Equation of state of PNJL model in magnetic field and non Zero chemical potential

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Abstract

We extended our calculations of the recent research work for two flavor magnetized PNJL model cooperating non zero chemical potential and thermal mass in the potential as in the Lagrangian. We calculate the equation of state of PNJL model and its thermodynamic properties. We Show the results of the phase transition temperature obtain to a lower value in comparison to earlier value of phase transition, the result is much conformation with the lattice data. The result shows that the thermodynamic behavior of lattice data are well agreed with the prediction of the model field theories.

Introduction

• At non-zero density and high temperature, the theory has predicted a matter of deconfined state known as Quark-Gluon Plasma.

• The PNJL model describes the two characteristic phenomena of QCD namely deconfinement and chiral symmetry breaking.

• In this paper, we focus to find the equation of state using thermal quark mass and magnetized field introduced in the PNJL model at non zero chemical potential and temperature.

Gibbs Free Energy of Magnetized PNJL model

The thermodynamic potential for the two flavor quarks in presence of chemical potential dependent thermal quark mass and magnetic field written as:

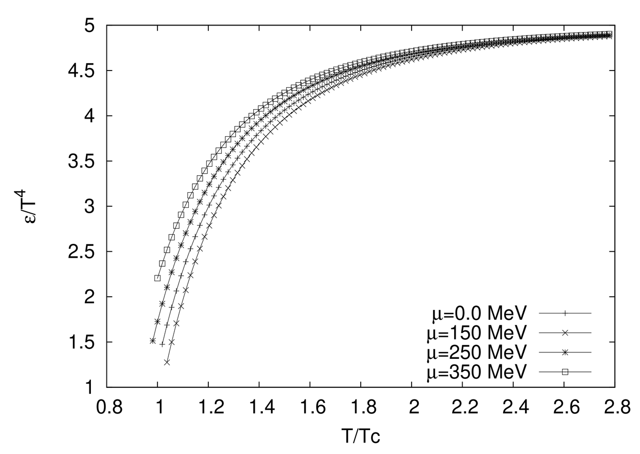
$$\begin{aligned}\Omega(\phi,\phi^*,m;T,\mu) &= U(\phi,\phi^*,T)\\ &+\frac{M(T,\mu)-(m_0-\mu}{)}4G_1\\ &-2N_f\int_\pi d^3pE_p\frac{2}{\pi^3}\\ -2N_f eBT\int d^3p\frac{2}{\pi^3}&[Tr\ln(1+Le^{(E_p-\mu)/T})\\ &+Tr\ln(1+L^\dagger e^{-(E_p-\mu)/T})]\\ -\frac{3(qB)^2}{2\pi^2}&[\zeta'(-1,x_f)-\frac{1}{2}(x_f^2)-x_f\ln(x_f)\\ &+\frac{x_f^2}{4}]\end{aligned} \tag{1}$$

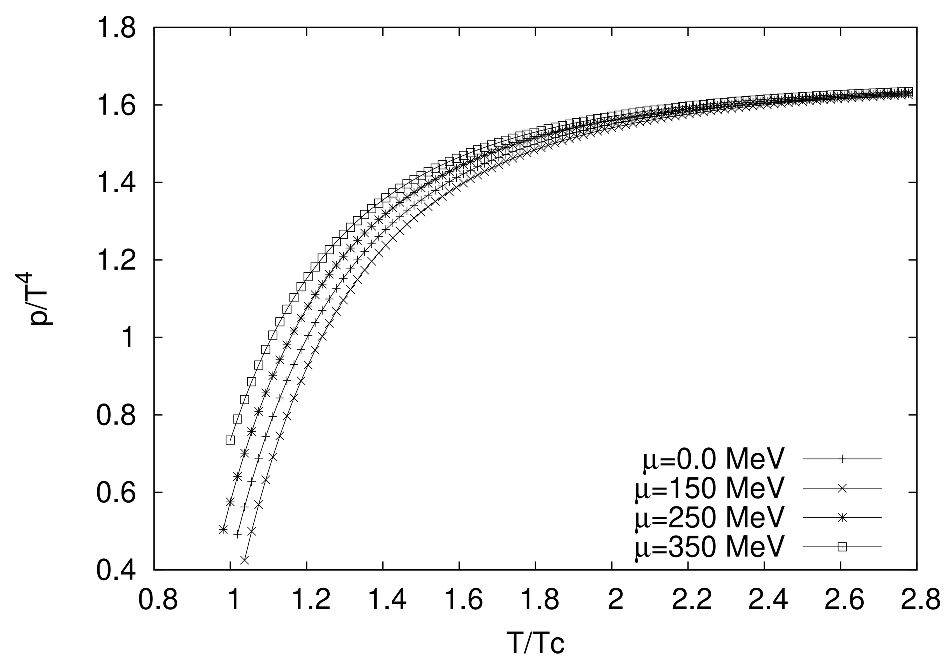
In the above formula $E_p=\sqrt{(p^2+m^2(T,\mu)+2eB)}\pm\mu$ is the Hartree single quasi-particle energy calculated with the thermal quark mass. The thermal mass is defined as:

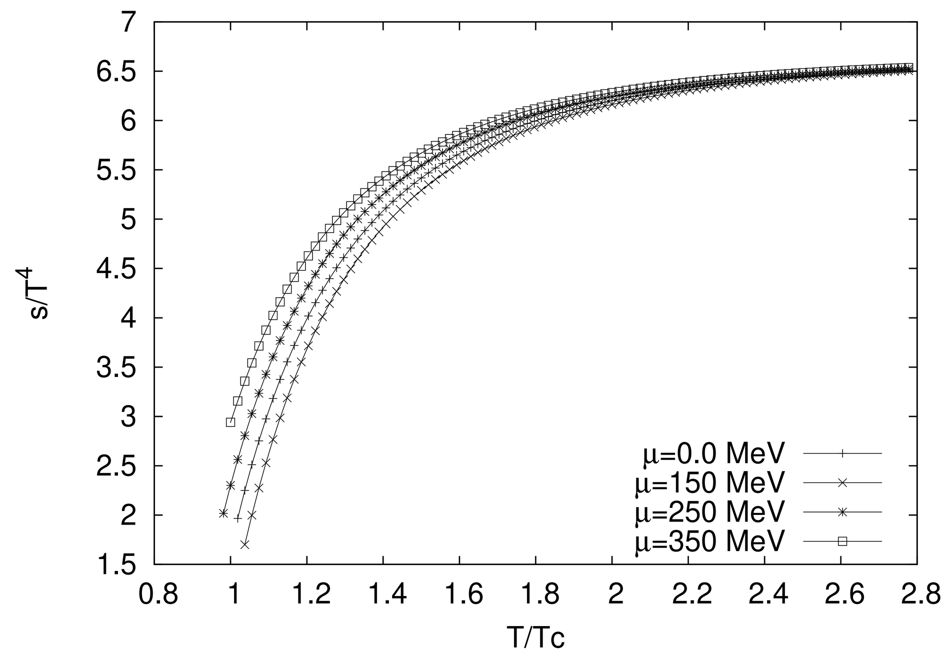
$$m^2(T,\mu) = 16\pi\gamma_{q,g}\alpha_s(E_p)(T^2+\frac{\mu^2}{\pi^2}) \tag{2}$$

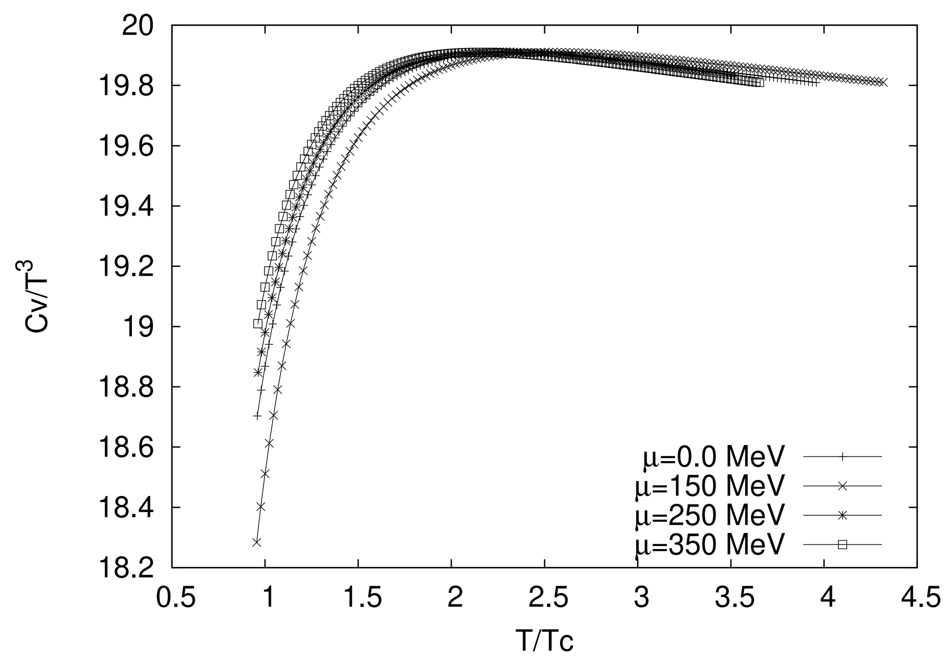
Results

In order to discuss QGP phase structure, we look forward energy density, pressure and entropy at various temperature for the thermal mass and magnetized PNJL model. In figures 1,2 and 3 we plot energy density, pressure, entropy and specific heat with respect to temperature at non zero chemical potential with the thermal mass and magnetized PNJL model.









Conclusions

It concludes that chemical potential with magnetized PNJL model can give the formation of QGP around the temperature, $T = 170$ MeV. So phase transi- tion can be obtained at temperature $T = 170 - 200$ MeV with the chemical potential and non zero magnetic field. Yet we assumed the transition temperature as same value of Ratti's model in order to make easier for the whole of calculations in comparison to other models. As the temperature is raised then the intensity will be increased from the predicted lattice data.

Refrences

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