# Forward di-jet production in dilute-dense collisions

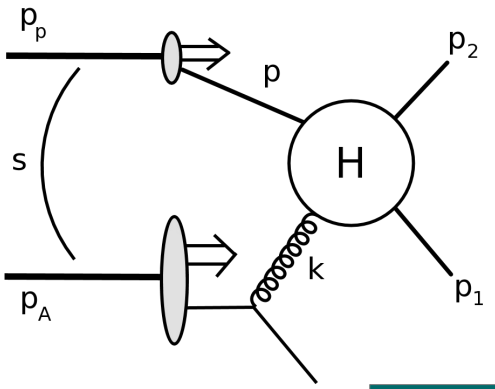

Elena Petreska

École Polytechnique and Universidade de Santiago de Compostela

Piotr Kotko, Krzysztof Kutak, Cyrille Marquet, Sebastian Sapeta and Andreas van Hameren



JHEP 1509 (2015) 106, and preliminary results


The projectile is probed at large-*x*. The target is probed at small-*x*.

Optimal for studying small-*x* saturation effects.

***Motivation*: Unifying three theoretical approaches:**

| Color Glass Condensate | High-Energy Factorization | Transverse Momentum Dependent factorization |
|---|---|---|
| *L. McLerran and R. Venugopalan, 1994*<br>*J. Jalilian-Marian, A. Kovner, A. Leonidov, and H. Weigert, 1997, 1999.*<br>*E. Iancu, A. Leonidov, and L. D. McLerran, 2001*<br>*A. H. Mueller, 2001*<br>*E. Ferreiro, E. Iancu, A. Leonidov, and L. McLerran, 2002* | $Q_s \ll k_t \sim P_t$<br>*S. Catani, M. Ciafaloni and F. Hautmann, 1991*<br>*M. Deak, F. Hautmann, H. Jung and K. Kutak, 2009*<br>*K. Kutak and S. Sapeta, 2012* | $k_t \sim Q_s \ll P_t$<br>*C. J. Bomhof, P. J. Mulders and F. Pijlman, 2006*<br>*F. Dominguez, C. Marquet, B. -W. Xiao and F. Yuan,2011* |

## *Result I*

High-Energy Factorization ⟷ Color Glass Condensate

can be derived from the

in the dilute target limit.

## *Result II*

Improved Transverse Momentum Dependent factorization

Extension to finite $N_c$ ; Three new TMD gluon distributions;
+ Reduction to 2 independent TMD gluons per channel.

## *Result III*

**Unifying Transverse Momentum Dependent factorization formula:**

$$\frac{d\sigma^{pA\to \text{dijets}+X}}{d^2P_t d^2k_t dy_1 dy_2} = \frac{\alpha_s^2}{(x_1 x_2 s)^2} \sum_{a,c,d} x_1 f_{a/p}(x_1,\mu^2) \sum_{i=1}^{2} K^{(i)}_{ag\to cd}(k_t) \Phi^{(i)}_{ag\to cd}(k_t) \; \frac{1}{1+\delta_{cd}}$$

Off-shell matrix elements are derived with two independent methods:
Feynman diagrams technique and helicity method for color-ordered amplitudes.

The new formula:
Is valid for for an arbitrary value of the momentum imbalance of the jets;
It encompasses the regimes of validity of both HEF and TMD.

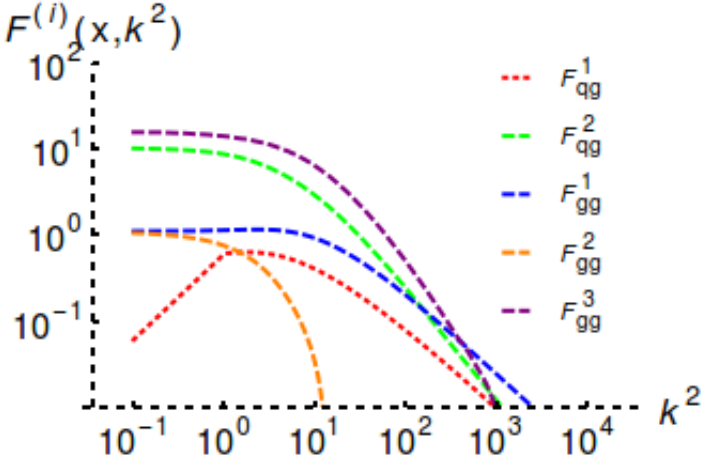
*P. Kotko, K. Kutak, C. Marquet, EP, S. Sapeta, A. van Hameren (2015)*

Preliminary results

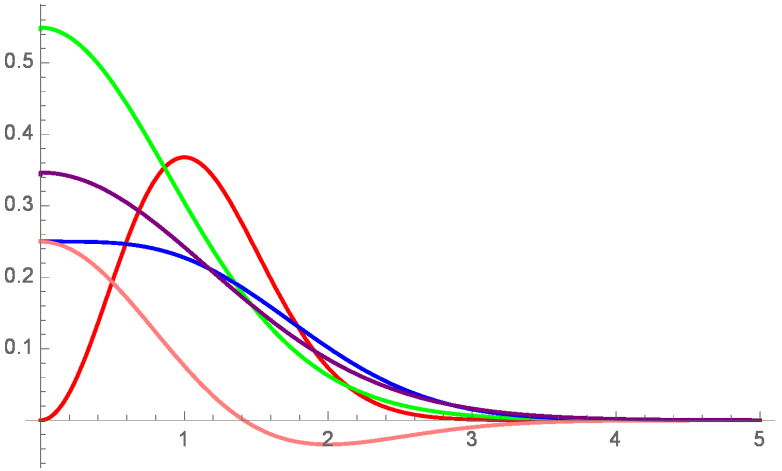
Phenomenology with the new formula

# TMD gluon distributions:

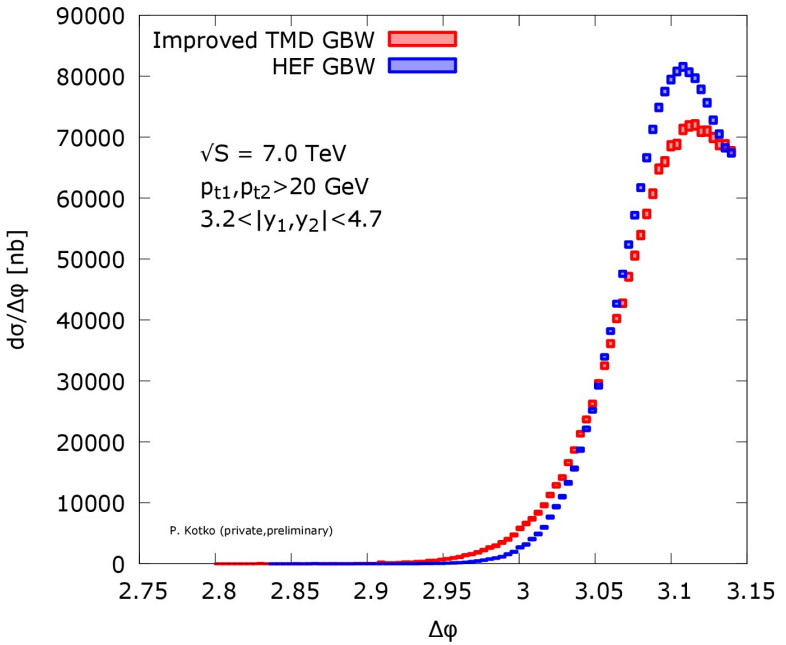
Kutak-Sapeta gluons with non-linear evolution:




From analytical expressions in the Golec-Biernat-Wusthoff model:



Azimuthal correlations in forward di-jet production with the unifying formula

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