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Enhancing Bayesian parameter estimation by simultaneously adapting to multiple energy-scales with RHIC and LHC data

The evolution of the strongly interacting medium formed in heavy-ion collison is modelled with multi-stage models. The models are driven by a large number of parameters that quantify the properties of the medium and the initial stage of the heavy-ion collision. The need to find model parameters which give the best description of the experimental data imposes a multidimensional optimization problem. The Bayesian analysis has shown to be successful in constraining the parameter values, and the combined inclusion of LHC Pb—Pb 5.02 and 2.76 TeV data with additional flow observables has greatly narrowed down the uncertainties [1].

In this talk, we present our latest study in inferring the transport properties of QGP by including the RHIC Au—Au collision data in addition to the LHC data used in the previous studies [1]. Additionally, we now define the centrality separately for all parametrisations instead of using a singular definition for all of them. With the added Au—Au data and exclusive centrality calibration, the data now favour smaller values for nucleon width and minimum distance between nucleons. The model calculations with the *maximum a posteriori* (MAP) parameters give notably better agreement with the data for the anisotropic flow and the identified particle yields than the previous results.

Furthermore, we quantify the sensitivities of newly developed flow observables, Asymmetric Cumulants and Symmetry Plane Correlations, highlighting the importance of measuring independent and sensitive observables. Finally, we explore alternative initial-state models with fewer parameters to improve the estimation and address the current model limitations. This is further studied by comparing the marginal likelihood of the models. These efforts require ongoing advancements in both theoretical frameworks and computational methods.

[1] J.E. Parkkila *et al.*, New constraints for QCD matter from improved Bayesian parameter estimation in heavy-ion collisions at LHC, *Physics Lett. B* 835, 137485

Category

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