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Proton number cumulants and correlation functions from hydrodynamics and the QCD phase diagram

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We present a dynamical description of (anti)proton number cumulants and correlation functions in heavy-ion collisions by utilizing hydrodynamics simulations [1]. The cumulants are calculated via an appropriately extended Cooper-Frye procedure describing particlization of an interacting hadron resonance gas [2] while the effects of global baryon number conservation are taken into account using a generalized subensemble acceptance method [3]. The experimental data of the STAR and ALICE Collaborations are consistent at $\sqrt{s_{\rm NN}} \geq 20$ GeV with simultaneous effects of global baryon number conservation and repulsive interactions in baryon sector, the magnitude of the latter being in line with the behavior of baryon number susceptibilities observed in lattice QCD. The STAR and HADES data at lower collision energies show indications for notable multi-particle correlations, which can indicate sizable attractive interactions among baryons due to the QCD critical point in baryon-rich region as well as the influence of volume fluctuations. We also clarify differences between cumulants and correlation functions (factorial cumulants) of (anti)proton number distribution, proton versus baryon number fluctuations, as well the effects of hadronic afterburner and multiple conserved charges.

[1] V. Vovchenko, V. Koch, C. Shen, arXiv:2107.00163
[2] V. Vovchenko, V. Koch, Phys. Rev. C 103, 044903 (2021)
[3] V. Vovchenko, arXiv:2106.13775, to appear in Phys. Rev. C

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