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Abrupt switching from hadron resonance gas to quark-gluon plasma at smooth chiral crossover

Based on a generalized Beth-Uhlenbeck approach to thermodynamics of QCD we explain why the abundances of hadrons produced in ultrarelativistic heavy-ion collisions are well described by the hadron resonance gas (HRG) model with a sudden chemical freeze-out at a well-defined hadronization temperature despite the fact that state of the art results of lattice QCD indicate a smooth chiral crossover. The hadrons are treated as color singlet multiquark clusters in medium with a background gluon field in the Polyakov gauge coupled to the underlying chiral quark dynamics. The confining aspect of QCD is accounted for by a large vacuum quark mass motivated by a confining density functional approach. At low temperatures the HRG phase appears as a statistical ensemble of the multiquark clusters. Restoration of chiral symmetry at high temperatures triggers their Mott dissociation and deconfinement of quark-gluon plasma (QGP). While perfectly reproducing the smooth behavior of entropy density [1] and chiral condensate of lattice QCD [2], the approach indicates an abrupt switching between the hadrons and partons. This is manifested by a rapid change of the ratio of baryon number susceptibilities χ_4^B/χ_2^B from the value of HRG to the one of QGP [2]. We report for the first time that χ_4^B/χ_2^B shall not be mistaken for a measure of the fraction of hadrons in the system. Its deviation from unity below the chiral restoration temperature can actually quantify a repulsive residual interactions in the HRG. We associate it with the effects of Pauli blocking and model by a temperature dependent correction to the phase shift of baryons, in accordance with lattice QCD results on χ_4^B/χ_2^B [2].

[1] D. Blaschke, M. Cierniak, O. Ivanytskyi and G. Röpke, Eur. Phys. J. A 60 (2024)
[2] D. Blaschke, O. Ivanytskyi and G. Röpke, in preparation

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