A model study of D-h and D-$\bar{D}$ azimuthal correlation at LHC energies

S.K.Tripathy[1 2,*] M.Younus[1], Z. Naik[2], and P.K.Sahu[1]
[1]*Institute of Physics, Bhubaneswar-751005, India and*
[2]*Sambalpur University, Burla-768019, India*

Introduction

Charm-hadron azimuthal correlation is able to infer properties like charm production and fragmentation process while that of charm-anti-charm can discern the contribution of NLO-pQCD and LO-pQCD to two particle correlation spectra. p+p being the baseline, correlation study in p+Pb will clearly indicate the effect due to initial cold nuclear matter effect, while p+Pb study of D-h and D-$\bar{D}$ correlation will show the early effect due to quark gluon plasma.

In this paper, we will show D-h azimuthal correlation calculations from NLO(MNR), LO calculations from AMPT along with ALICE results [1] in p+Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV. D-$\bar{D}$ correlation and others (p+p collisions at $\sqrt{s} = 7$ TeV and HIJING) results will be presented during the conference.

Analysis Technique

Charm cross-section in HIJING [2] is given by the following equation:

$$\frac{d\sigma_{cc}^{pp}}{dp_T^2 dy_1 dy_2} = K \sum_{a,b} x_1 f_a(x_1, p_T^2) x_2 f_b(x_2, p_T^2) \times \frac{d\hat{\sigma}_{ab}}{d\hat{t}} \quad (1)$$

here a, b are the parton species, y_1, y_2 are the rapidities of the scattered partons, and x_1, x_2 are the fraction of momentum carried by the initial partons. Value of K = 2.0 has been used to account for the higher order corrections.

Shadowing effect as included in HIJING is as follows:

$$R_A(x) \equiv \frac{f_{a/A}(x)}{A f_{a/N}(x)} = 1 + 1.19\, ln^{1/6} A[x^3 - 1.5(x_0 + x_L)x^2 + 3x_0 x_L x]\Big[\alpha_A(r) - \frac{1.08(A^{1/3} - 1)}{ln(A+1)}\sqrt{x}\Big] e^{-x^2/x_0^2} \quad (2)$$

where $\alpha_A(r) = 0.1(A^{1/3} - 1)\frac{4}{3}\sqrt{1 - r^2/R_A^2}$. Here r is the transverse distance of the interacting nucleon its centre of nucleus, R_A is the radius of the nucleus,value of $x_0 = 0.1$ and $x_L = 0.7$. Significant nuclear dependence term is proportional to $\alpha_A(r)$, which determines the shadowing for $x < x_0$. Other terms gives small A dependence nuclear effect on the structure function for $x > x_L$.

AMPT [3] also uses leading order two body partonic interaction as in HIJING, followed by secondary interaction of partons after hadronisation. Charm cross-section is given as following:

$$\frac{d\sigma_{gg}}{dt} = \frac{9\pi\alpha_s^2}{2_s^2}(3 - \frac{ut}{s^2} - \frac{us}{t^2} - \frac{st}{u^2}) \equiv \frac{9\pi\alpha_s^2}{2}(\frac{1}{t^2} + \frac{1}{u^2}) \quad (3)$$

where α_s is the strong coupling constant. s,t & u are the standard Mandelstam variables. Shadowing effect in AMPT included HIJING like (Eq 2) impact parameter dependent, in addition to Q^2 and flavor independent paramerterrization.

In NLO [4], p_T differential spectrum of heavy quarks produced in p+p collisions is de-

*Electronic address: `srikanta2012@iopb.res.in`

fined in general as:

$$E_1 E_2 \frac{d\sigma}{d^3p_1 d^3p_2} =$$
$$x_a x_b \sum_{ij} \left[f_i^{(a)}(x_a, Q^2) f_j^{(b)}(x_b, Q^2) \frac{d\hat{\sigma}_{ij}(\hat{s}, \hat{t}, \hat{u})}{d\hat{t}} \right.$$
$$\left. + f_j^{(a)}(x_a, Q^2) f_i^{(b)}(x_b, Q^2) \frac{d\hat{\sigma}_{ij}(\hat{s}, \hat{u}, \hat{t})}{d\hat{t}} \right] / (1+\delta_{ij}) \quad (4)$$

where x_a and x_b are the fractions of the momenta carried by the partons from their interacting parent hadrons.

The effective transverse momentum kick, $\langle k_T^2 \rangle_{pA}$, obtained after a series of re-scattering can be written as

$$\langle k_T^2 \rangle_A = \delta^2 . n . \ln \left(1 + \frac{p_T^2}{\delta^2 / c} \right) \quad (5)$$

where the parameters δ^2/c, average squared momentum kick per scattering and $n = 2L_A/\lambda$, $L_A = 4R_A/3$, average number of re-scattering

In FONLL [5], p_T spectra of heavy quarks produced in p+p collisions can be written as

$$E_c \frac{d\sigma}{d^3p_c dy_c} = \int d^3p_{\bar{c}} dy_{\bar{c}} \frac{d\sigma^{pp \to c\bar{c}}}{d^3p_c d^3p_{\bar{c}} dy_c dy_{\bar{c}}} \quad (6)$$

where y_c and $y_{\bar{c}}$ are the rapidities of heavy quark and anti-quark and $p_{\mathbf{T}_i}$ are their transverse momenta.

Results & Conclusion

In Fig 1 we have presented azimuthal correlation of D^0, D^+ and D^{*+} mesons in p+Pb data at $\sqrt{s_{NN}} = 5.02$ TeV. Here p_T of D-mesons taken from $5 < p_T < 8 GeV/c$ and that of charged particles taken to be $p_T > 1 GeV/c$, both particle falling under pseudo-rapidity window $|\eta| < 1$.

AMPT results give a better correlation pattern comparable to data at both near side and away side region while NLO is almost flat for $\Delta\phi > \pi/2$, showing near-side correlation is more prominent than away side pattern. In future we will study the parametric dependence of differences between these two models.

References

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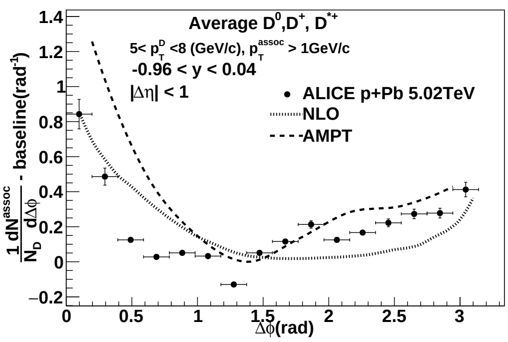

FIG. 1: Azimuthal correlation of D-mesons in p+Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV after baseline subtraction. Uncertainties in data points are putted by hand to be 10%.

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