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Diffusion of Heavy Quark in a hot and magnetic Quark Gluon Plasma-perturbative vs non perturbative

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The recent studies have indicated an existence of a strong magnetic field in non central Heavy Ion Collisions(HICs). Though strong to begin with the field decays fast. It is still possible for the magnetic field to exist in the thermalised Quark Gluon Plasma(QGP) depending on the electrical conductivity of the medium. If a significant amount of magnetic field is present in the medium, it will affect various aspects. We have calculated different diffusion coefficients of Heavy Quark(HQ), a very good probe of QGP, in presence of a strong magnetic field inside a hot QGP in some of our recent works. It is well established that perturbative QCD description is not enough in order to explain certain experimental observations at the low to intermediate p_T region of HQ and at temperatures close to the critical temperature. There are various studies approaching the non-perturbative calculation from various vantage points within the framework of perturbative QCD, like T-matrix and potential approach.

In this present work, we have considered the complex HQ potential in presence of a strong magnetic field in a hot QGP and posed it as effective gluon propagator. The part of the potential which is Yukawa type is responsible for the perturbative and the string part is responsible for the non-perturbative contribution. We calculate the scattering rate of HQ interacting elastically with the medium light quarks/anti-quarks and gluons.and consequently, estimate the various diffusion coefficients for two cases: 1) HQ velocity is along the direction of the magnetic field and 2) HQ velocity in the perpendicular direction to the magnetic field.

We have compared the perturbative diffusion coefficients with their non-perturbative counterparts in presence of a strong magnetic field for the first time. Though the perturbative contribution is always dominant over that due to non-perturbative, the difference between those two is lower at lower temperatures rendering the non-perturbative estimation more important at the lower temperatures. At higher temperatures, the asymptotic freedom enhances perturbative contribution while the lower value of string tension (taken from finite temperature lattice calculations) or confinement reduces non-pertubative effect. All these might have profound effect on various experimental observations.

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