Exclusive J/ψ production in pp and $p\bar{p}$ collisions and the QCD Odderon

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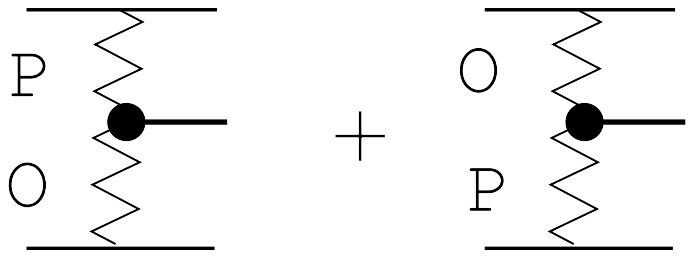
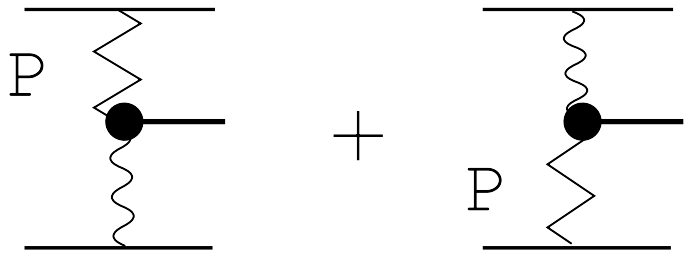
May 27 - June 5, 2006

J/ψ and Odderon are C odd, Pomeron is C even

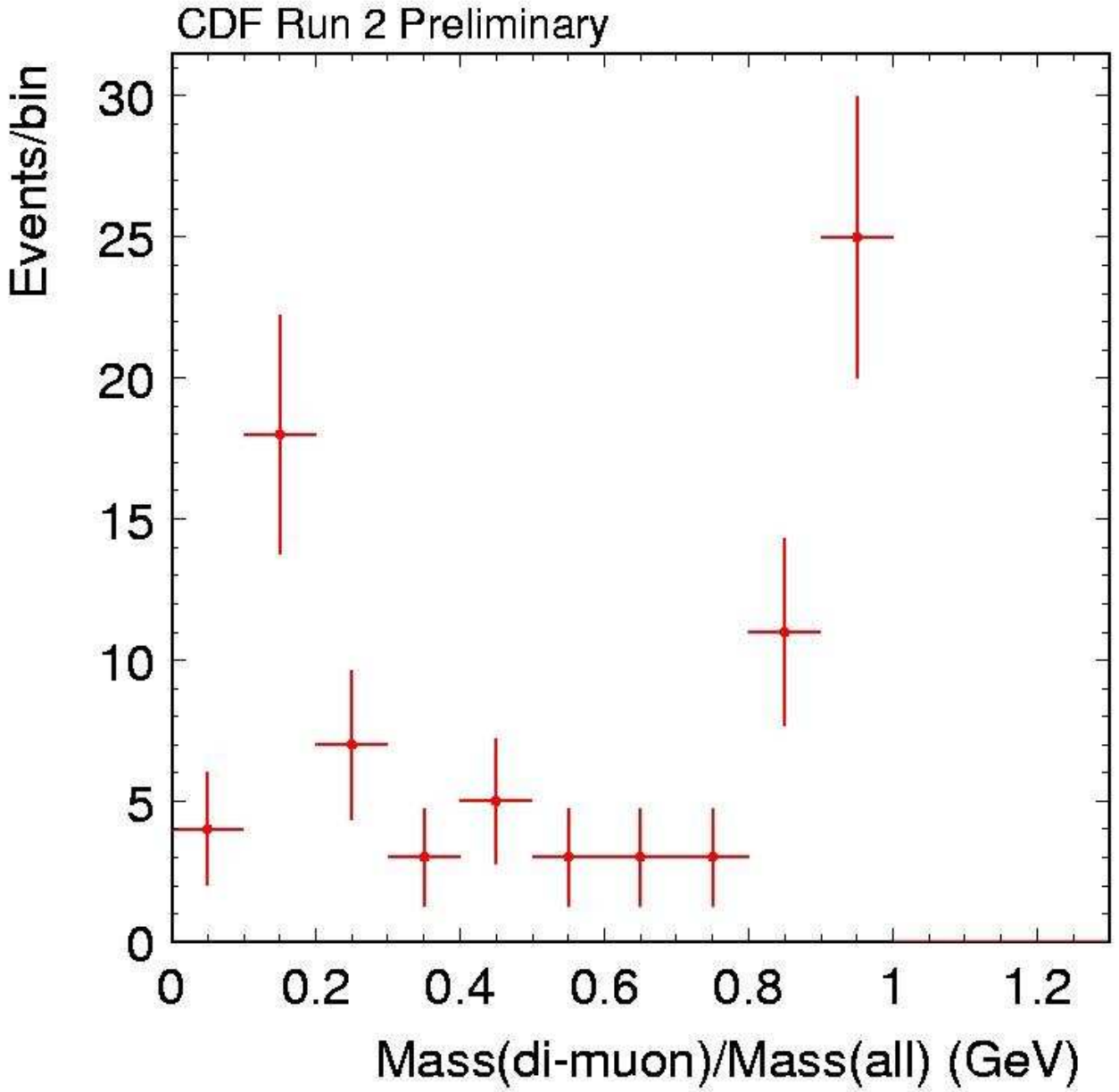


$$\sigma_{tot} \leq 75 \text{ nb}$$

The photon pomeron fusion should be taken into account

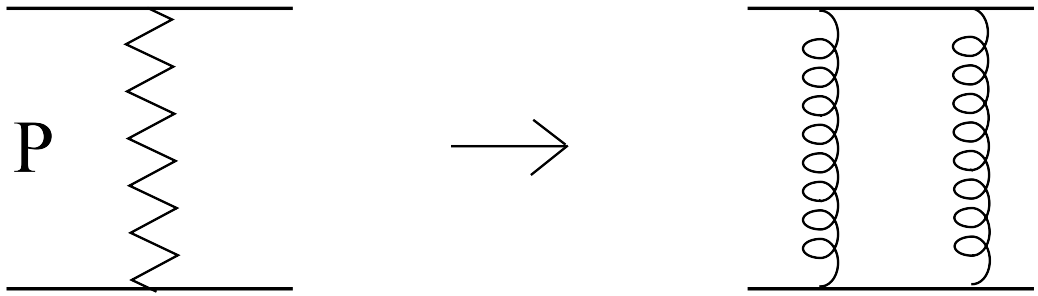


1991 - A. Schafer, L. Mankiewiecz, O. Nachtmann

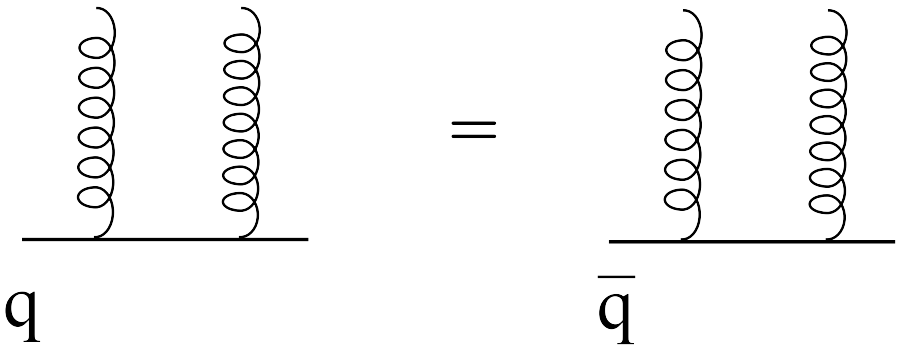

CDF Run 2 Preliminary
Events/bin
30
25
20
15
10
5
0
0
0.2
0.4
0.6
0.8
1
1.2
Mass(di-muon)/Mass(all) (GeV)

The Pomeron

Vacuum quantum numbers $\rightarrow$ colour neutral, C even

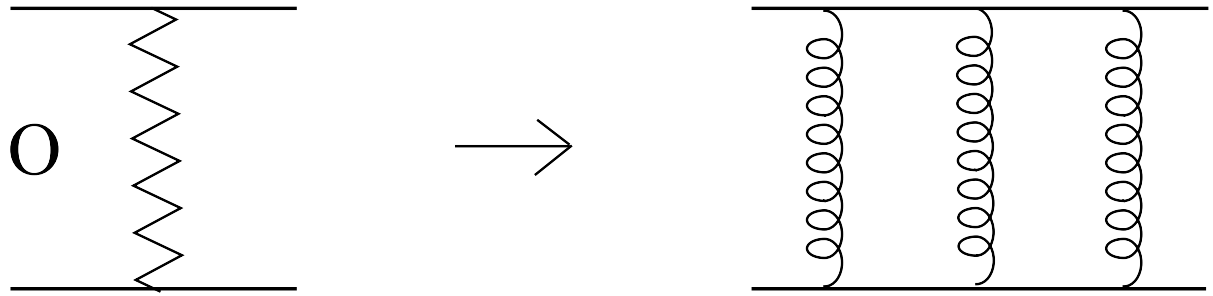


The Pomeron does not distinguish between particle and antiparticle



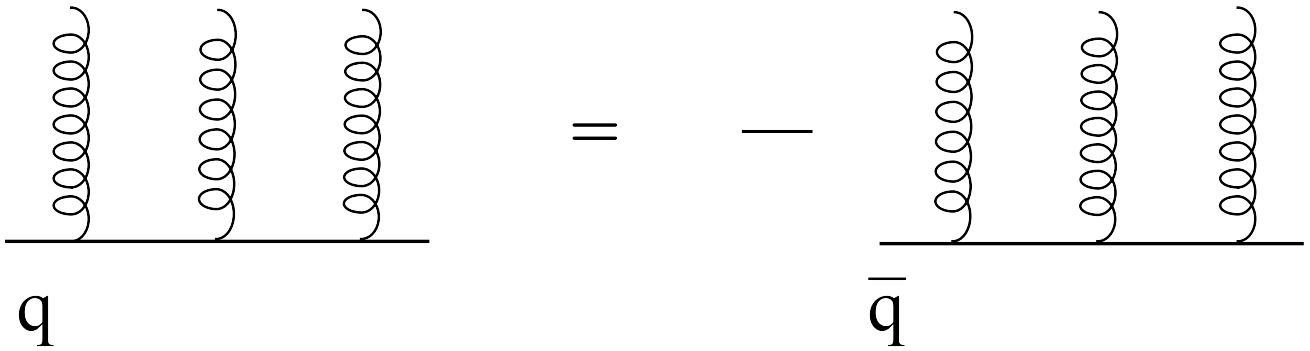
The Odderon

Colour neutral, C odd



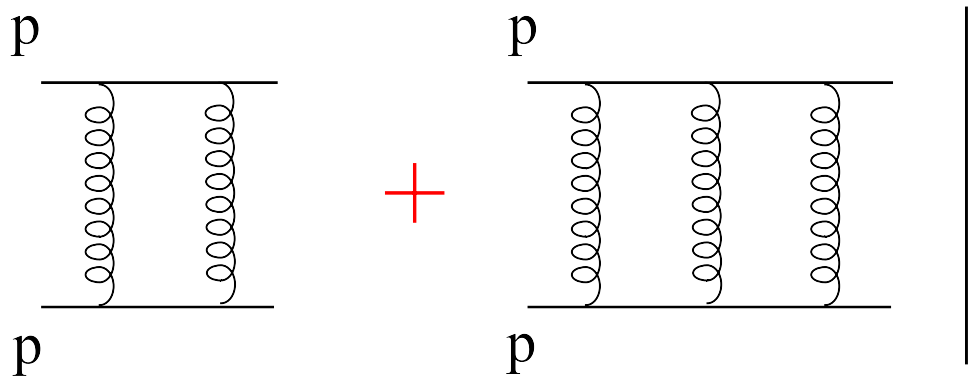
One would expect a suppression by a power of $\alpha_s \Rightarrow O \lesssim P$

The Odderon distinguishes between particle and antiparticle



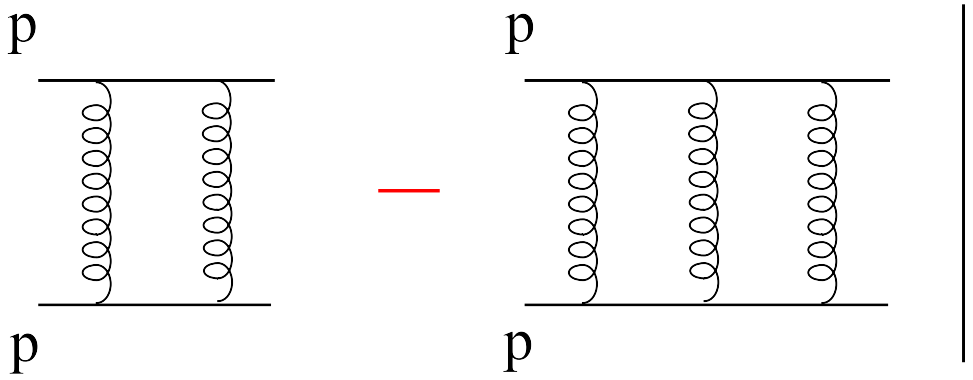
Differential cross sections for elastic pp and $p\bar{p}$ scattering

$$\frac{d\sigma}{dt}\,[pp] \;\sim\; \Big|$$



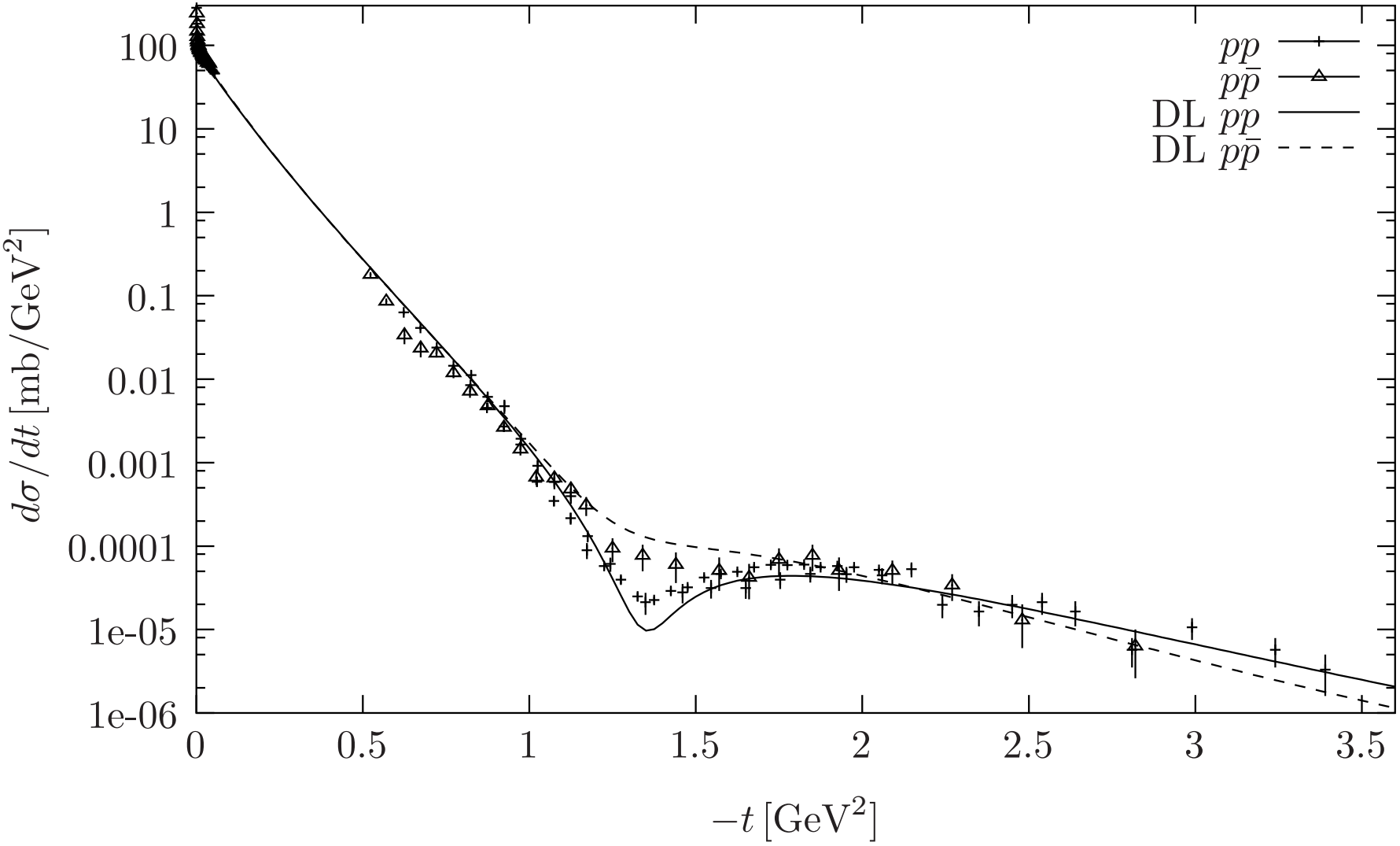
$$\Big|^2$$

$$\frac{d\sigma}{dt}\,[p\bar{p}] \;\sim\; \Big|$$



$$\Big|^2$$

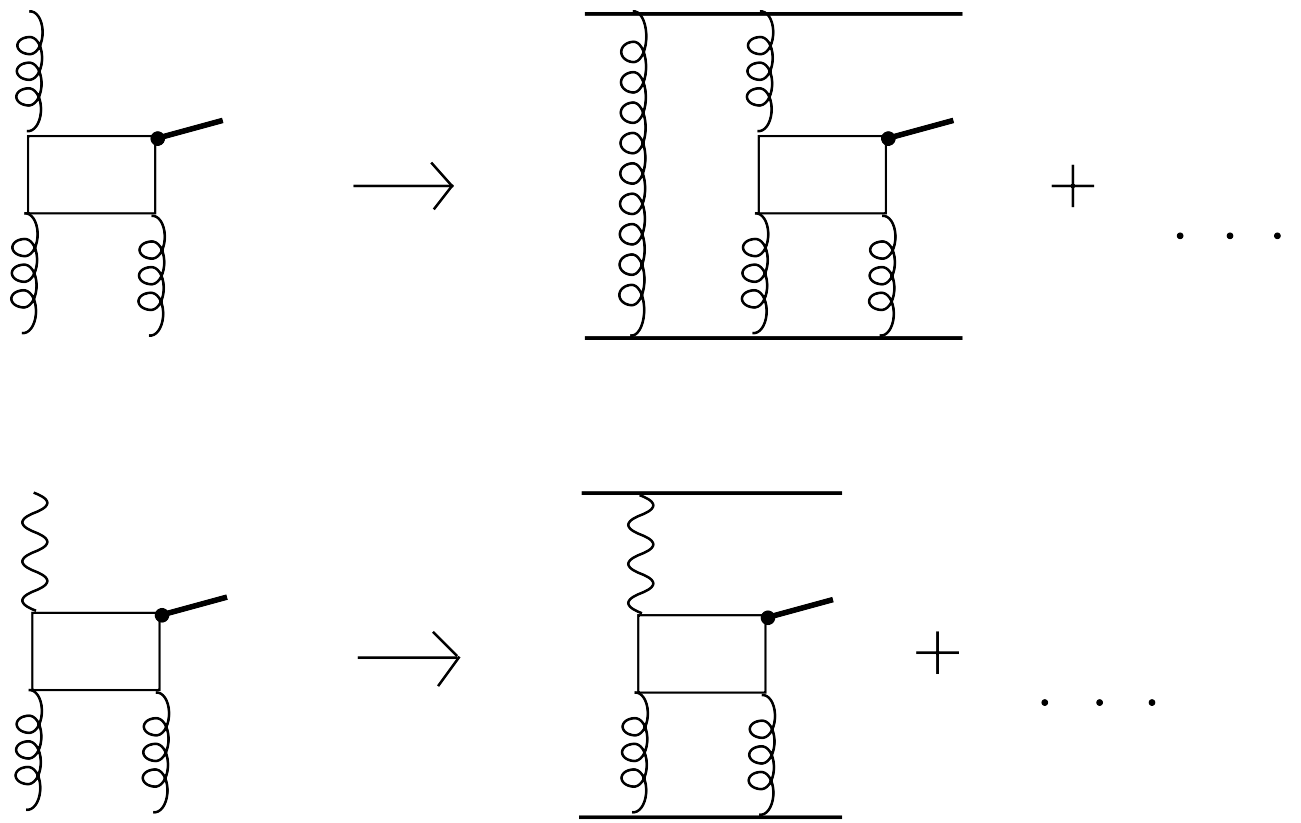
The best but weak evidence for the Odderon - CERN ISR at $\sqrt{s} = 53\,\mathrm{GeV}$



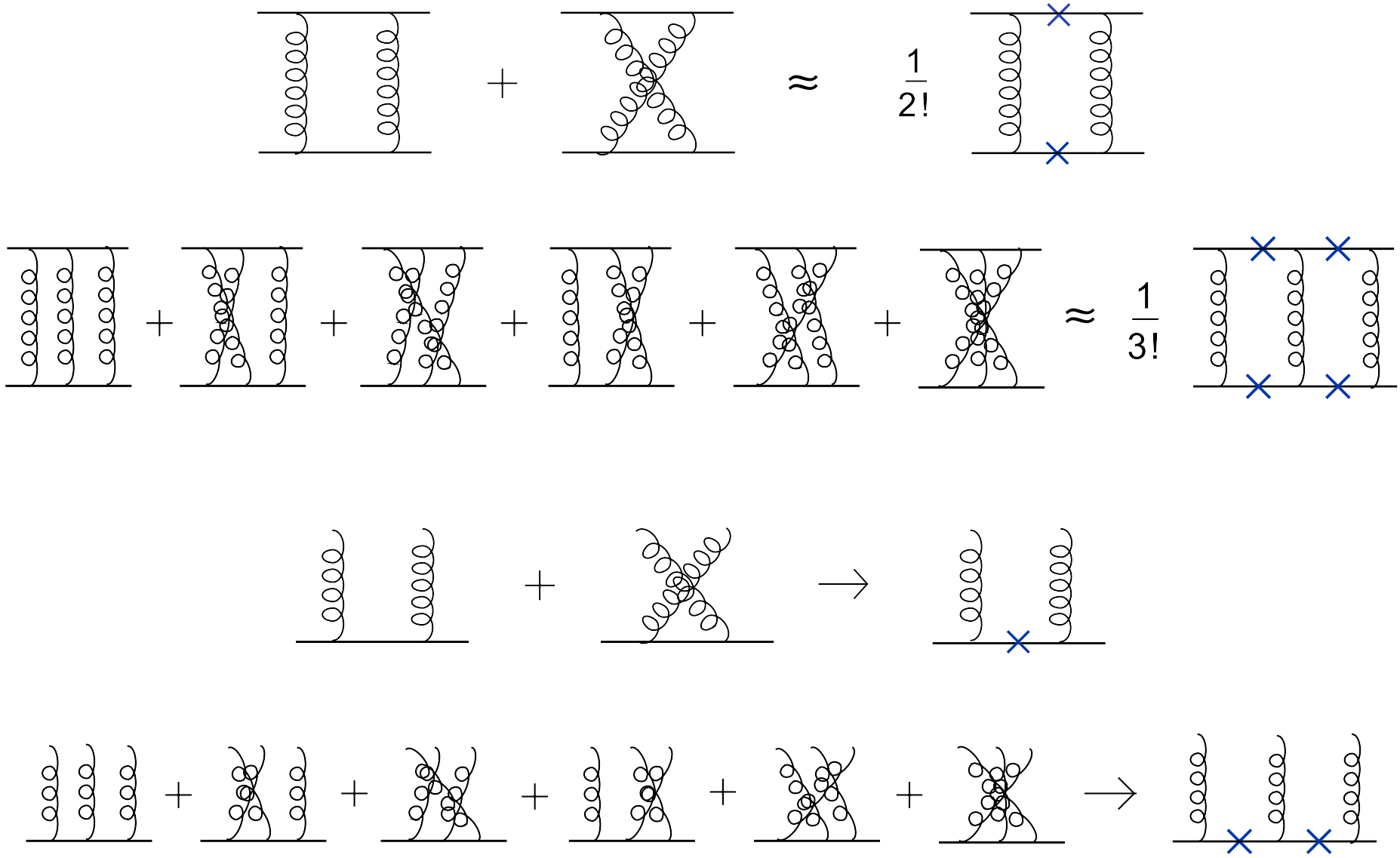
C. Ewerz, hep-ph/0306137

J/ψ in perturbative QCD

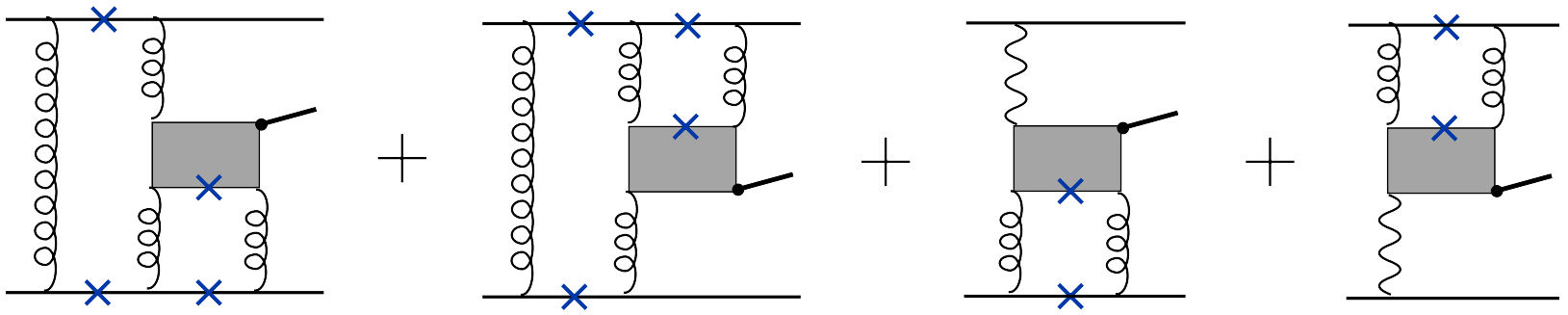
J/ψ is C odd (photon, gluon), $M_{J/\psi} \approx 3$ GeV



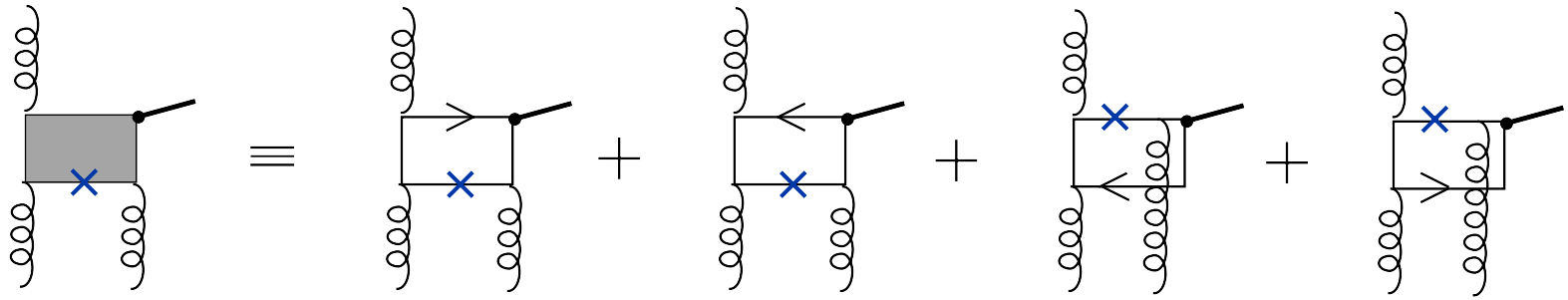
At high energies life is simpler



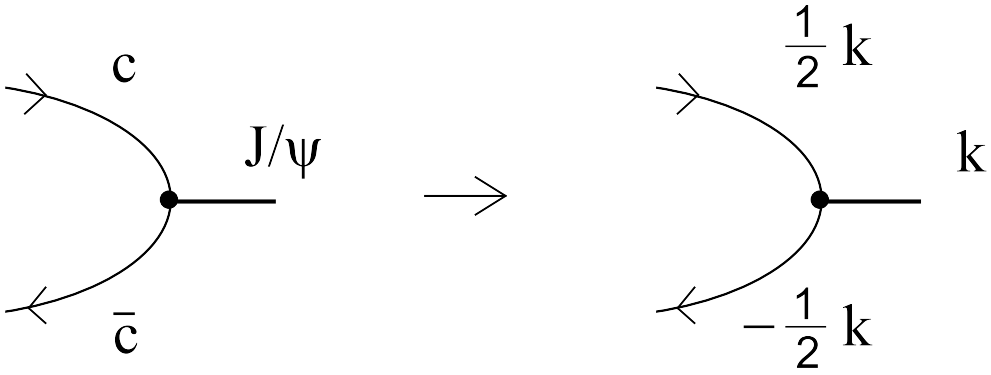
An amplitude ($*2!$) for exclusive J/ψ production reads:

$\mathbf{M} \cdot 2! \; =$ 

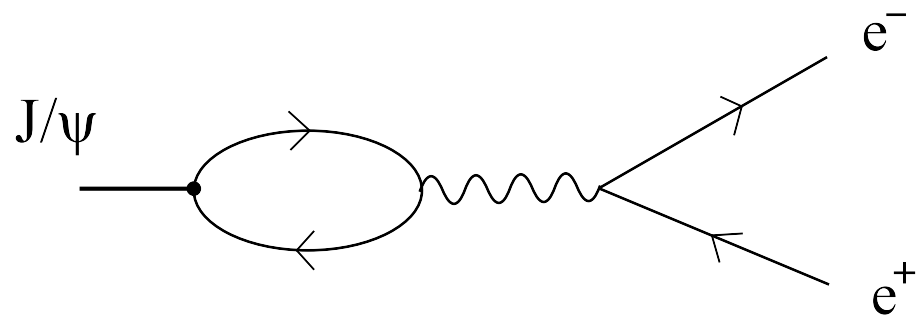
where:



It is enough to apply the collinear non-relativistic approximation

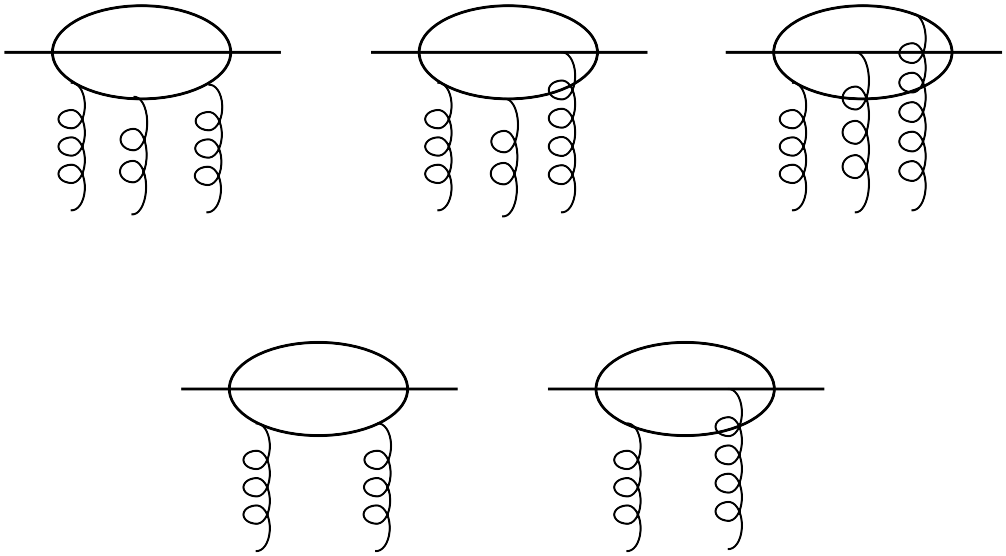


The coupling constant may be expressed in terms of the electronic width $\Gamma^{J/\psi}_{e^-e^+}$ of $J/\psi \longrightarrow e^-e^+$ decay

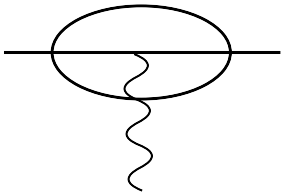


The Fukugita-Kwiecinski's model

We consider the proton as a system of three valence quarks with totally antisymmetric wave function in the colour space



$\frac{G^2}{4\pi}$ originally ≈ 1 (possible ≈ 0.3, Ewerz at al.)



Gap survival factor S^2_{gap}

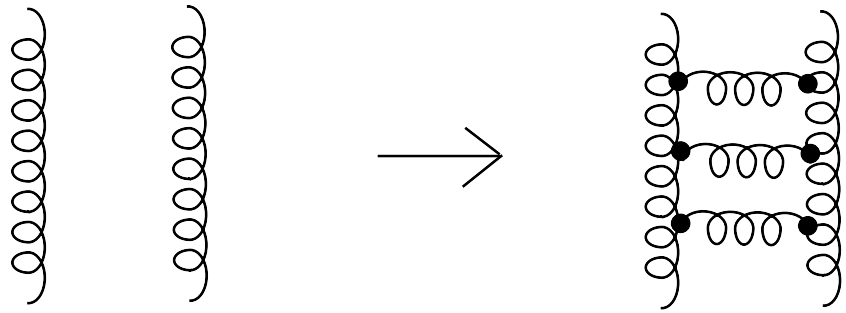
The probability of the gaps not to be populated by secondaries produced in the soft rescattering

Photon, $S^2_{gap} \approx 1$ (mainly from $|t| \approx 10^{-4} - 10^{-2}$ GeV^2)

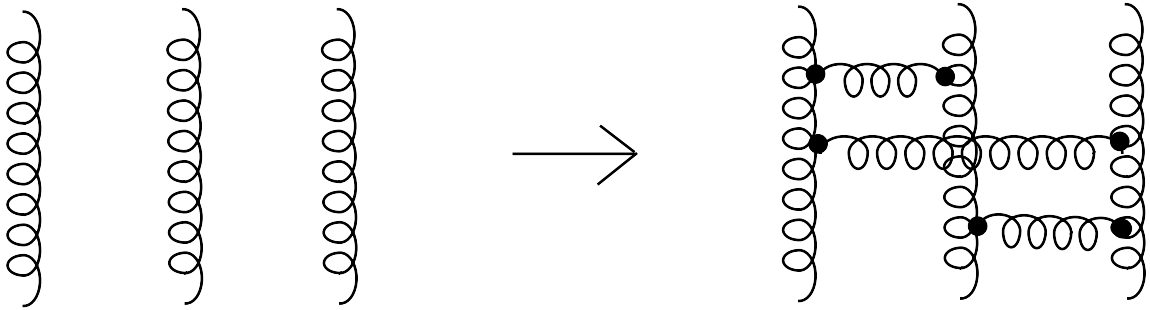
Odderon, $S^2_{gap} \approx 0.05$ for $\sqrt{s} = 1.8$ TeV (KKMR, χ_c)

BFKL evolution, $s^0 \to s^\alpha$

For the Tevatron energy we expect enhancement by a factor ~ 3



BKP evolution



Preliminary results and summary

General remarks

$\sigma_{pp} < \sigma_{p\bar{p}}$

$\frac{d\sigma}{dy}$ weekly depends on the rapidity of the produced J/ψ

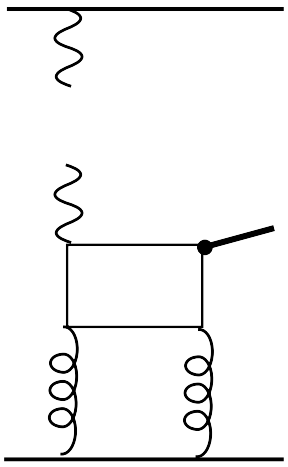
Odderon and photon do not interfere

Our estimations for the Tevatron energy ($p\bar{p}$)

Photon: $\frac{d\sigma}{dy}(y=0) \approx 2.5$ nb

Odderon: $\frac{d\sigma}{dy}(y=0) \approx 0.5 - 3$ nb (coupling)

Photon's contribution may be well estimated in a model independent way from HERA data on $\gamma\ p \to J/\psi\ p$



Weizsäcker-Williams

HERA

For the Tevatron $\Rightarrow$ 3 nb

For $|t_1|\,,\,|t_2| > 0.25$ GeV^2

The Pomeron-Odderon fusion decreases about 10 times

The Pomeron-photon fusion decreases about 200-500 times

Our recipe for the Odderon:

– take proton and antiproton

– collide them at very high energy

– switch off the light

– if you see something, it is the Odderon