Heavy Quarks in Ultrarelativistic Heavy Ion Collisions *

J. Uphoff[1], *O. Fochler*[1], *Z. Xu*[2], *and C. Greiner*[1]

[1]Institut für theoretische Physik, Johann Wolfgang Goethe-Universität Frankfurt, Frankfurt am Main; [2]Physics Department, Tsinghua University, Beijing 100084, China

In ultra-relativistic heavy ion collisions a unique state of matter is produced, in which quarks and gluons form the relevant degrees of freedom. This quark gluon plasma (QGP) has exciting properties such as collective behavior like a nearly perfect liquid or the quenching of high energy particles. In particular heavy quarks (charm and bottom) provide an insightful way to learn more about the properties of this matter. Since they are heavy, their production time is at a very early stage of the heavy ion collision when enough energy is available [1].

In the last year we extended the partonic transport model Boltzmann Approach to MultiParton Scatterings (BAMPS) to study heavy quarks at the LHC [2] and also included interactions between light and heavy quarks. More specifically, we investigated the elliptic flow and nuclear modification factor of several heavy flavor particles, namely D mesons, non-prompt J/ψ, muons, and electrons. Using only elastic collisions of heavy quarks with medium particles with an improved Debye screening inspired by hard thermal loop calculations and a running coupling the RHIC heavy flavor electron data can only be reproduced with scaling the binary cross section with $K = 3.5$. With the same parameter we find a good agreement with the D meson and electron elliptic flow data at LHC (see Fig. 1). However, the R_{AA} of D mesons, non-prompt J/ψ, and

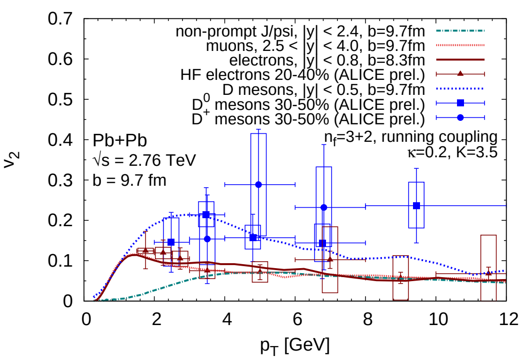

Figure 1: Elliptic flow v_2 of D mesons, non-prompt J/ψ, muons, and electrons at LHC together with available data.

muons are underestimated. Currently, we are implementing also the radiative processes [3] for heavy quarks in BAMPS. It will be highly interesting to see what impact these have on the results. As part of this work, we extensively compared the widely used Gunion-Bertsch approximation of the radiative matrix element to the exact one for both light and heavy partons [4]. Furthermore, we are working on implementing also the running coupling for light particles for both elastic and radiative processes.

Complimentary to the open heavy flavor particles are particles in which the flavor is hidden. That is, bound states of a heavy quark and an anti-heavy quark. They can survive in the QGP to some extent, but melt if the temperature of the medium is too high [5]. Therefore, they could be used as a thermometer. In addition to this melting they can also be regenerated by two heavy quarks which meet in the medium. The most prominent hidden heavy flavor particle is the J/ψ, which consists of a charm and an anti-charm quark.

First BAMPS results on the suppression of J/ψ mesons at RHIC were presented in Ref. [6]. With a J/ψ formation time of $\tau = 0.6$ fm to prevent early melting when the temperature cannot be properly defined, the experimental data of the R_{AA} at mid-rapidity is well described. However, our results at forward rapidity underestimate the suppression for central and semi-central events. In recent calculations [2] we investigated the elliptic flow of prompt J/ψ and found a small v_2, even with regeneration of J/ψ, which is in good agreement with the experimental findings. BAMPS is an ideal framework to study this in more detail since it reproduces the D meson flow and also allows recombination of charm quarks to J/ψ. Currently, we are also studying the J/ψ suppression and elliptic flow at the LHC.

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