UNIVERSITÄT BIELEFELD

Fakultät für Physik

Giuliano Giacalone

Institut de Physique Théorique/Gif-sur-Yvette

Mode-by-mode Relativistic Hydrodynamics for the Quark-Gluon Plasma: Moving towards Precision in Heavy-Ion Phenomenology

The quark-gluon plasma (QGP) is the hot state of strong-interaction matter, and the characterization of its physical properties is the main aim of the heavy-ion collision programs conducted at the BNL Relativistic Heavy Ion Collider (RHIC) and the CERN Large Hadron Collider (LHC). In this talk, I introduce FluiduM, a new code for fast simulations of the hydrodynamic expansion of the QGP. Based on a background-fluctuation splitting of the equations of fluid dynamics, in FluiduM we replace the costly 2+1D hydrodynamic QGP evolution with a system of de-coupled 1+1D equations, leading to a reduction of orders of magnitude in computation time compared to more traditional 2+1D solvers. I present the results of precision calculations of particle production performed with this code, highlighting how they can be used to characterize the QGP from comparisons with recent RHIC and LHC measurements, as well as results for the elliptic flow coefficient in the limit of ultra-central collisions, largely inaccessible to standard event-by-event hydrodynamic frameworks.

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