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Equations of state with conserved charge conditions for heavy-ion collisions

In this talk, I will describe first-principles-based equations of state (EoSs) for QCD that serve as crucial input for simulations of strongly-interacting matter produced in the laboratory during heavy-ion collisions (HICs) [1,2]. The first is solely informed by the fundamental theory by utilizing all available diagonal and off-diagonal susceptibilities up to $\mathcal{O}(\mu_B^4)$ that allow for the reconstruction of a full EoS at finite baryon number, electric charge, and strangeness chemical potentials. For the second, we go beyond information from the lattice in order to explore the conjectured phase structure, not yet determined by Lattice QCD methods. We incorporate critical features into the EoS by relying on universal scaling behavior. This allows one to study the effects of a singularity on the thermodynamical quantities that make up the equation of state used for hydrodynamical simulations of HICs. Additionally, we ensure that these EoSs are valid for applications to HICs via constraints on the conserved charge chemical potentials that yield strangeness neutrality and a fixed electric-charge-to-baryon-number ratio of 0.4.

1) J. Noronha-Hostler, P. Parotto, C. Ratti, J.M. Stafford, Physical Review C 2019, 100, 064910

2) J.M. Karthein, D. Mroczek et al, Eur.Phys.J.Plus 136 2021 6, 621

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