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Characterization of the initial state and QGP medium from a combined Bayesian analysis of RHIC and LHC data

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A primary goal of heavy-ion physics is the measurement of the fundamental properties of the quark-gluon plasma (QGP), notably its transport coefficients, such as the specific shear viscosity η/s. Since these properties are not directly measurable, one relies on a comparison of the data to computational models of the time-evolution of the collision to connect measured observables to the properties of the transient QGP state. The computational model parameters are tuned such that simulated observables optimally match experimental data.

We employ a Bayesian model-to-data comparison method for extracting QGP properties [1303.5769, 1502.00339]. First, we choose a set of salient model parameters – including physical properties such as η/s – then evaluate a modern event-by-event heavy-ion collision model at a small set of points in the multidimensional parameter space, varying all parameters simultaneously. We use a Gaussian process emulator to non-parametrically interpolate the parameter space, providing fast predictions at any point in parameter space with quantitative uncertainty. Finally, we systematically explore the parameter space with Markov chain Monte Carlo (MCMC) to obtain rigorous constraints on all parameters simultaneously, including all correlations.

In this work, we apply the Bayesian methodology to the new TRENTO initial condition model [1412.4708] and standard MC-Glauber initial conditions, coupled to event-by-event viscous 2+1D hydrodynamics and UrQMD [1409.8164]. We calibrate several initial condition and medium parameters to experimentally observed particle yields, spectra, and flows from RHIC and the LHC.

This systematic model-to-data comparison yields rigorous constraints on the nature of the initial state and on fundamental QGP medium properties. The method is general and easily extensible to future studies.

On behalf of collaboration:

NONE

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