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## **BFKL: High-Energy Asymptotics for Jet and Higgs Production**

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- Motivation: high-energy limit of QCD (SM)
- (N)LO BFKL and current phenomenology
- BFKL for jet and Higgs production
- Summary

## **Motivation**

**ALL (!) particles behave like hadrons  
at high-energy limit:  $s \rightarrow \infty$**

## Motivation

### QCD:

All-order resummation at  $s \rightarrow \infty$  (BFKL):

⇒ rising gluon-gluon cross section

⇒ rising hadronic cross section

### Electro-Weak:

Emission of (virtual) quarks and gluons

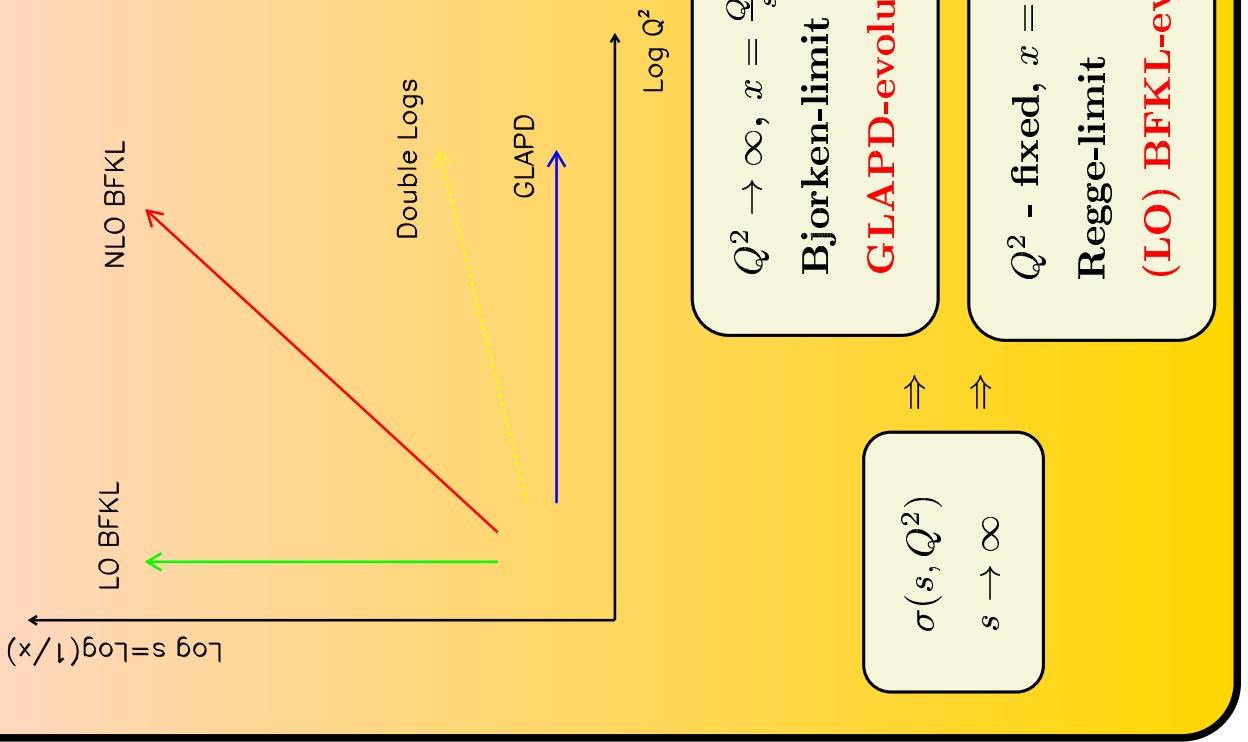
via (virtual) photon and weak bosons

⇒ rising cross sections due to gluons

The strong energy dependence (BFKL)  
eventually overcomes the suppression  
by coupling constants ( $\alpha_{EW}, \alpha_S$ )



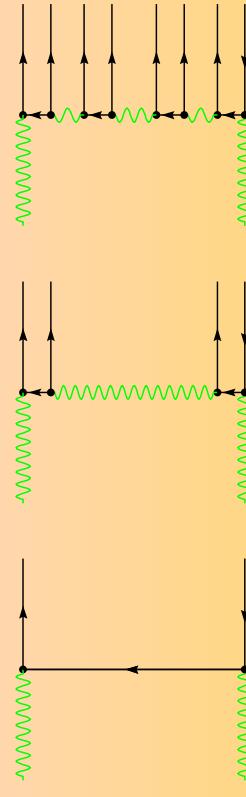
**ALL (!) particles behave like hadrons**  
**at high-energy limit:  $s \rightarrow \infty$**



## High-energy $\gamma\gamma$ in QED

GRIBOV, LIPATOV, FROLOV & GORSHKOV (67-71)

CHENG & WU (67-70)



$$\sigma \sim \alpha^2 \left( \frac{\log s}{s} \right)$$

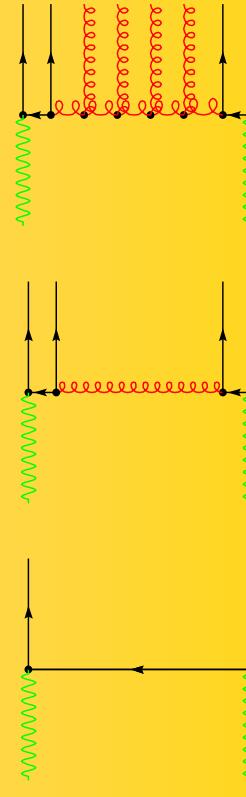
$$\sigma \sim \alpha^4 s^0$$

$$\omega = \frac{11}{32} \pi \alpha^2 \simeq 6 \cdot 10^{-5}$$

## High-energy $\gamma\gamma$ in QCD

LIPATOV, FADIN & KURAEV (75-77)

BALITSKY & LIPATOV (78)



$$\sigma \sim \alpha^2 \alpha_S^2 s^0$$

$$\text{BFKL: } \omega_{LO} = \frac{12 \log 2}{\pi} \alpha_S \simeq 0.5 \quad \omega_{NLO} \simeq 0.13 \div 0.18$$

## LO and NLO BFKL

$$\sigma(s, Q^2) \sim \left( \frac{s}{s_0} \right)^{\omega(Q^2)}$$

$\omega = \alpha_F - 1 \leftarrow \text{NOT A FREE PARAMETER!}$

The only parameter in (N)LO BFKL:  $s_0 \sim Q^2$   
[due to neglected (sub-)subleading subserieses]

- at  $s \rightarrow \infty$  cross sections do not depend on  $s_0$
- at finite  $s \Rightarrow s_0$ -dependence

LO BFKL:  $\omega = 0.55$  at  $\alpha_S = 0.2$

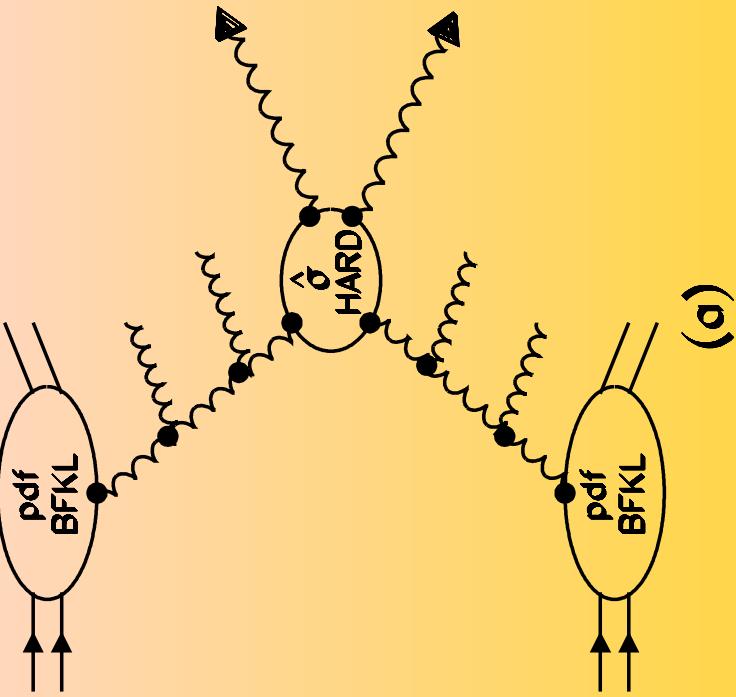
FADIN, KURAEV & LIPATOV (75-77)

NLO BFKL: ...

FADIN & LIPATOV (98); CIAFALONI & CAMICI (98)

NLO BFKL in BLM:  $\omega = 0.13-0.18$

BRODSKY, FADIN, VK, LIPATOV & PIVOVAROV (99)

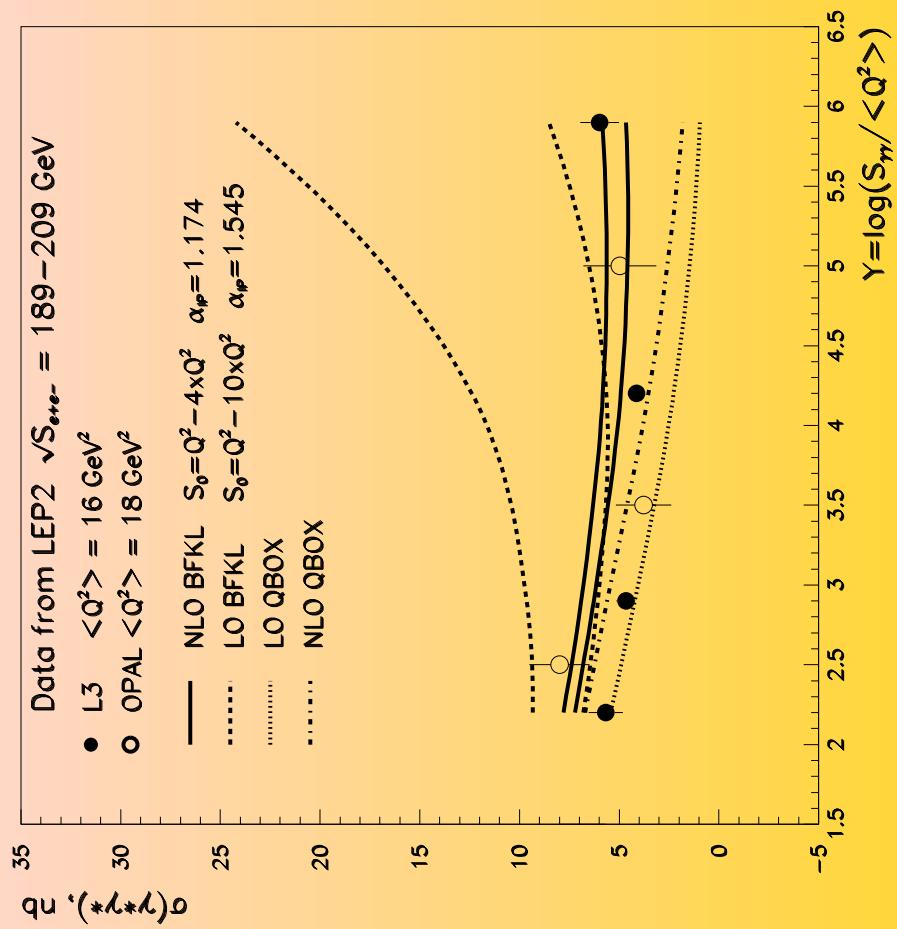


$k_\perp$ -factorization scheme

CATANI, CIAFALONI & HAUTMANN (90-91)

COLLINS & K. ELLIS (91)

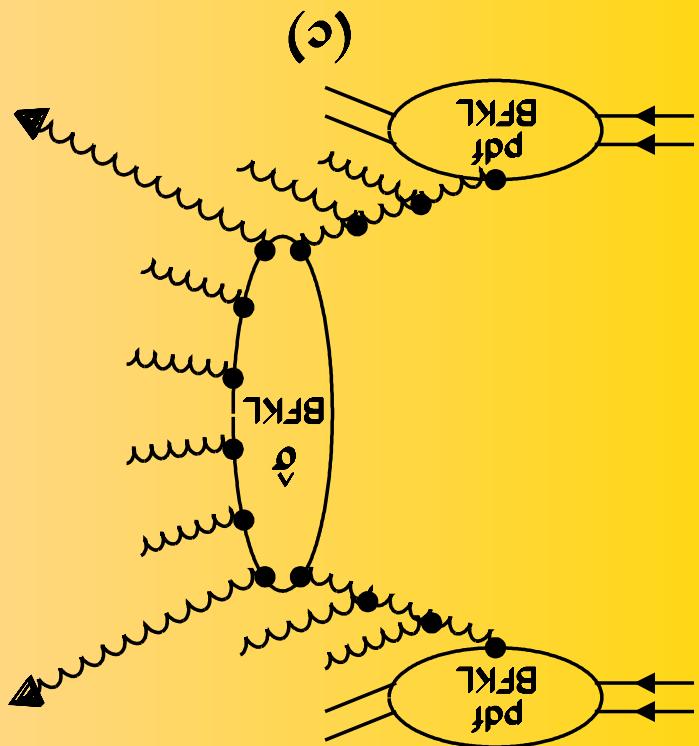
LEVIN, RYSKIN, SHABELSKY & SHUVAEV (91)



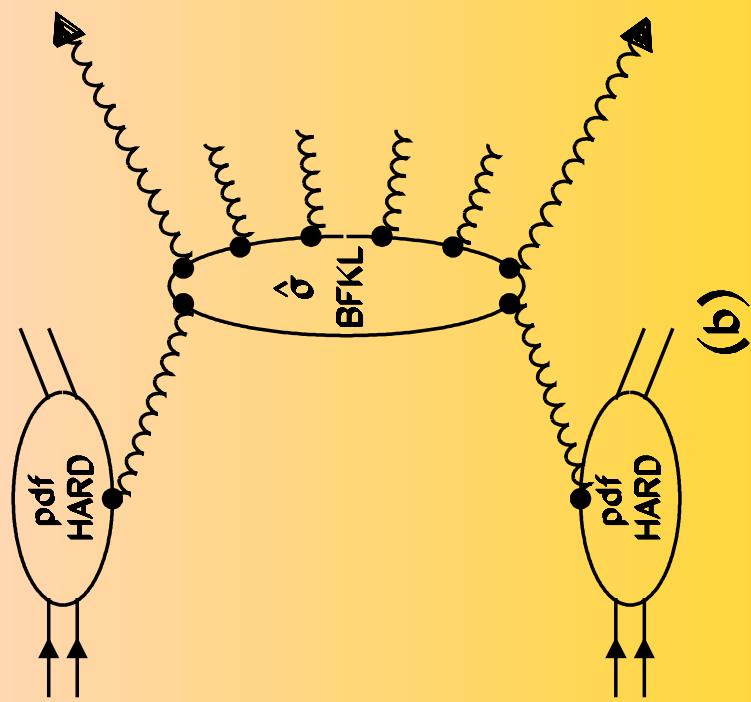
V.K., LIPATOV & PIVOVAROV (99)

BRODSKY, FADIN, VK, LIPATOV & PIVOVAROV (01)

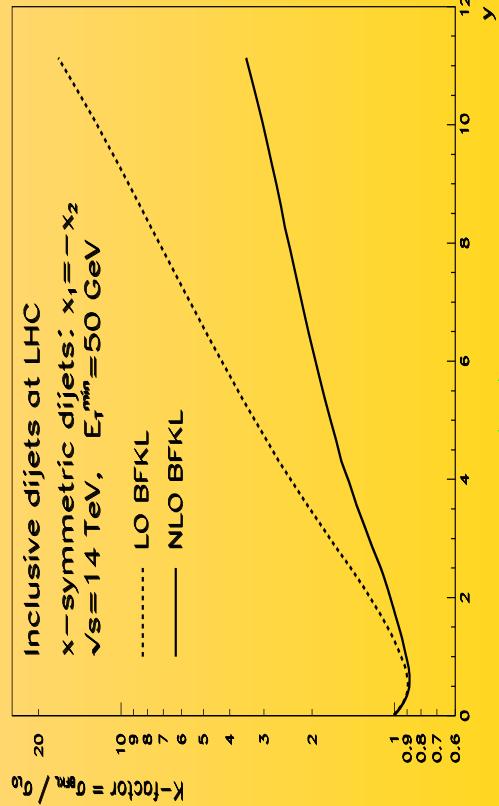
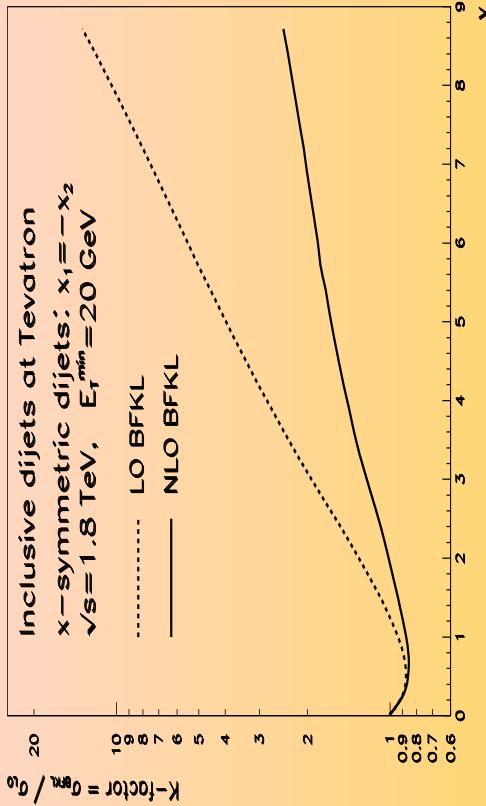
BFKL-factorization scheme



MUELLER & NAVELLET (87)

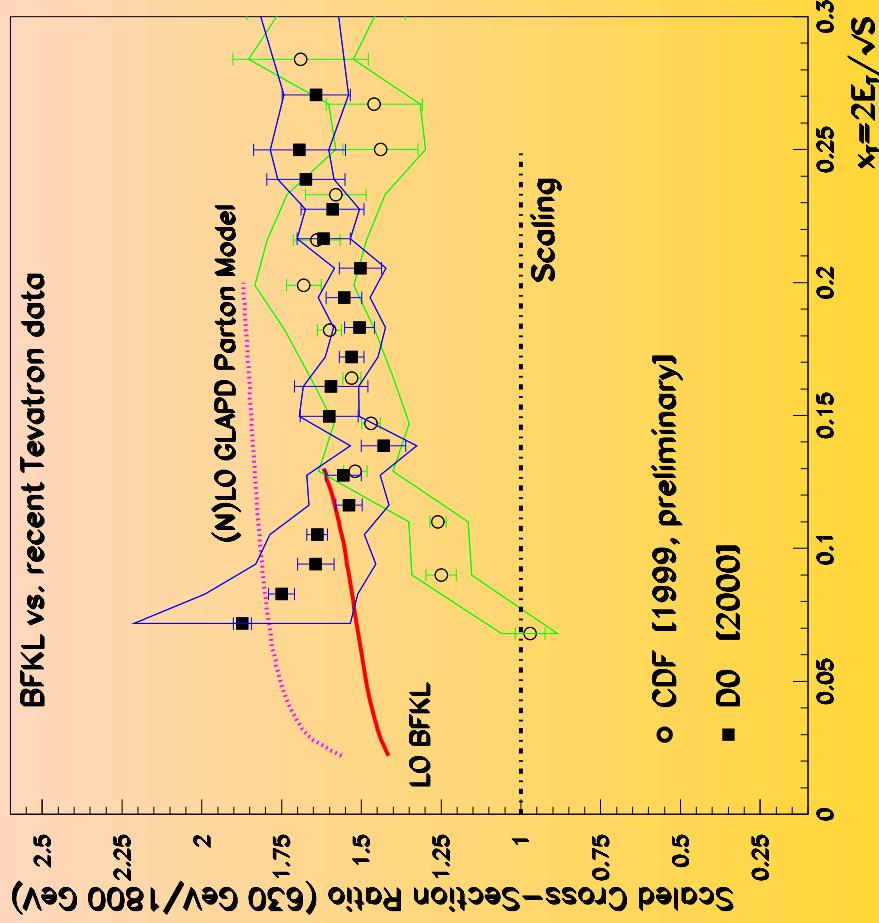


Mueller-Navelet-factorization scheme



VK & PIVOVAROV (96)

VK, LIPATOV, ROYON, PESCHANSKI, & PIVOVAROV (01)



VK & PIVOVAROV (98)

## Summary

### Inclusive Higgs production at LHC

$$\sigma(gg \rightarrow H)$$

$K$ -factor for  $M_H = 130$  GeV at LHC

Fixed order pQCD:

NLO: 2.2

NNLO: 2.9

High-energy resummation (BFKL):

**VK & G. PIVOVAROV (Preliminary)**

LO BFKL: 1.6

NLO BFKL: 1.3

**Study of BFKL-effects at LHC  
will provide a very unique opportunity  
to test high-energy asymptotics of QCD (SM)**

- BFKL dynamics will be important at LHC in
- \*  $pp-$  ( $AA-$  and  $\gamma\gamma-$ ) collisions
  - \* inclusive jet and multijet production
  - \* jets associated with Higgs, SUSY, etc.
  - \* heavy-quark production
  - \* rapidity gap (diffraction) physics

BFKL MC event generators: in progress