Net Charge Fluctuations in PNJL model

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I. INTRODUCTION

Strongly interacting matter at very high temperatures and densities is expected to undergo a transition from the color confined hadronic phase with broken chiral symmetry to the partonic phase with restored chiral symmetry and/or deconfined quarks and gluons. It is essential to identify unambiguous signals which would establish the formation of the quark-gluon plasma (QGP). One such viable signal is the fluctuations of net electric charge Q [1, 2]. It has been argued that since the unit of Q in the hadronic phase is 1, and that in the QGP phase is 1/3, the net charge fluctuation in the two phases would have very distinct values, even if the net charge remains unaffected.

II. MEASURING CHARGE FLUCTUATIONS

The observable $D - measure$ quantified by D is defined as, $D = \langle N_{ch}\rangle \langle \delta R^2\rangle = 4\frac{\langle \delta Q^2\rangle}{\langle N_{ch}\rangle} = 4\frac{\chi_Q}{n_{ch}/T^3}$ where n_{ch} is the total charge density and χ_Q is the dimensionless charge susceptibility.

III. RESULTS

Here we report on the study of net charge fluctuations in terms of the $D-measure$ using the Polyakov loop enhanced Nambu−Jona-Lasinio (PNJL) model [3–7]. In this model the quark condensates and the Polyakov loop fields are the basic degrees of freedom. The method of obtaining χ_Q is quite standard as has been discussed by us earlier [3]. On the other hand n_{ch} has been computed from the quark distribution functions as they appear in the PNJL model. In Fig.(1) $D_{free}(T, \mu_B)$ is the temperature and chemical potential dependent limit of $D(T, \mu_B)$ for a free massless gas of quarks. For small μ_B the variation of D shows a peak close to T_c, which gradually smears away as μ_B is increased and D falls

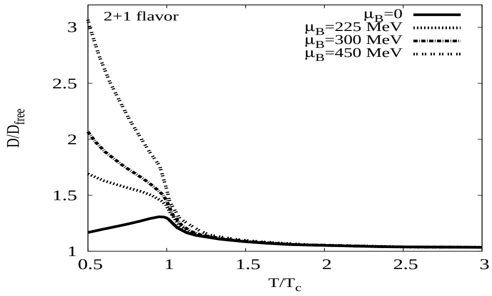

FIG. 1: Variation of D with T/T_c for different values of μ_B around $\mu_Q = 0$

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*Electronic address: `saha.k.09@gmail.com` monotonically. It is observed that D always remains above its free field limit, approaching it at high enough T. In Fig.(2), again we find D to remain above its free field limit for all T and μ_B. For a lower temperature $\sim$ 100 MeV, there is an initial rise and a subsequent fall with increasing μ_B, while for larger T there is a just a monotonous fall.

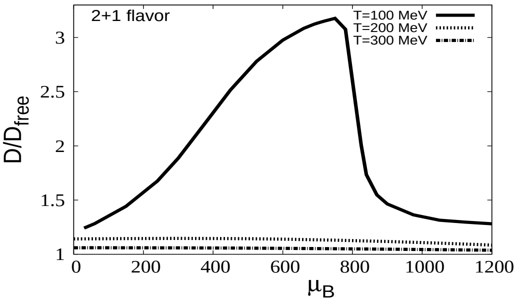

FIG. 2: Variation of D/D_{free} with μ_B for three values of T around $\mu_B = 0$

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With an input of temperature and chemical potential from particle multiplicities at the freeze-out surface in heavy ion collision experiments, one may study the expected nature of D for different experimental conditions. Among the different parametrization of the freeze-out conditions available in the literature we choose that of [8]. Results are shown in Fig.(3). It is highly exciting to find that the general features of D vs $\sqrt{s}$ curve obtained in the PNJL model are found to be similar to those obtained directly in heavy-ion collision experiments [9, 10]. Furthermore the numerical range of D itself is exceptionally consistent.

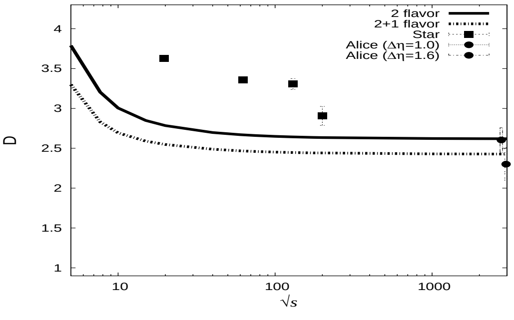

FIG. 3: D as a function of $\sqrt{s}$ computed along the freeze-out curve.

It should however be remembered that D as given in Fig.(3) is the value obtained when the system is in complete thermal equilibrium at the given values of temperature and chemical potentials. Also being on the freeze-out curve, we are always inside the hadronic phase, i.e. Fig.(3) correspond to varying environmental conditions in the hadronic phase.

IV. ACKNOWLEDGEMENT

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