENA framework as a multipurpose tool for QGP tomography

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Abstract

DREENA framework is fully optimized numerical procedure, based on our dynamical energy loss formalism, which has unique properties in the description of high $p_T$ parton interactions with the medium. Importantly, DREENA provides a natural framework where temperature profile from any medium evolution can be straightforwardly implemented. We exploit this by implementing different state-of-the-art medium evolutions within DREENA framework. DREENA does not use fitting parameters, i.e. it’s only input is the temperature profile that comes directly from various hydrodynamics and kinetic theory models. This opens possibility to use DREENA on both light and heavy flavor to test and differentiate between different available QGP evolution models, including both large and smaller systems. This makes DREENA a unique multipurpose QGP tomography tool, which enables us to gain a better understanding of the bulk QGP medium created at RHIC and LHC.

Introduction

- Dynamical energy loss formalism:
  - finite size finite temperature QCD medium
  - finite temperature field theory and generalized HTL approach
  - same theoretical framework for both radiative and collisional energy loss
  - applicable to both light and heavy flavor
  - finite magnetic mass effects
  - running coupling
- all effects are important for accurate description of high $p_T$ data

Contrary to the existing models, which for full hydro evolution models lead to $v_2$ puzzle, with DREENA we obtain a very good joint agreement between $R_{AA}$ and $v_2$ data. This well known puzzle therefore appears to be a consequence of a simplified energy loss commonly used by other models – once a proper description of parton medium interactions is used, $v_2$ puzzle is abolished. While a widely accepted paradigm is that proper medium evolution description dominates in explaining high $p_T$ data, this result strongly suggests that proper description of parton-medium interactions is much more important.

DREENA framework

- Dynamical Radiative and Elastic Energy loss Approach: fully optimized numerical procedure for suppression calculations based on dynamical energy loss formalism.

Version C: evolution taken in a simplest form (constant temperature medium) [1] useful for exploring the influence of medium evolution on both light and heavy flavour and different observables

Version B: introduced medium evolution through 1+1D Bjorken expansion [2] differences in results should suggest the sensitivity of observables to different aspects of medium evolution

Version A: full temperature evolution profile introduces full medium evolution but not at the expense of simplified energy loss capable to account for event-by-event fluctuations

Conclusion

DREENA-A

Glb-eBCf, $\tau_0 = 1.0$ fm

used in Mohar-Holopainen-Hoivinen-Niemi 3d hydro energy density based on a third-order polynomial of the binary collision density from optical Glauber

$Pb+Pb, \sqrt{s_{NN}} = 5.02$ TeV, Charged hadrons

$Pb+Pb, \sqrt{s_{NN}} = 5.02$ TeV, D meson

$Pb+Pb, \sqrt{s_{NN}} = 5.02$ TeV, B meson

Glb-eBC, $\tau_0 = 0.5$ fm

used in SONICv1.7 energy density based on the binary collision (BC) density from optical Glauber

$Pb+Pb, \sqrt{s_{NN}} = 5.02$ TeV, Charged hadrons

$Pb+Pb, \sqrt{s_{NN}} = 5.02$ TeV, D meson

$Pb+Pb, \sqrt{s_{NN}} = 5.02$ TeV, B meson

MCGlb-sMix, $\tau_0 = 0.6$ fm

used in IBBE-VISHNU entropy density based on a mixture of wounded nucleon and binary collision densities from Monte Carlo Glauber

$Pb+Pb, \sqrt{s_{NN}} = 5.02$ TeV, Charged hadrons

$Pb+Pb, \sqrt{s_{NN}} = 5.02$ TeV, D meson

$Pb+Pb, \sqrt{s_{NN}} = 5.02$ TeV, B meson

Both high-$p_T$, $R_{AA}$ and $v_2$ predictions are notably sensitive to different temperature profiles →

DREENA framework provides unique opportunity for exploring bulk QGP properties through high-$p_T$ theory and data, i.e. for QGP tomography.

References


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