Heavy flavor phenomenology in Pb+Pb collision with IP-Glasma initial state and Bayesian calibrated hydrodynamics

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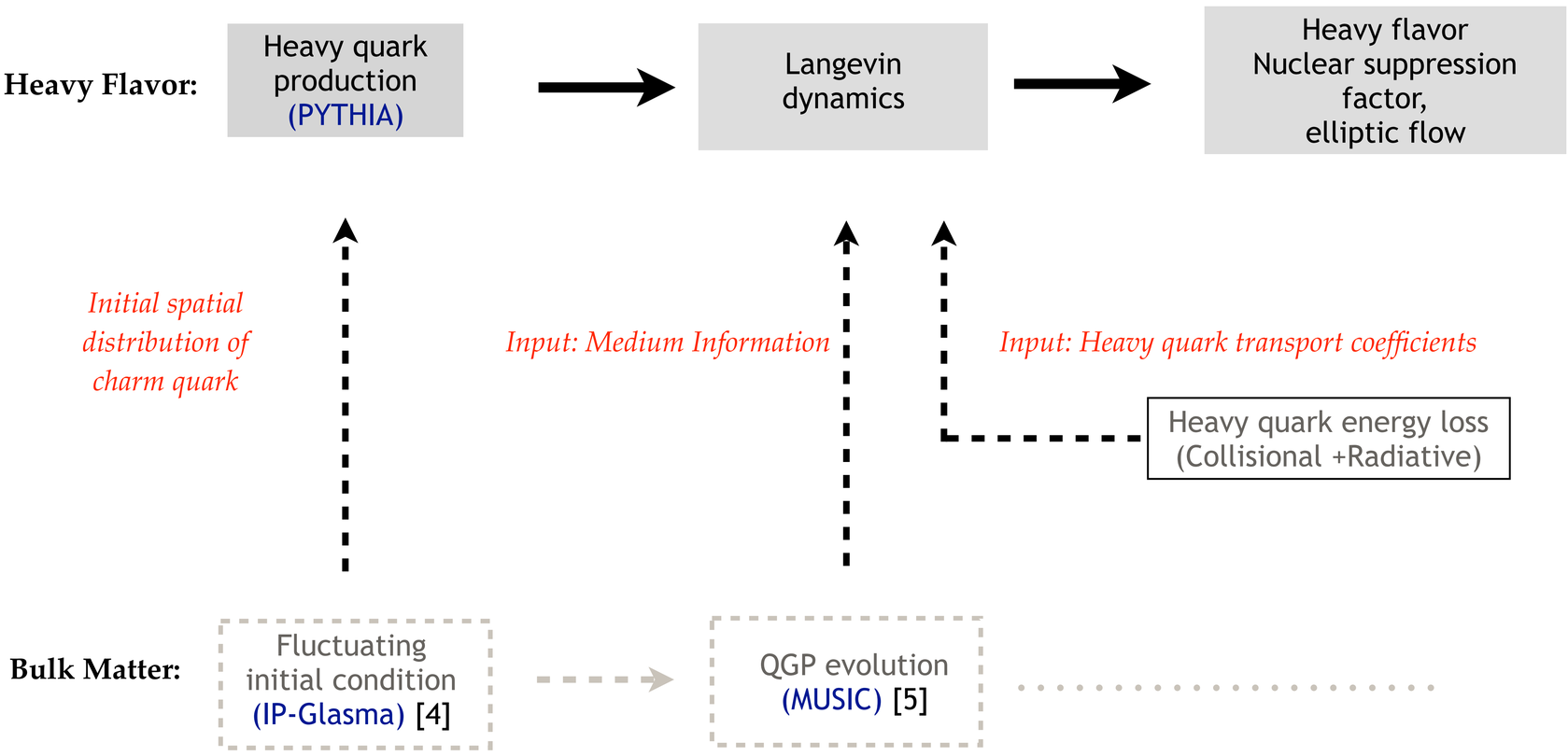
Abstract

- We study open charm flavor observables in Pb+Pb collision at 2.76 TeV within a multi-stage hybrid framework [1]
- The sensitivity of charm observables to the heavy quark interaction strength, fluctuating initial state, bulk medium evolution, and centrality of the collision is studied
- The model parameters, including the viscous coefficients, were obtained from a recent Bayesian model-to-data comparison [2]
- Utilizing IP-Glasma initial states for the first time in the multistage hybrid framework for charm quark, we show that the D-mesons observables are strongly influenced by the fluctuating initial state
- We evolve heavy quarks in this background using Langevin dynamics while incorporating their collisional and radiative processes in the medium.

Multi-stage hybrid framework



Introduction

- Advances in hydrodynamical models and initial state are expected to have a significant impact on the heavy quark observables
- The charm dynamics are encoded in the drag and momentum diffusion coefficients in the Langevin equation [3]
- We consider three different setups of energy loss to characterize the coupling strength of heavy quarks in the QGP medium

  Setup I: Constant value of (taken as 3.0)
  Setup II: T-dependent heavy quark transport coefficients
  Setup III: T and p—dependent heavy quark transport coefficients

- Setup II and Setup III are obtained from Fokker-Planck approach with modified IR regulator and running coupling [1]

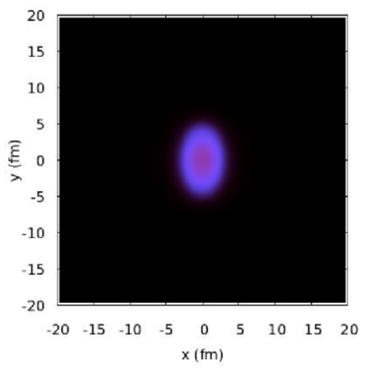


Figure 1. Smooth initial condition

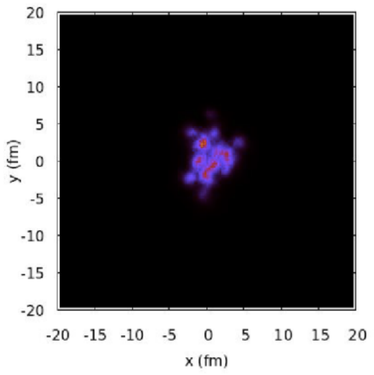
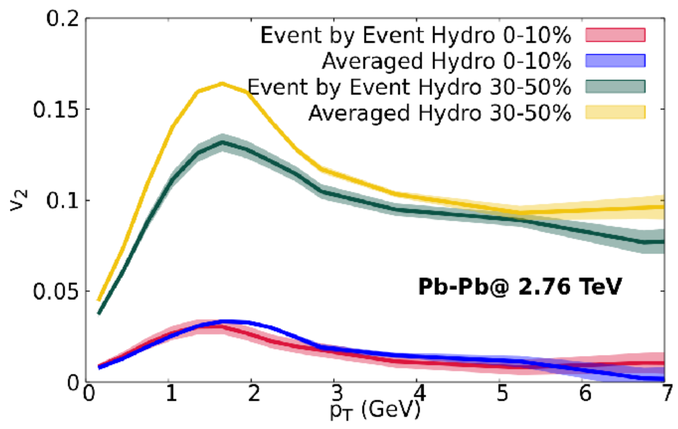


Figure 2. IP-Glasma fluctuating initial condition

Results

Observation I: At low p_T, the fluctuating initial condition seems to have a significant influence on the D-meson v_2 for 30-50 % centrality

The enhancement in v_2 from the increased flow due to the fluctuating initial state is more than compensated by the decorrelation between the event planes of light and heavy flavor mesons

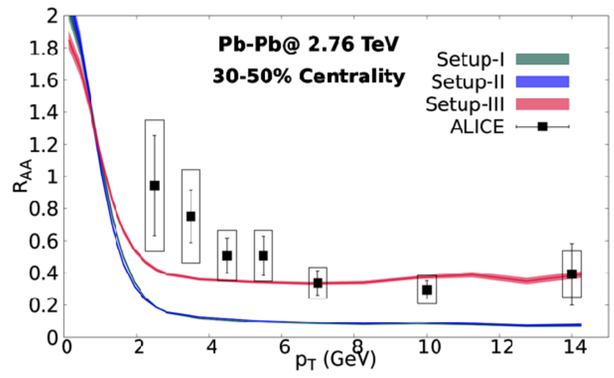


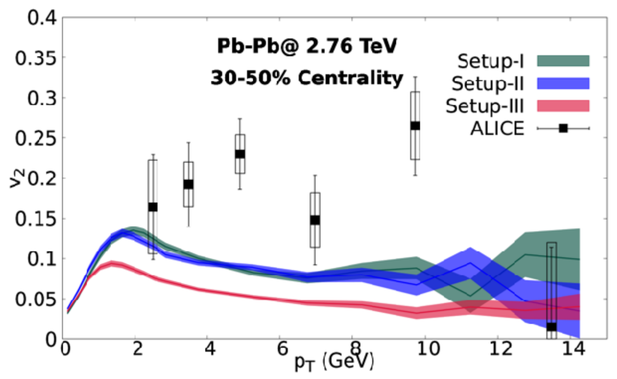
The energy loss profiles of a charm quark and non-perturbative effects in the QGP have a significant role in charm quark observables

Both the temperature and momentum dependence of charm quark drag and diffusion coefficients for collisional+radiative processes are considered in Setup III

Fluctuation-dissipation relation is enforced in setup III for longitudinal diffusion coefficient to ensure the equilibration of heavy quarks

Observation II: Setup III have a better agreement with the data for R_{AA} in comparison with other setups





Observation III: In contrast, setup III underestimates D meson v_2 (*Heavy flavor puzzle*)

Conclusions

- This is an up-to-date study of the heavy flavor using the recent developments in the initial state physics, hydrodynamical description, and drag/ diffusion coefficients of the charm quarks.
- Specifically, this work demonstrates, both qualitatively and quantitatively, the importance of realistic IP-Glasma fluctuating initial conditions on the open charm observables

References

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[3] Manu Kurian, Mayank Singh, V. Chandra, Sangyong Jeon, Charles Gale, PRC 102, 044907 (2020)
[4] Bjoern Schenke, Prithwish Tribedy, Raju Venugopalan, PRL 108, 252301 (2012)
[5] Bjoern Schenke, Sangyong Jeon, Charles Gale, PRC 82, 014903 (2010)