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Constraints on hadron resonance gas interactions via first-principles Lattice QCD susceptibilities

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We investigate extensions of the Hadron Resonance Gas (HRG) Model beyond the ideal case by incorporating both attractive and repulsive interactions into the model [1]. When considering additional states exceeding those measured with high confidence by the Particle Data Group, attractive corrections to the overall pressure in the HRG model are imposed. On the other hand, we also apply excluded-volume corrections, which ensure there is no overlap of baryons by turning on repulsive (anti)baryon-(anti)baryon interactions. We emphasize the complementary nature of these two extensions and identify combinations of conserved charge susceptibilities that allow us to constrain them separately. In particular, we find interesting ratios of susceptibilities that are sensitive to one correction and not the other. This allows us to constrain the excluded volume and particle spectrum effects separately. Analysis of the available lattice results suggests the presence of both the extra states in the baryon-strangeness sector and the repulsive baryonic interaction, with indications that hyperons have a smaller repulsive core than non-strange baryons. We note that these results are interesting for heavy-ion-collision systems at both the LHC and RHIC.

1. J. M. Karthein, V. Koch, C. Ratti, V. Vovchenko, Phys. Rev. D, 104, 094009 (2021)

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