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Heavy quark diffusion coefficient in the light of Gribov-Zwanziger action

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As a result relativistic heavy ion collision in Large Hadron Collider(LHC) at CERN and Relativistic Heavy Ion Collider(RHIC), at Brookhaven National Laboratory(BNL),the constituent of those, namely Quarks and Gluons deconfined for a short amount of time, and its internal(color) degrees of freedom governs its dynamics. The deconfinement of the nuclear matter happens at bizzare temperature of ~ 150 MeV which results in the emergence of a new state of matter, identified as Quark Gluon Plasma(QGP). A well-established result that deconfined matter is not a free gas of quarks and gluons but rather strongly interacting and correlated system signals to incorporate dissipative hydrodynamics as a tool to extract the properties of this extremely dense matter, QGP, in the form of various transport coefficients. Due to the rapid thermalization of the produced particles as a result of collision, characterizing the plasma state of matter based on the information provided in the final stage becomes a head scratching task.

Heavy quarks are produced in the pre-equilibrium phase i.e. before the formation of QGP. The long relaxation time of heavy quark make it an apt tool to diagnose QGP.

The study of quarks and gluons falls under perturbative QCD as well as non-perturbative QCD. While the perturbative QCD has been well developed, the analytical and numerical solution of non-perturbative QCD has still a long way to go. One of the non-perturbative approaches that seem quite promising in the non-perturbative scale is given by Gribov, which later was updated by Zwanziger by formulating renormalizable action at finite temperature, termed as Gribov-Zwanziger(GZ) action. Within the GZ action, the gluon propagator in covariant gauge is expressed as: $D^{\mu\nu}(P) = \left[\delta^{\mu\nu} - (1-\xi)\frac{P^\mu P^\nu}{P^2}\right]\left(\frac{P^2}{P^4+\gamma_G^4}\right)$ $,where \xi$ is the gauge parameter and γ_G is termed as the Gribov parameter, which is fixed either by matching the thermodynamic quantities with lattice equation of state or by solving one loop gap equation. I calculated the diffusion coefficient of heavy quark(in gluonic medium) under Gribov prescription and match it with lattice data available in the range $1 \leq (T/T_c) \leq 5$. We noticed that it has a good agreement with the lattice data.

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