Momentum dependence of drag coefficients and heavy flavour suppression in quark gluon plasma

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Simulations of QCD equation of state (EoS) on lattice show that at very high temperatures and/or densities the nuclear matter undergoes a phase transition to a new state of matter called Quark-Gluon Plasma(QGP). It is expected that QGP can be produced by colliding two nuclei at ultra-relativistic energies. Relativistic Heavy Ion Collider(RHIC) at BNL and Large Hadron Collider(LHC) at CERN are two such experimental facilities. The depletion of hadrons with high transverse momentum (p_T) produced in Nucleus + Nucleus collisions with respect to those produced in proton + proton (pp) collisions has been considered as a signature of QGP formation. The two main processes which cause the depletion are (i) the elastic collisions and (ii) the radiative loss or the inelastic collisions of the high energy partons with the quarks, anti-quarks and gluons in the thermal bath. The abundance of charm and bottom quarks in the partonic plasma (in the expected range of temperature to be attained in the collisions) will be small. Consequently, the bulk properties of the plasma is not decided by them and hence heavy quarks may act as an efficient probe for the diagnosis of QGP. In the present work we focus on the energy loss of heavy quarks in QGP taking dead cone and LPM effects into account in deducing the properties of the medium.

The system under study has two components. The equilibrium component, the QGP, is assumed to be formed at a temperature T_i at an initial time τ_i after the nuclear collisions. The QGP, due to its high internal pressure expands, and consequently it cools to hadronic phase at a temperature, $T_c \sim 175$ MeV. The non-equilibrium component, the heavy quarks produced due to the collision of partons of the colliding nuclei has momentum distribution determined by the perturbative QCD (pQCD) [1], which evolves due to their interaction with the expanding QGP background. The evolution of the heavy quark momentum distribution is governed by the Fokker-Planck equation. The interaction of the heavy quarks with the QGP is contained in the inputs to the FP equation *i.e.* through the drag and diffusion coefficients, which are in general dependent both on temperature and momentum. The solution of the FP equation [2] for the charm and bottom quarks give the (quenched) momentum distribution of hadrons (D and B mesons) through fragmentation process. The fragmentation of the initial momentum distribution of the heavy quarks results in the unquenched momentum distribution of the B and D mesons. The ratio of the quenched to the unquenched p_T distribution is the nuclear suppression factor which is experimentally measured. The quenching is due to the dragging of the heavy quark by the QGP. Hence the properties of the QGP can be extracted from the suppression factor. In contrast to earlier works, where the momentum dependence of the drag coefficient were ignored, in the present work we emphasize on its momentum dependence. Fokker-Planck equation has been solved with momentum dependent drag and diffusion coefficients which contain both the elastic as well as inelastic processes. The effect of the momentum dependence on R_{AA} can be seen from Fig 1 for charm quark. It is also seen that the radiative loss plays more dominant role than the collisional one. In case of bottom quark the effect is smaller. In the present work we

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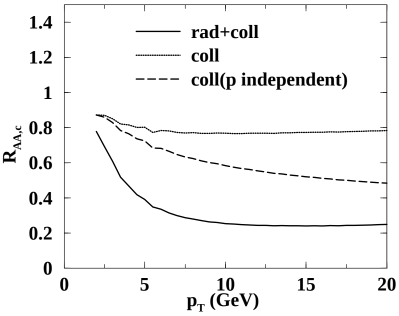

FIG. 1: R_{AA} vs p_T for charm

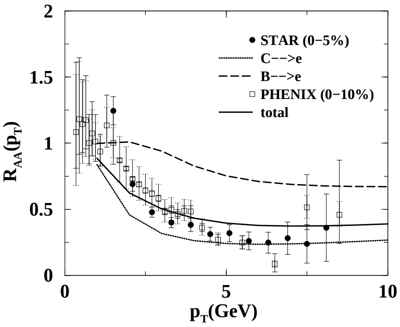

FIG. 2: c_s^2 = 1/3 and initial temperature, T_i = 300 MeV.

study the effect of different Equation of State (EoS) characterized by different values of velocity of sound allowed by the recent lattice calculations [3]. The single electron spectra originating from the decays of (open) heavy flavours can be obtained by using standard techniques [2]. Constrains on the value of the initial entropy density may be imposed by comparing the theoretical results with the experiments [4, 5]. The sensitivity of the results on the EoS are displayed in Figs. 2, 3 and 4. The range of initial entropy density obtained from the analysis will be presented in the symposium.

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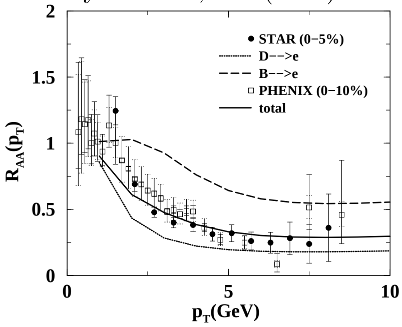

FIG. 3: c_s^2 = 1/4 and initial temperature, T_i = 240 MeV.

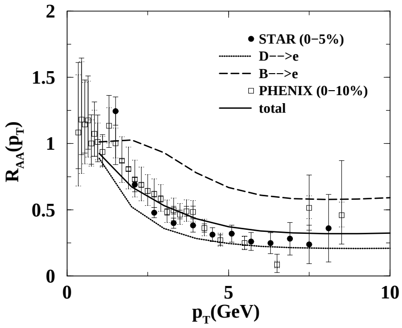

FIG. 4: c_s^2 = 1/5 and initial temperature, T_i = 210 MeV.

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