What can we learn with Drell-Yan in p(d)-Nucleus collisions

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We argue that the forward Drell-Yan lepton pair production can be used to probe the nontrivial QCD dynamics associated with small-x physics. In particular, the saturation scale Q_s^2 is order of 3-4GeV^2, which is not too small compared to the hard scale: the invariant mass of the lepton pair. We estimate the nuclear suppression factor is less than 0.5 for small transverse momentum lepton pair production, which is unprecedented for Drell-Yan process. In this kinematics, the traditional DGLAP-based shadowing approach is not applicable any more. The Color-Glass-Condensate/Color-dipole approach is more suitable to describe these processes. We further argue that the single spin asymmetries in pp and pA collisions can provide more information on small-x physics, and may shed light on the underlying mechanism for the AN in various processes.

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In p(d) Au Collisions

- **Inclusive cross section**
  - ☐ Invariant mass not so large compared to the saturation scale
- **Pt dependent observables**
  - ☐ Directly probe the unintegrated gluon distributions
  - ☐ Correlation of DY-hadron
    - Al's, Bowen's talks

How relevant is the saturation scale at RHIC

Saturation Scale in Drell–Yan in pp and pA

$Q_s^2(GeV^2)$ for M=5GeV at RHIC (200GeV)

$A^{1/3}$

$Q_s^2(GeV^2)$

x_F
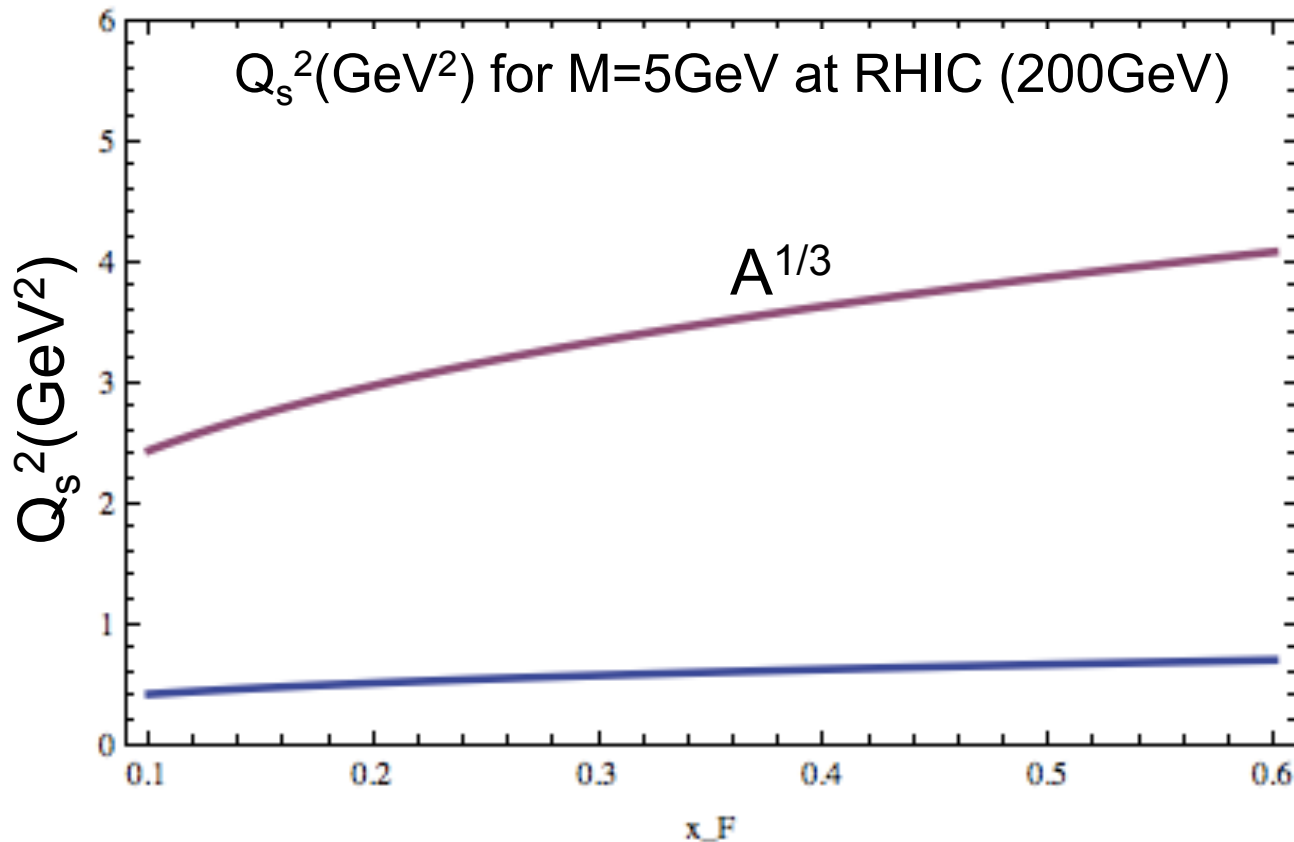
For typical
Range of lepton
Pair mass at
RHIC, Saturation
Is going to
Be important

DGLAP shadowing
Will not be enough

Jamal's talk
Anna's talk

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Advantage of Low Pt Drell-Yan

- Direct probe for the transverse momentum dependence of partons
  - Saturation effects explicitly show up in the transverse momentum distribution
- Factorization can be argued for large Q
- Related to the TMD factorization
- Complementary study in SIDIS

Pt dependence of the Nuclear suppression

$$R_{pA} = \frac{d\sigma^{pA \to \gamma^*}}{A d\sigma^{pp \to \gamma^*}}$$

Suppression Factor of Drell–Yan in pA
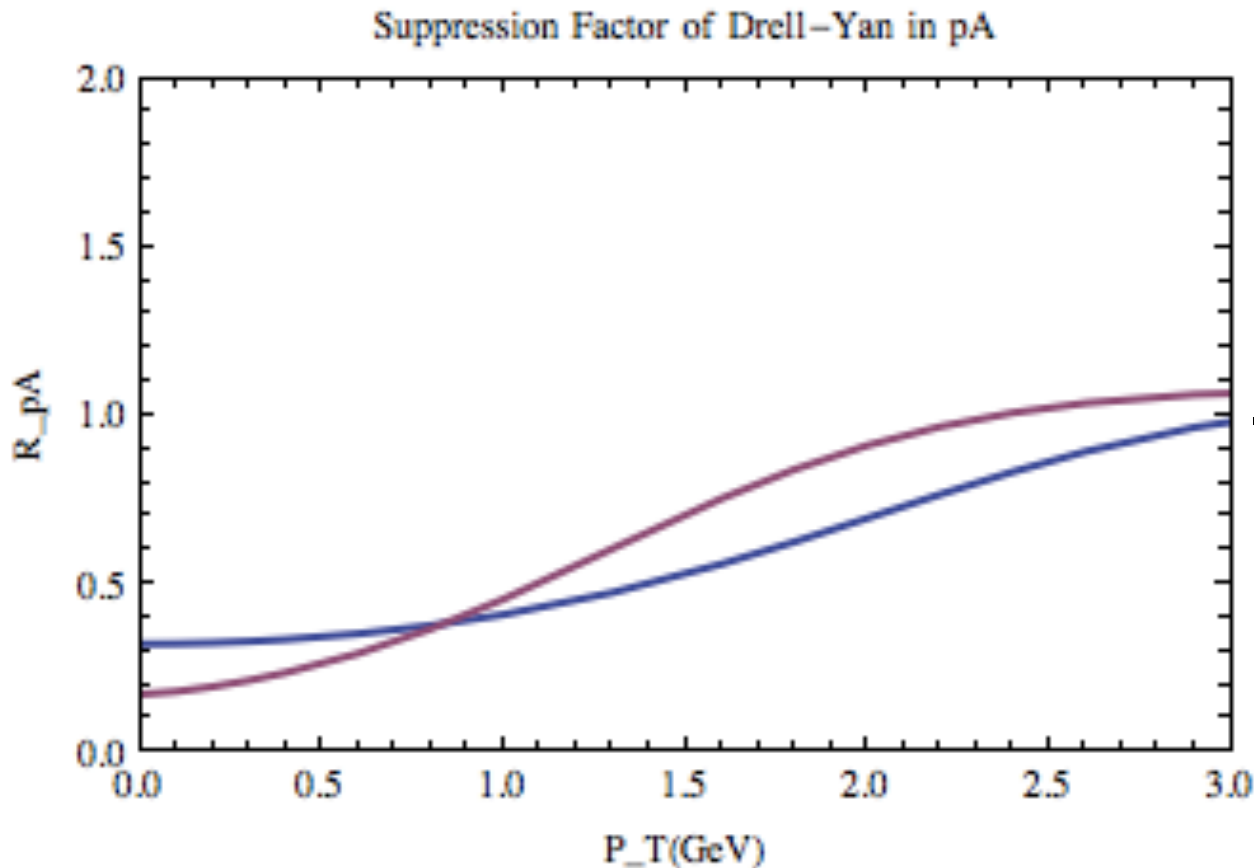
With smearing effects

See also,
Guo,Qiu,Zhang, 00

5/15/11

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Pt dependence for A$_N$
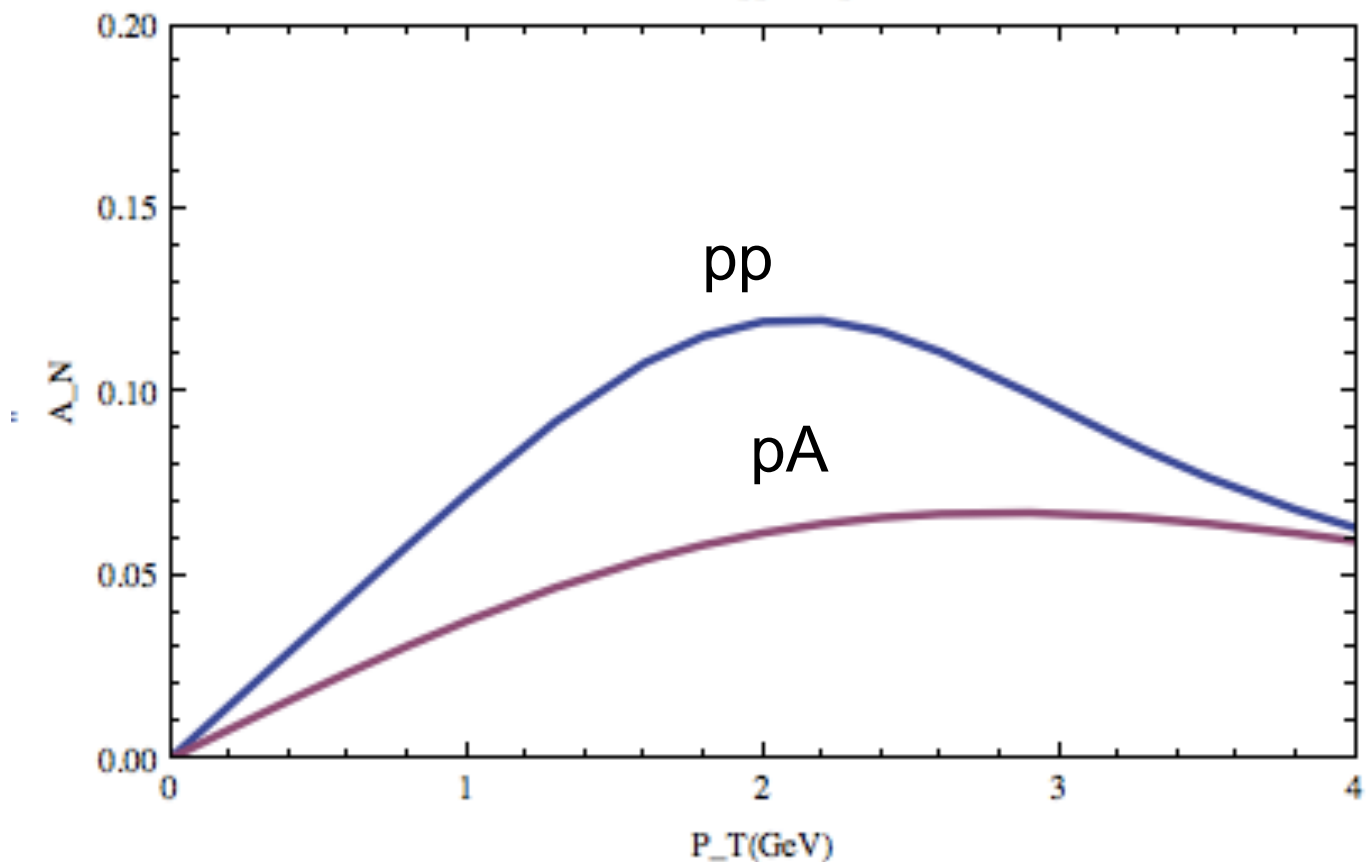
A_N for Drell—Yan in pp and pA (Arbitral Scale)

Illustration purpose

Trivial assumption
For the Sivers
Function

Full calculations
Underway

Similar analysis for
Pion A$_N$