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Heavy quarkonia in hot and dense strongly magnetized quark matter

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In this work, we address how the properties of a specific hadronic probe in the form of heavy quark-antiquark bound states can be affected in a thermal medium of quarks and gluons with finite chemical potential (μ) under the influence of a strong magnetic field, unlike the same in the absence of finite μ reported in the literature. The aforesaid problem may be relevant to the matter produced in relativistic heavy ion collisions. The effect of strong magnetic field on the properties of the heavy quarkonia in a baryon symmetric matter has recently been studied either by computing the potential perturbatively or by a generalized Gauss law. However, the medium correction to the non-perturbative string term gets inducted by dimension-two gluon condensate in usual resummed HTL propagator.

We have started with the general covariant tensor structure of the gluon self-energy in above environment for a thermal QCD medium with finite μ and have obtained the real and imaginary parts of resummed gluon propagator by calculating the relevant form factors. These real and imaginary parts of the resummed propagator in the static limit facilitate the computation of the complex potential between Q and $\bar{Q}$ in coordinate space through inverse Fourier transform. We have included a phenomenological non-perturbative term induced by the dimension two gluon condensate to the usual HTL resummed propagator to evaluate the medium modification to string part of the $Q\bar{Q}$ potential.
We observe that in the presence of the baryon asymmetry, the real-part of potential becomes slightly more attractive.
The more attractive nature of the real part can be understood in terms of the Debye mass which inherits the medium properties and decreases with the chemical potential. The magnitude of the imaginary-part gets reduced in the medium having finite chemical potential.
We have solved the radial part of the Schr\"{o}dinger equation numerically plugging the real-part of the potential to obtain the energy eigenvalues which are utilized to calculate the binding energy of quarkonia.
The decay width has been calculated considering the imaginary part of the potential as a perturbation in the small distance limit.
Presence of the chemical potential in the medium leads to the enhancement of binding energies and the reduction of thermal widths of $Q\bar{Q}$ ground states, respectively. Finally, we compute the dissociation temperatures of J/ψ and Υ states by

studying the relative competition between the binding energy and decay width. Dissociation temperatures are found to have slightly larger values in the medium having non-zero baryon density. We have noticed that J/ψ gets dissociated at $1.64\ T_c$, $1.69\ T_c$, and $1.75\ T_c$, whereas Υ is dissociated at $1.95\ T_c$, $1.97\ T_c$ and $2.00\ T_c$, for $\mu = 0, 60$ and 100 MeV, respectively. In conclusion, the strongly magnetized hot quark matter having non-zero baryon density prevents early dissociation of quarkonia as compared to the baryonless matter.

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