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Integrated HydroKinetic Model at Relativistic Heavy Ion Collider Energies

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One of the aims of current and future collider experiments in the GeV range, such as the Beam Energy Scan program at the Relativistic Heavy Ion Collider (RHIC BES) and the Compressed Baryonic Matter experiment at the Facility for Antiproton and Ion Research (FAIR CBM), is to study the phase diagram of Quantum Chromodynamics. At much higher energies, such as those at the Large Hadron Collider, the system created in heavy-ion collisions becomes extremely hot and dense, forming a quark-gluon plasma. As the system evolves, it cools down, transitioning into a hadron resonance gas. However, this transition is believed to be a crossover at low baryon chemical potentials.

In lower-energy experiments, a significant portion of the baryon charge from the initial nuclei stops at low rapidities, resulting in a system with a high baryon chemical potential. At certain energies, the transition is expected to shift from a crossover to a first-order phase transition, with the critical point marking the connection between these regimes. These anticipated peculiarities of strongly interacting matter could influence observables through mechanisms such as the softening of the equation of state, an increase in fluctuations, or other phenomena. Experimental programs aim to identify signals of the critical point and phase transition by scanning the phase diagram by varying collision energies.

Recently, we developed a new theoretical model [1] for the numerical simulation of such experiments. This model extends the integrated hydrokinetic model [2], originally designed for ultrarelativistic collisions. I will present our first results for the RHIC BES program, utilizing two different equations of state: one with a phase transition and one without. We compared the resulting observables from these two scenarios with experimental data. Our preliminary results suggest potential signals favoring a phase transition at the lower edge of the energy range, while a crossover appears more likely at higher energies.

[1] M. Adzhymambetov, Y. Sinyukov *arXiv:2412.00458 [hep-ph]* (2024).

[2] V. M. Shapoval, M. D. Adzhymambetov, Yu. M. Sinyukov, *Eur. Phys. J. A* **56** (2020) 260, [arXiv:2006.16697 [nucl-th]], https://doi.org/10.1140/epja/s10050-020-00266-x.