# HK 13: Heavy-Ion Collisions and QCD Phases IV

Time: Monday 16:00–17:15 Location: HK-H2

HK 13.1 Mon 16:00 HK-H2

**Coarse Grained Transport Dynamics with FRG spectral function** — •Maximilian Wiest[1], Tetyana Galatyuk[1,2,4], Ralf-Arno Tripolt[3], Lorenz von Smekal[3,4], Jochen Wambach[1], and Joachim Stroth[2,4,5] — [1]TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]Justus Liebig University Giessen, Germany — [4]Helmholtz Research Academy Hesse for FAIR (HFHF), Germany — [5]Goethe University Frankfurt, Germany

The bulk of the detected particles stemming from heavy ion collisions are hadrons. Being strongly interacting, they are heavily influenced by final state interactions. As produced dileptons are not subject to the strong interaction, they do not suffer from this disadvantage and can leave the fireball undisturbed, probing the hot and dense matter before it freezes out. We use the microscopic transport model UrQMD to simulate gold-gold collisions at 1.23 AGeV at different centrality classes. Employing a Coarse Graining approach, we are able to combine the simulated microscopic dynamics with in-medium spectral functions obtained from FRG methods. This allows us to study the thermal dilepton production in heavy-ion collisions at SIS 18 energies. Our aim is to investigate the consistency of our approach. For this purpose, we will compare different methods of extracting the bulk observables as well as determining thermalization and explore the effect of variations in the underlying parameters like grid sizes. Supported by VH-NG-823, DFG CRC-TR 211 and GSI.

HK 13.2 Mon 16:15 HK-H2

**Quantum Mechanical Bound State Formation in Time Dependent Potentials** — •Jan Rais[1], Hendrik van Hees[2], and Carsten Greiner[3] — [1]Institute for theoretical physics, Goethe Universität Frankfurt — [2]Institute for theoretical physics, Goethe Universität Frankfurt — [3]Institute for theoretical physics, Goethe Universität Frankfurt

We study the formation of quantum mechanical bound states within a 1-dimensional attractive square well potential, by first solving the stationary system and then study a time dependent system. Here we introduce a time dependent potential, which could generally be of every shape. In our case, we introduce Gaussian potentials which are sufficiently small in space, due to the size of the box and differ due to different time lengths. We are interested to study the time scales, in which bound states populate and depopulate. Therefore we also clarify how to treat the question, where to obtain Heisenberg's uncertainty relation in energy and time and how it is fulfilled in our system. Furthermore we study the applicability of first order perturbation theory on the considered quantum system.

HK 13.3 Mon 16:30 HK-H2

**Dynamic critical behavior of spectral functions via classical statistical real-time simulations** — •Frederic Klette and Sören Schlichting — Bielefeld University, Bielefeld, Germany

Finding the position of the critical point in the QCD phase diagram and determining the behavior in its vicinity has been the subject of active research for several decades. Spectral functions of a system and other real-time observables, can not be reconstructed with an acceptable accuracy from Euclidean time data. Due to QCD being difficult to simulate directly in real time we use universality to investigate the physics near the QCD critical point. Using the fact that models with an O(n) symmetry are in the same, or at least a similar universality class as the chiral model, we study these via classical statistical simulations to learn about their dynamic critical behavior. More precisely, we aim to develop a detailed analysis of the dynamic critical scaling behavior of the spectral function and related observables of an O(4) symmetric model in (3+1) dimensions.

HK 13.4 Mon 16:45 HK-H2

**Non-Equilibrium Transport of Conserved Charges in High-Energy Heavy Ion Collisions** — •Philip Plaschke and Sören Schlichting — Bielefeld University, Germany

Non-equilibrium Green*s functions provide an efficient way to describe the pre-equilibrium evolution of macroscopic quantities in early stages of heavy-ion collisions. Within the kinetic theory framework we use moments of the distribution functions to calculate time dependent non-equilibrium Green*s functions describing the evolution of initial energy/momentum/charge perturbations [1]. Using kinetic theory in relaxation time approximation we will study the pre-equilibrium evolution of a Bjorken background and compute Green*s functions for the charge current and energy-momentum tensor for initial perturbations around this background. By calculating the Green*s functions, we show that only modes with long wavelength survive up into the hydrodynamic regime. [1] [Kamata, Martinez, PP, Ochsenfeld, Schlichting, Phys. Rev. D (2020)]

HK 13.5 Mon 17:00 HK-H2

**Classifying the QCD equation of state in heavy-ion collision experiments with Deep Learning** — •Manjunath Omana Kuttan[1,2,3], Kai Zhou[1], Jan Steinheimer[1], Andreas Redelbach[1,4], and Horst Stöcker[1,2,5] — [1]FIAS, Frankfurt am Main, Germany — [2]Institut fur Theoretische Physik, Johann Wolfgang Goethe Universität, Frankfurt am Main, Germany — [3]Xidian-FIAS international Joint Research Center, Frankfurt am Main, Germany — [4]Institut fur Informatik, Johann Wolfgang Goethe Universität, Frankfurt am Main, Germany — [5]GSI Helmholtzzentrum fur Schwerionenforschung GmbH, Darmstadt, Germany

We present a novel technique to identify the nature of QCD transitions that happen in a heavy-ion collision experiment, particularly at the CBM experiment [1]. We show that Deep Learning (DL) models based on PointNet can be used as a fast, online method for identifying a first order phase transition from a crossover transition that happens in heavy-ion collision experiments. We use a comprehensive data preparation method to train and evaluate the models in several hypothetical experimental scenarios. A model trained on the reconstructed tracks from CBM detector simulations requires only about 40 events for accurate predictions. This makes the PointNet models an ideal candidate for online analysis of the continuous datastream produced in the CBM experiment. The DL model is shown to have up to 99.8% prediction accuracy and outperforms conventional methods based on mean observables such as the $V_2$ or $<P_t>$.

[1] Omana Kuttan, M., et al. JHEP, 2021(10), 1-25.