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Odderon & all that…

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Tech&Science

Particle Physics: What's an Odderon, and Did CERN Just Reveal It Exists?

By Kastalia Medrano On 2/5/18 at 9:30 AM

What is the Odderon?

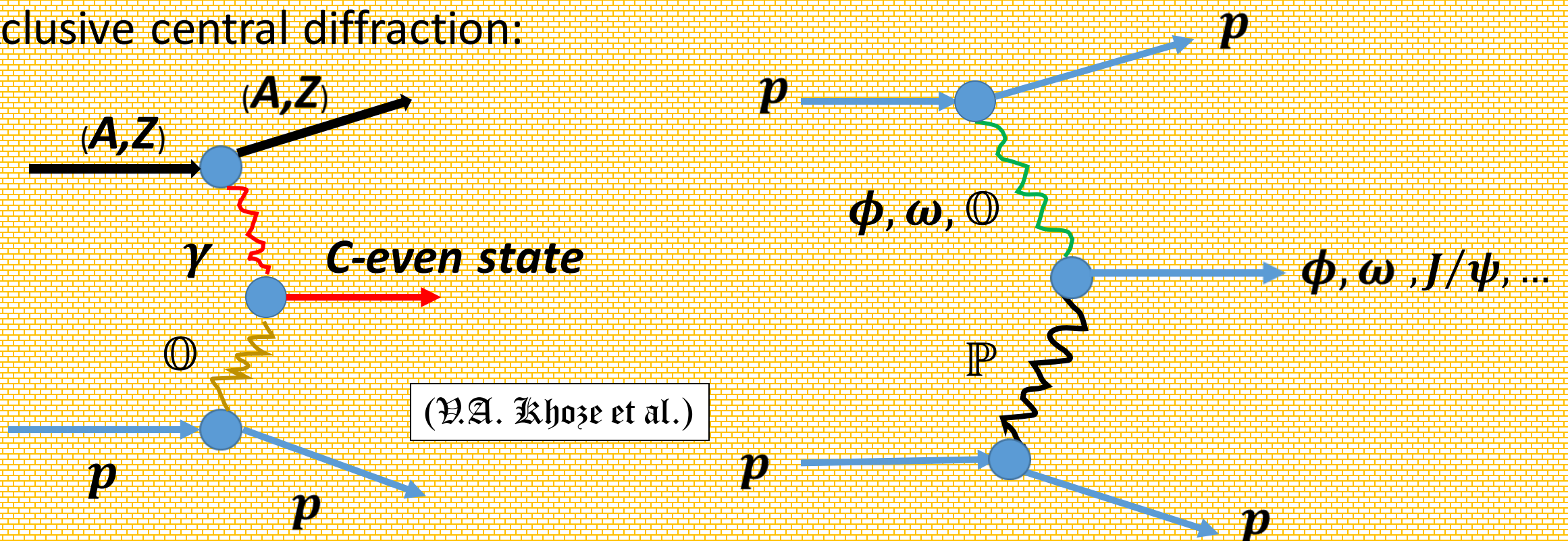
- Odderon is a rightmost singularity $j_{\mathbb{O}}(t)$ of the C-odd part of the scattering amplitude $T^{-}(j,t)$ in complex j-plane with $j_{\mathbb{O}}(0) \leq 1$.
- Odderon is a Regge-pole trajectory $\alpha_{\mathbb{O}}(t)$ of negative signature with the intercept much higher than that of the ω $-$ Reggeon. Intercepts $\alpha_{\mathbb{O}}(0) > 1$ are admitted. Unitarity implies that $\alpha_{\mathbb{O}} \leq \alpha_{\mathbb{P}}$.

In which processes can one hope to detect the Odderon?

- Standard :

$$\Delta\sigma_{\bar{p}p/pp} \qquad d\sigma / dt_{\bar{p}p} - d\sigma/dt_{pp} = 4ReT_+^* T_-$$

- Exclusive central diffraction:



Theory on the Odderon Intercept

$$j_{\mathbb{O}}(0) > 1$$

$$j_{\mathbb{O}}(0) < 1$$

$$j_{\mathbb{O}}(0) = 1$$

pQCD

$$-1 \leq \alpha_{\mathbb{O}}(0) \leq 0.44$$

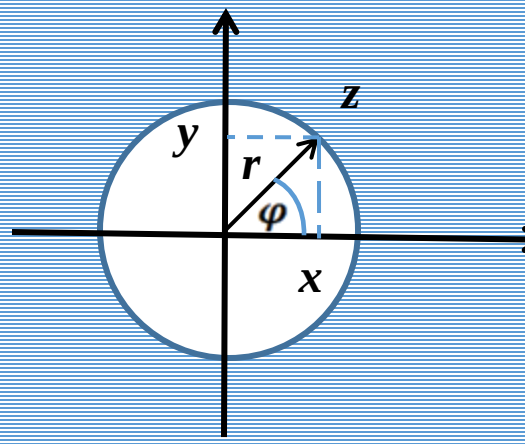
Lattice QCD,

non perturbative QCD Models

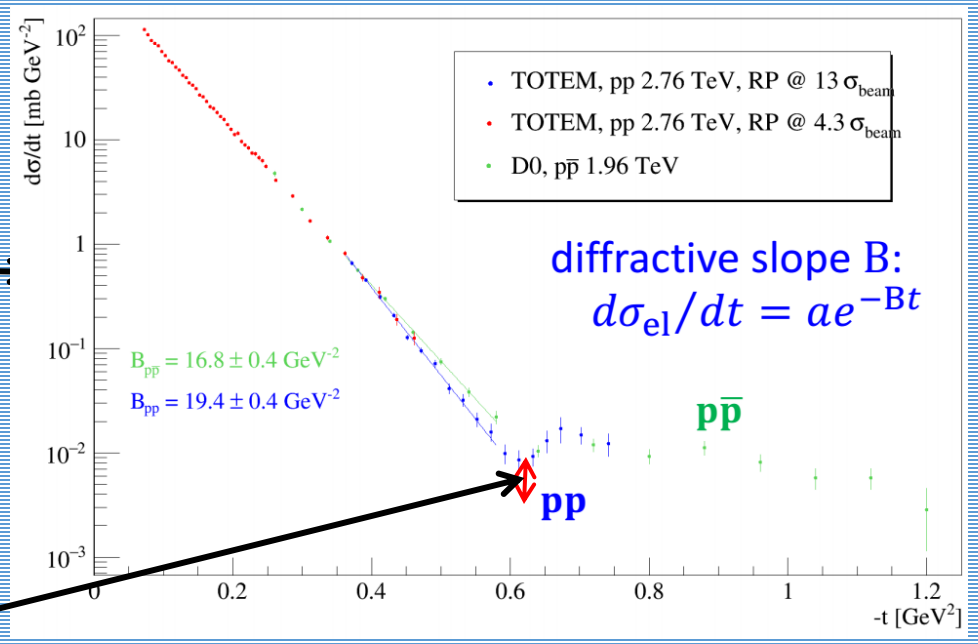
Do we really see the Odderon in the TOTEM 2017 data?

$\rho = Re\,T/ImT$: 50% *model dependent*

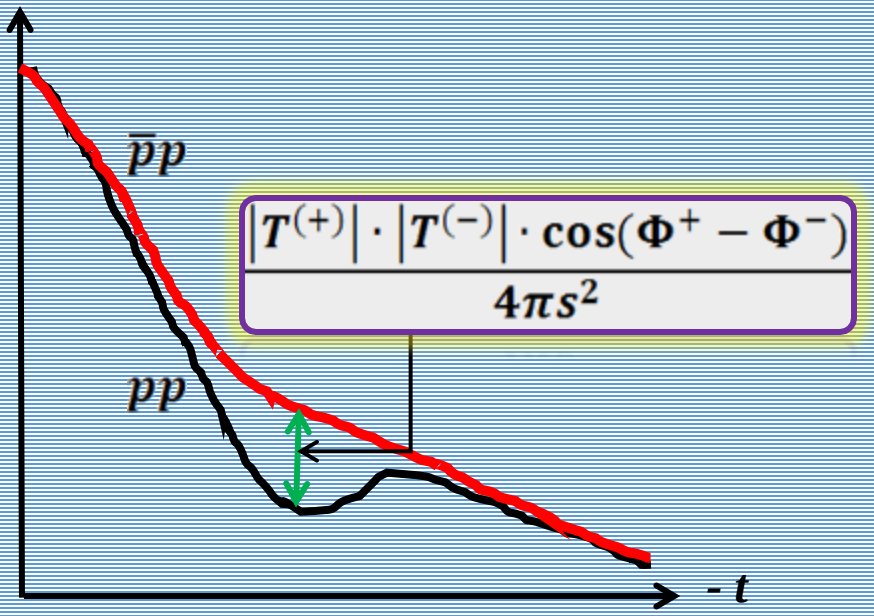
+ Different ways of the CNI treatment



$|z| = |x + iy| = |re^{i\varphi}| = r$



$\mathcal{O}(10^{-2}\,\mathrm{mb/GeV^2})$



$$\frac{|T^{(+)}| \cdot |T^{(-)}| \cdot \cos(\Phi^+ - \Phi^-)}{4\pi s^2}$$

From Kenneth Oesterberg's talk of 28/11/18

On Physical Content of the Maximal Odderon Models

- Early variant (till 2017 inclusively):

$$T^{-}(j,t) = \frac{\beta_{-}(j,t)}{(j-1)^2 - R_{-}^2\, t}$$

  - The problem: $T^{-}(1,t) = T^{\bar{p}p}(1,t) = \frac{g^2}{-t}$

- Modification (since 2018):

$$T^{-}(j,t) = \frac{\cos(\frac{\pi j}{2})\beta_{-}(j,t)}{[(j-1)^2 - R_{-}^2 t)]^{3/2}}$$

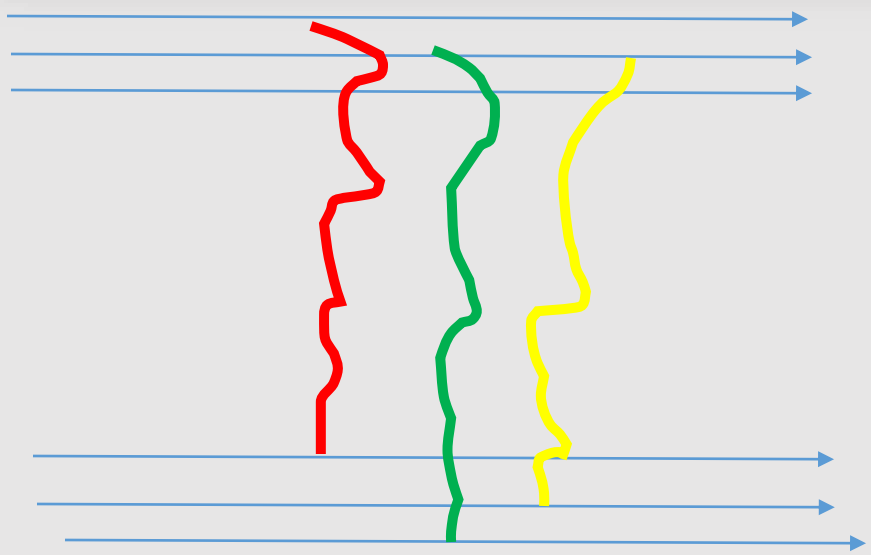
  - A puzzle ?: $T^{-}(j = odd \geq 1, t) = T^{\bar{p}p}(j = odd \geq 1, t) \equiv 0$

$$T^{-}(j = 1, t) = -\frac{\pi}{R_{-}^2}\beta_{-}(1,t)\delta(t)$$

- **Observed TOTEM/D0 difference ⟹ Odderon ⟹ 3g $J^{PC} = 1^{--}$ in QCD !!**

(modulo $\sqrt{s}$ difference D0 @ 1.96 TeV vs TOTEM @ 2.76 TeV)

⟹ implication: tensor nature of QCD & existence of vector glueball !!



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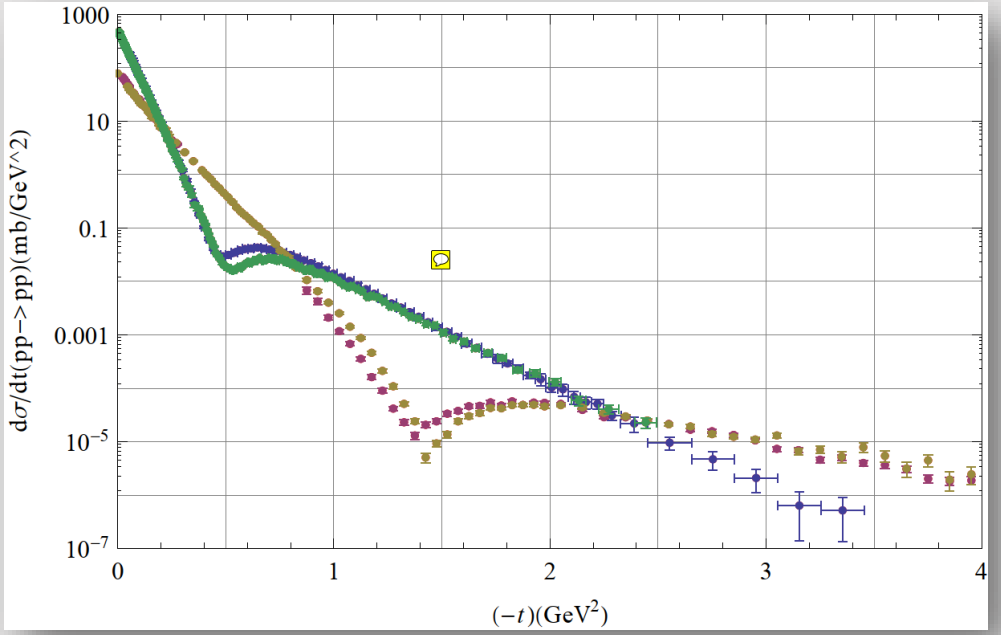


Donnachie-Landshoff: $\frac{d\sigma}{dt}_{pp}\left(-t \geq 2.5\ GeV^2\right) = const$

$World\ Market$: $Options\ for\ \rho$

$B.Nicolescu\&E.Martynov$: $\rho(8) = 0.106, \rho(13) = 0.098$

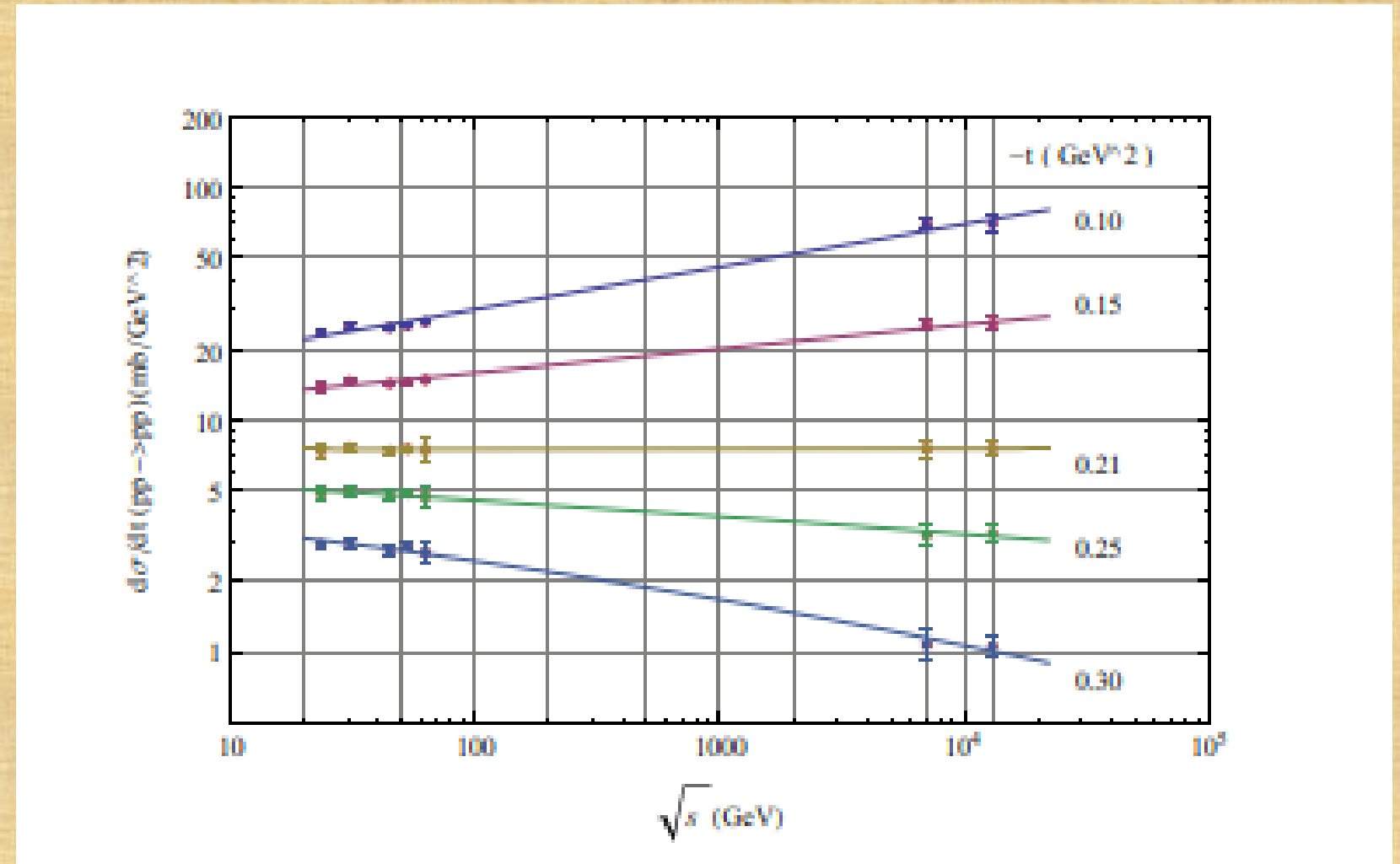
$L.Durand$ & $P.Hu$: $\rho(8) = 0.131, \rho(13) = 0.126$

$S.Pacetti\ et\ al.$: $\rho(8) = 0.136, \rho(13) = 0.134$

$O.Selyugin$ & $J.-R.Cudell.$: $\rho(8) = 0.136, \rho(13) = 0.134$

$V.Khoze\ et\ al.$: $\rho(8) = 0.112, \rho(13) = 0.109$

Quasi Stationarity at $-t \approx 0.21$ GeV^2?



Quasi stationary point: bad news from 2.76 TeV