Low-x physics: finding renormalonic effects in the BFKL equation

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General topics

- Exclusive central production of heavy quarks at the LHC
  - collinear approx.
  - k_T approx.
- Mueller Navelet jets at NLO
- '$\gamma * \gamma * \rightarrow$ *quarks*' processes
  - rapidity veto effects at LO and NLO
  - including the quark masses
  - different renormalization schemes: $\bar{MS}$, gluon brehmstrahlung
- Renormalons at low Bjorken-x
- ...

Renormalons (I)

- Renormalizable field theories $\Rightarrow$ perturbative series:

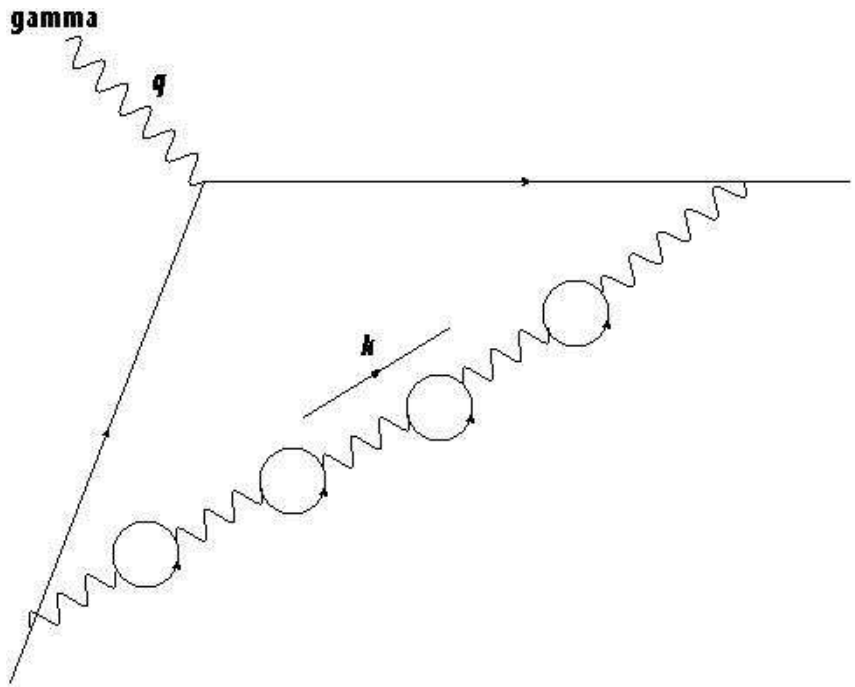
$$\mathcal{R} = \sum_{n=0}^{\infty} r_n \alpha_s^{n+1}$$

- Series valid up to n_0 s.t. $\left| \frac{r_{n_0} \alpha_s^{n_0+1}}{r_{n_0-1} \alpha_s^{n_0}} \right| > 1$

- So: $\mathcal{R} = \sum_{n=0}^{n_0-1} r_n \alpha_s^{n+1} \pm \Delta R$,

  $\Delta\mathcal{R} \sim \left(\frac{\Lambda_{QCD}}{Q} \right)^p \Leftrightarrow$ uncertainty

- $\Delta\mathcal{R} \Leftrightarrow$ non-perturbative information!

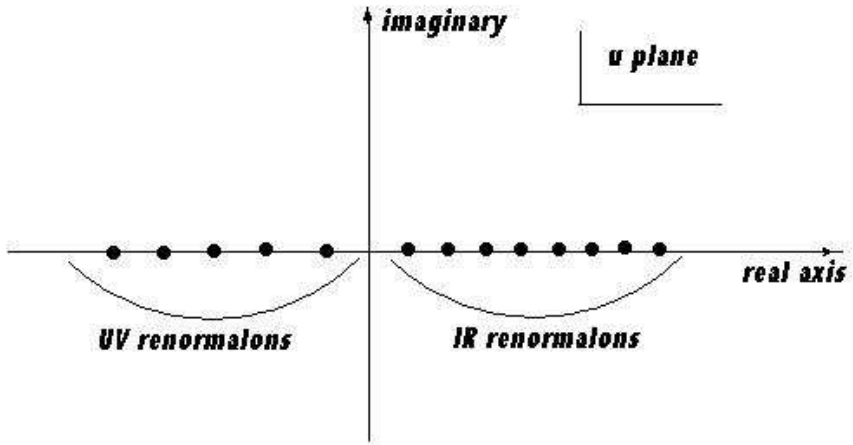


Renormalons (II)

- The diagram shown gives an $n!$ behavior for large n
- Borel transformation:

$$\mathcal{B}[\mathcal{R}](u) = \sum_{n=0}^{\infty} \frac{1}{n!} r_n u^n, \quad \text{s.t.} \quad \mathcal{R} = \int_0^{\infty} du\, e^{-u/\alpha_s} \mathcal{B}[\mathcal{R}](u)$$

- **Borel summable** $\Rightarrow$ well-defined [U+FFFD]orel integral, so no ambiguity found
- **No Borel summable** $\Rightarrow$ ill-defined Borel integral $\Rightarrow$ renormalons



Renormalons (III)

- QCD $\rightarrow$ **IR renormalons**
- Renormalonic chain $\Leftrightarrow$ **running of the coupling!**
- Low-x physics $\Rightarrow$ BFKL evolution equation for the gluon density function
  - BFKL eigenvalue equation: integral equation in k
  - Our aim:

$$\bar{\alpha}_s(q^2) \rightarrow \bar{\alpha}_s(k^2) = \frac{\bar{\alpha}_s(q^2)}{1 + \frac{\beta_0}{4\pi}\alpha_s(q^2)\log\left(q^2/k^2\right)}$$

$\Rightarrow$ extract information about renormalons

Renormalons (IV)

If we are lucky...

- non-perturbative region studied analitically!
- matching between different scales

Observations: (a bit technical...)

- more physical info. than with α_s out of the integral
- state of the art: finding a proper vacuum polarization prescription

THANK YOU!!