VECC
ATOMS IN THE SERVICE OF THE NATION

The nuclear modification factor of D and B mesons in a field fluctuating quark-gluon plasma at LHC energies

Ashik Ikbal Sheikh*[1], Zubayer Ahammed[1] and Munshi Golam Mustafa[2]

[1]Variable Energy Cyclotron Centre, Department of Atomic Energy, HBNI, Kolkata-700064, India

[2]Theory Divison, Saha Institute of Nuclear Physics, HBNI, Kolkata-700064, India

*Electronic address: ashikhep@gmail.com

BEAUTY2018
La Biodola - Isola d'Elba ITALY
May, 6-11 2018

Abstract

We have calculated the nuclear modification factor (R_{AA}) of heavy mesons(D and B mesons) by considering the collisional and radiative energy loss suffered by heavy quarks while propagating through the hot and densed deconfined medium of quarks and gluons created in the heavy ion collisions, along with the energy gain due to chromo-electromagnetic field fluctuations. Our results are in good agreement with the experimentally measured R_{AA} of D and B mesons by ALICE and CMS experiments at $\sqrt{s_{NN}}$ = 2.76 TeV and $\sqrt{s_{NN}}$ = 5.02TeV.

I. Introduction

- Heavy Quarks(HQs) are mostly produced at the early stage of the heavy ion collisions from the initial fusion of the partons.
- During their path of travel, they lose energy by elastic collisions and bremsstrahlung gluon radiations.
- These energy loss calculations are usually obtained by considering the QGP medium in an average manner and statistical field fluctuations of the QGP medium are ignored.
- QGP could be charecterized by statistical fluctuations of chromo-electromagnetic fields which leads to energy gain of HQs.

II. Field fluctuations and Heavy Quarks(HQs)

- Partons inside the QGP produce chromoeletro-magnetic field due to their motions.
- QGP being a statistical system, it is characterized by stochastics fluctuations. So, the chromoeletro-magnetic fields produced are fluctuating in nature. Motion of HQs in such a plasma is random and resembles Brownian motion.
- The HQs while moving inside the plasma, experience a statistical change in energy due to the fluctuations of this fields and as well as the velocity of HQs under the influence of this fields.
- This effect leads to the energy gain of heavy qaurks, significantly at the lower momentum.

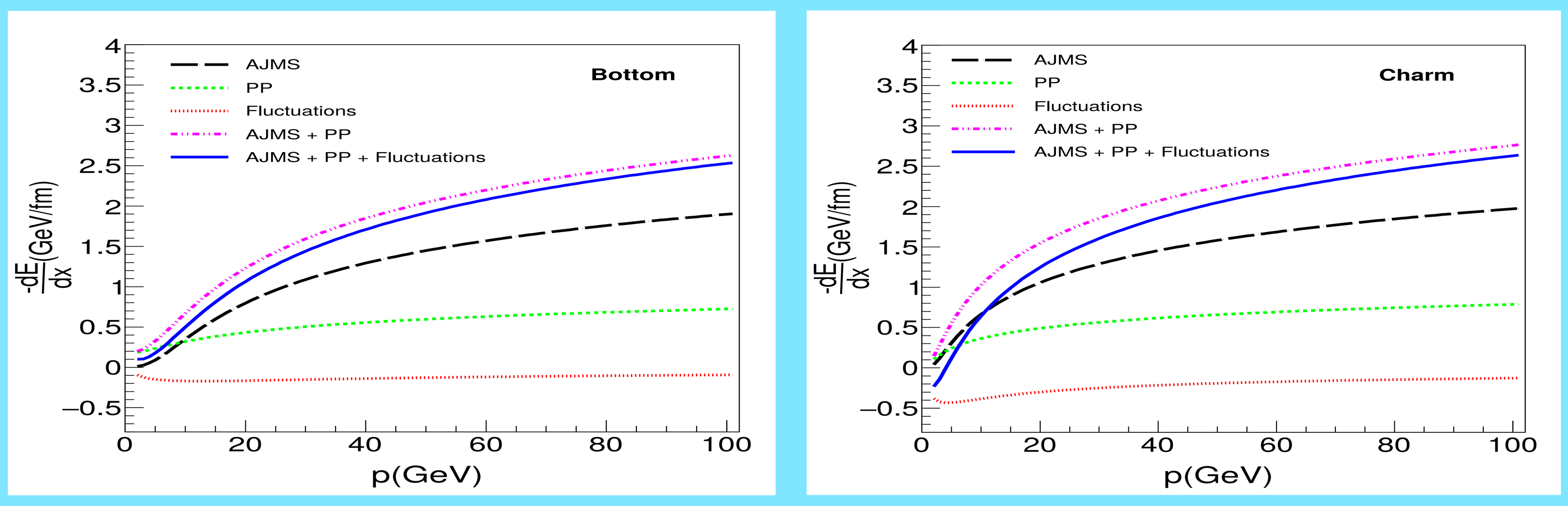
The leading-log contribution of this energy gain is obtained as[1],

$$\left(\frac{dE}{dx}\right)_{fl}^{leading-log} = 2\pi C_F \alpha_s^2 \left(1+\frac{n_f}{6}\right)\frac{T^3}{Ev^2}\ln\frac{1+v}{1-v}\ln\frac{k_{max}}{k_{min}}$$

Where $K_{min} = \mu_g =$ Debye mass and $K_{max} = min\left[E, \frac{2q(E+p)}{\sqrt{M^2+2q(E+p)}}\right]$

with q ~ T(temperature of the medium) is the typical momentum of thermal partons. C_F is the casimir factor and n_f is no. of quark flavours in QGP.

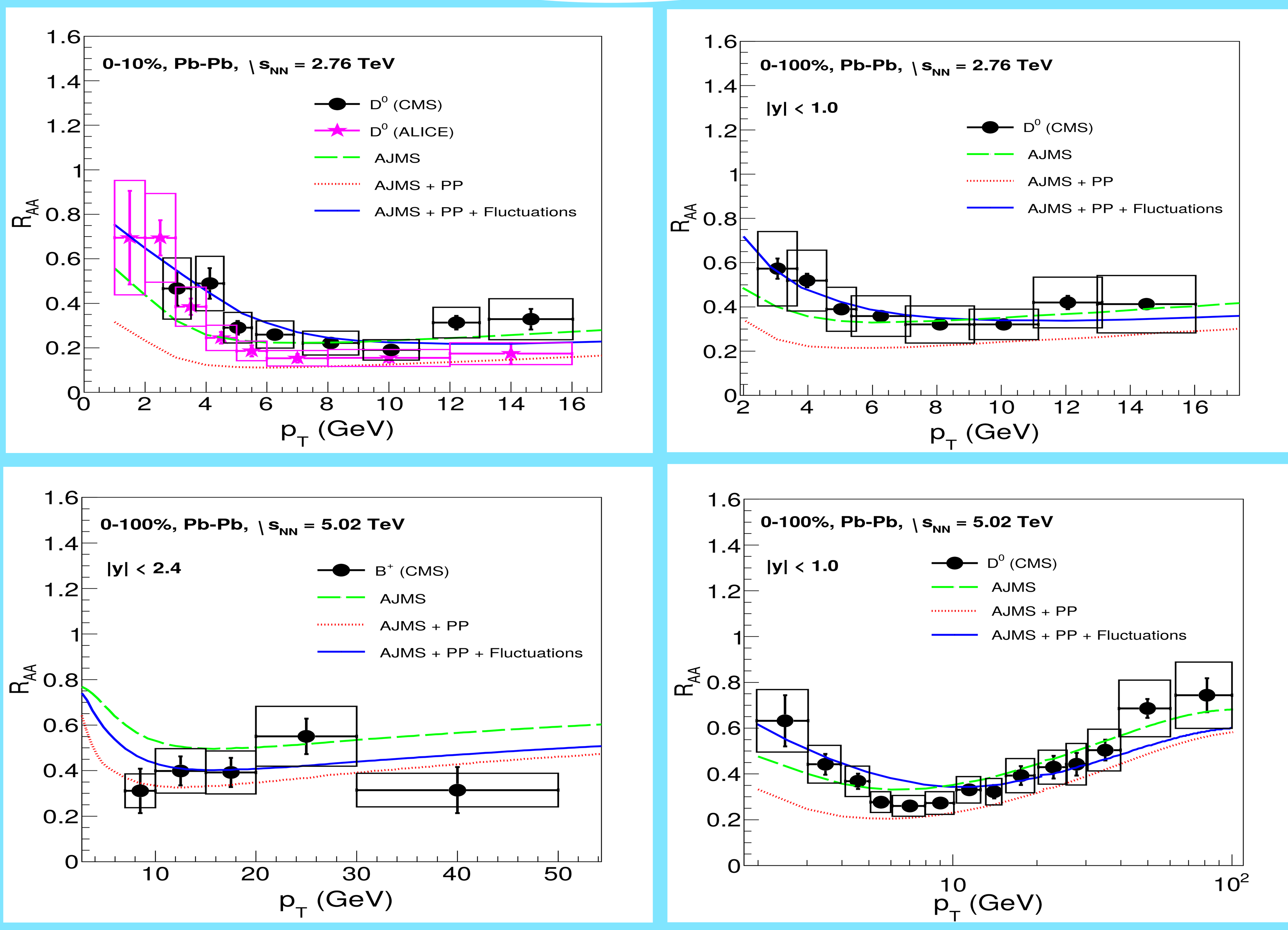
- The collisional and radiative energy loss of HQs has been used from Peigne and Pashier(PP)[2] and Abir, Jamil, Mustafa and Srivastava(AJMS)[3] formalism respectively.



- At lower momentum(below 7-8 GeV), the collisional loss dominates over radiative energy loss both for charm and bottom quarks. At higher momentum(above 8 GeV) radiative loss dominates.
- The effect of fluctuations on charm and bottom quarks energy loss is significant at lower momentum. The energy gain is more at lower momentum.

III. Results and Discussions

$$\text{Nuclear Modidfication factor : } R_{AA} = \frac{\left(\frac{dN}{d^2p_T dy}\right)^{AA}}{N_{coll}\left(\frac{dN}{d^2p_T dy}\right)^{PP}}$$



- The nuclear modification factor(R_{AA}) has been calculated with consideration of collisional and radiative energy loss along with the energy gain due to field fluctuations and compared with ALICE[4] and CMS[5,6,7] experiments.
- Only radiative energy loss(AJMS) or collisional energy loss(PP) along with the radiative energy loss can not explain the data properly. Though the transverse momentum above 10 GeV, radiative energy loss(AJMS) alone can describe the data.
- However, if the energy gain due to field fluctuations is taken into account with radiative and collisional energy loss, the data can be nicely described in the entire momentum region.

IV. Conclusion

- Radiative energy loss(AJMS) alone can describe the D-mesons suppresions at higher transverse momentum.
- The D-mesons suppresions for all transverse momentum can be nicely described by collisional(PP) plus radiative energy loss(AJMS) if the energy gain due to fluctuations is taken into account.
- This energy gain due to fluctuations along with the collisional and radiative energy loss can also explain the B-mesons suppresion at the LHC.

V. References

[1] P. Chakraborty, M.G. Mustafa and M.H. Thoma, Phys. Rev. C 75, 064908 (2007).
[2] S. Peigne and A. Peshier, Phys. Rev. D 77, 114017 (2008).
[3] R. Abir, U. Jamil, M.G Mustafa and D.K Srivastava, Phys. Lett. B 715 (2012) 183-189.
[4] ALICE Collaboration, JHEP 1603 (2016) 081, 2016.
[5] CMS Collaboration, CMS-PAS-HIN-15-005.
[6] CMS Collaboration, CMS-PAS-HIN-16-001.
[7] CMS Collaboration, Phys. Rev. Lett. 119, 152301 (2017).