Gluon Densities and Dihadron correlations

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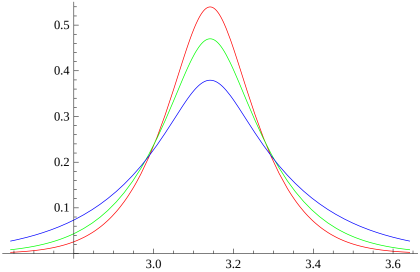
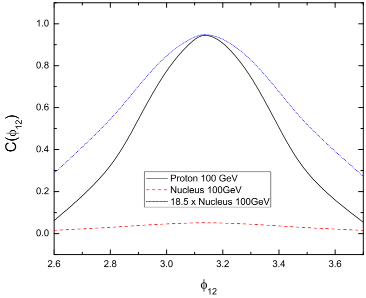
- In this talk, a complete calculation of dijet production in various processes is presented. It is well-known that there are two fundamental unintegrated gluon distributions in high density QCD. The first unintegrated gluon distribution, which measures the number density of gluons inside the target nucleus, can be directly measured in DIS dijet production; whereas the second unintegrated gluon distribution, defined as the Fourier transform of the color-dipole amplitude, can be probed in the Drell-Yan-jet correlation in pA collisions. Dijet production cross section in pA collision depends on both gluon distributions through convolutions. We conduct two independent calculations (one is in CGC formalism and the other uses TMD approach.) for all of above processes. We find these two calculation agree perfectly. These calculation has shown important impact on the present RHIC and future EIC and LHeC. In the end, I also present a comprehensive comparison between our numerical results and the forward dihadron production data measured by STAR.

Drell-Yan workshop at BNL, May, 2011

DIS dijet correlation

Azimuthal angle correlation of dijet in DIS probes the WW gluon distributions





Remarks:

- $k_{1\perp} = 5.5\text{Gev}$, $k_{2\perp} = 5.0\text{Gev}$ and $Q_s^2 = 1\,,1.5\,,3\text{GeV}$;
- Only away side peak is plotted due to the correlation limit.
- Suppression of away side peak and increase of width at large Q_s^2.
- Dramatic change between ep and eA collisions. $Q^2 = 4\text{GeV}^2$, $z_{h1} = z_{h2} = 0.3$, $2\text{GeV} < p_{1\perp} < 3\text{GeV}$ and $1\text{GeV} < p_{2\perp} < 2\text{GeV}$.
- No pedestal.

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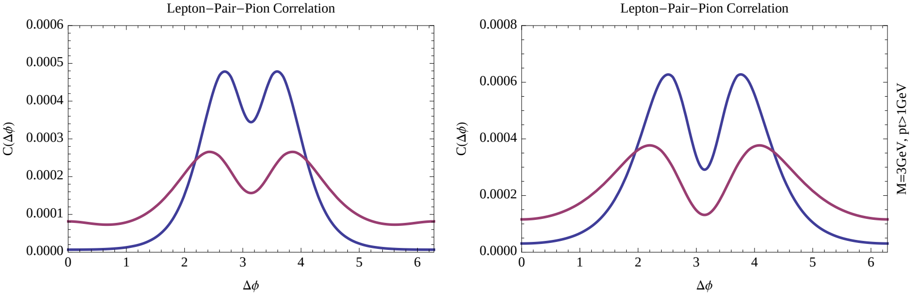
[F. Dominguez, BX and F. Yuan, in preparation]

Azimuthal angle correlation of $\gamma^*+\pi^0$ at forward rapidity 3.2:



Remarks:

- $p_{1\perp} > 1.5\text{Gev}$, $p_{2\perp} > 1.5\text{Gev}$ and $M^2 = 1\text{GeV}^2$;
- $p_{1\perp} > 1\text{Gev}$, $p_{2\perp} > 1\text{Gev}$ and $M^2 = 9\text{GeV}^2$;
- Suppression of away side peak at central *dAu* collisions.
- Double peak structure on the away side comes from the fact that $xG^{(2)} \propto q_\perp^2$ in the small $q_\perp$ limit.

Gluon+quark jets correlation

Including all the $qg \to qg$, $gg \to gg$ and $gg \to q\bar{q}$ channels, a lengthy calculation gives

$$\frac{d\sigma^{(pA\to \text{Dijet}+X)}}{d\mathcal{P}.\mathcal{S}.} = \sum_q x_1 q(x_1,\mu^2)\frac{\alpha_s^2}{\hat{s}^2}\left[\mathcal{F}_{qg}^{(1)}H_{qg}^{(1)}+\mathcal{F}_{qg}^{(2)}H_{qg}^{(2)}\right]$$
$$+x_1 g(x_1,\mu^2)\frac{\alpha_s^2}{\hat{s}^2}\left[\mathcal{F}_{gg}^{(1)}\left(H_{gg\to q\bar{q}}^{(1)}+\frac{1}{2}H_{gg\to gg}^{(1)}\right)\right.$$
$$\left.+\mathcal{F}_{gg}^{(2)}\left(H_{gg\to q\bar{q}}^{(2)}+\frac{1}{2}H_{gg\to gg}^{(2)}\right)+\mathcal{F}_{gg}^{(3)}\frac{1}{2}H_{gg\to gg}^{(3)}\right],$$

with the various gluon distributions defined as

$$\mathcal{F}_{qg}^{(1)} = xG^{(2)}(x,q_\perp),\quad \mathcal{F}_{qg}^{(2)} = \int xG^{(1)}\otimes F\,,$$
$$\mathcal{F}_{gg}^{(1)} = \int xG^{(2)}\otimes F,\quad \mathcal{F}_{gg}^{(2)} = -\int \frac{q_{1\perp}\cdot q_{2\perp}}{q_{1\perp}^2}xG^{(2)}\otimes F\,,$$
$$\mathcal{F}_{gg}^{(3)} = \int xG^{(1)}(q_1)\otimes F\otimes F\,,$$

where $F = \int \frac{d^2r_\perp}{(2\pi)^2}e^{-iq_\perp\cdot r_\perp}\frac{1}{N_c}\left\langle \text{Tr}U(r_\perp)U^\dagger(0)\right\rangle_{x_g}$.
Remarks: Only the first term was known before.

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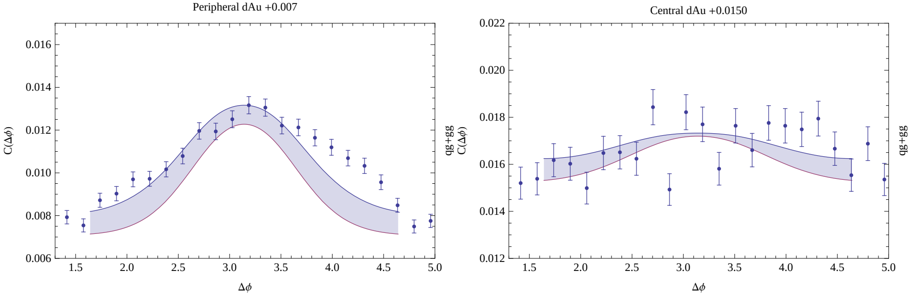
Comparing to STAR data including both $q+g$ and $g+g$

[A. Stasto, BX, F. Yuan, in preparation]

For away side peak in both peripheral and central dAu collisions:



- Adding a $k-$factor of 2 to the ratio since the total single inclusive cross section is twice of the data at $\eta = 3.2$.
- Other parameters are kept the same.

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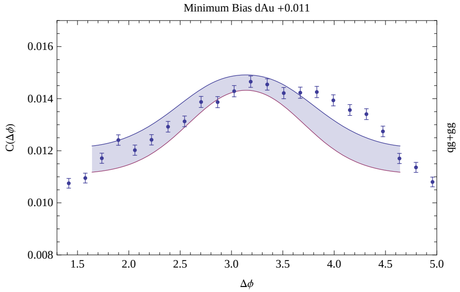
Comparing to STAR data including both $q + g$ and $g + g$

[A. Stasto, BX, F. Yuan, in preparation]

For minimum bias away side peak in *dAu* collisions in $q + g$ channel:



- Adding a $k-$factor of 2 to the ratio since the total single inclusive cross section is twice of the data at $\eta = 3.2$.
- Peripheral $b = 6.8 \pm 1.7$fm with $c(b) = 0.45$ and width $\sigma \simeq 0.99$;
- Central $b = 2.7 \pm 1.3$fm with $c(b) = 0.85$ and width $\sigma \simeq 1.6$;
- Minimum Bias $c(b) = 0.56 \Rightarrow \langle b \rangle = 6$fm and width $\sigma \simeq 1.2$.

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