

Moments of charge fluctuations, pseudo-critical temperatures and freeze-out in heavy ion collisions

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In the chiral limit and at temperatures close to the QCD phase transition temperature physical observables are expected to show universal properties that are controlled by the symmetry class of a 3-dimensional $O(4)$ spin model [1]. Higher moments of net baryon number as well as electric charge fluctuations are sensitive to these universal features of the chiral phase transition [2].

The sixth order moments are the first moments which will diverge in the chiral limit at the QCD phase transition temperature. At non-zero values of the light quark masses the sixth order moment of baryon number fluctuations has a pronounced minimum at a pseudo-critical temperature which is close to the temperature where fluctuations of the chiral order parameter are the largest.

We present a calculation of the $O(4)$ scaling functions that control scaling properties of the net baryon number fluctuations [3]. Using these universal scaling functions as well as PNJL model calculations [4] we show that the sixth order moment of baryon number fluctuations is negative in the vicinity of the pseudo-critical temperature for the chiral transition and present new results from lattice calculations using the highly improved staggered fermion action (hisq). These QCD results are in striking contrast to hadron resonance gas model calculations. We conjecture that higher order moments of net baryon number and electric charge fluctuations are well suited to characterize freeze-out conditions in heavy ion collisions. Their experimental analysis in low-energy runs at RHIC as well as at LHC will allow to verify to what extent freeze-out occurs from a thermal medium close to criticality.

[1] O. Kaczmarek et al., Phase boundary for the chiral transition in $(2+1)$ -flavor QCD at small values of the chemical potential Phys. Rev. D83, 014504 (2011).

[2] F. Karsch and K. Redlich, Probing freeze-out conditions in heavy ion collisions with moments of charge fluctuations, Phys. Lett. B695, 136 (2011).

[3] J. Engels and F. Karsch, The scaling functions of the free energy density and its derivatives for the 3d $O(4)$ model, in preparation.

[4] J. Engels, B. Friman, F. Karsch, K. Redlich and V. Skokov, Fluctuations as probe of the QCD phase transition and freeze-out in heavy ion collisions at LHC and RHIC, arXiv:1103.3511.

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