pp Elastic Scattering in Condensate-Enclosed Chiral-Bag Model at 13 TeV

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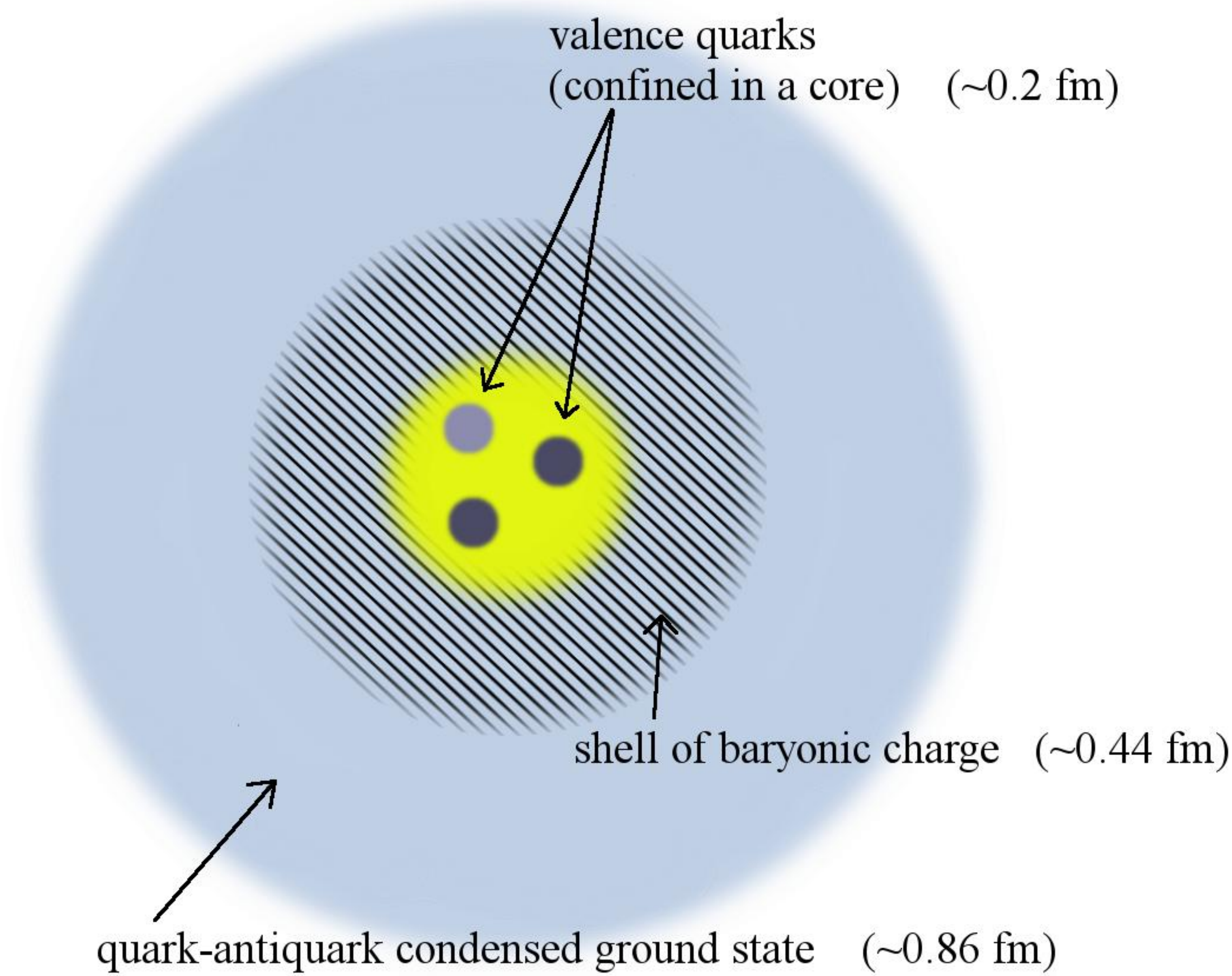
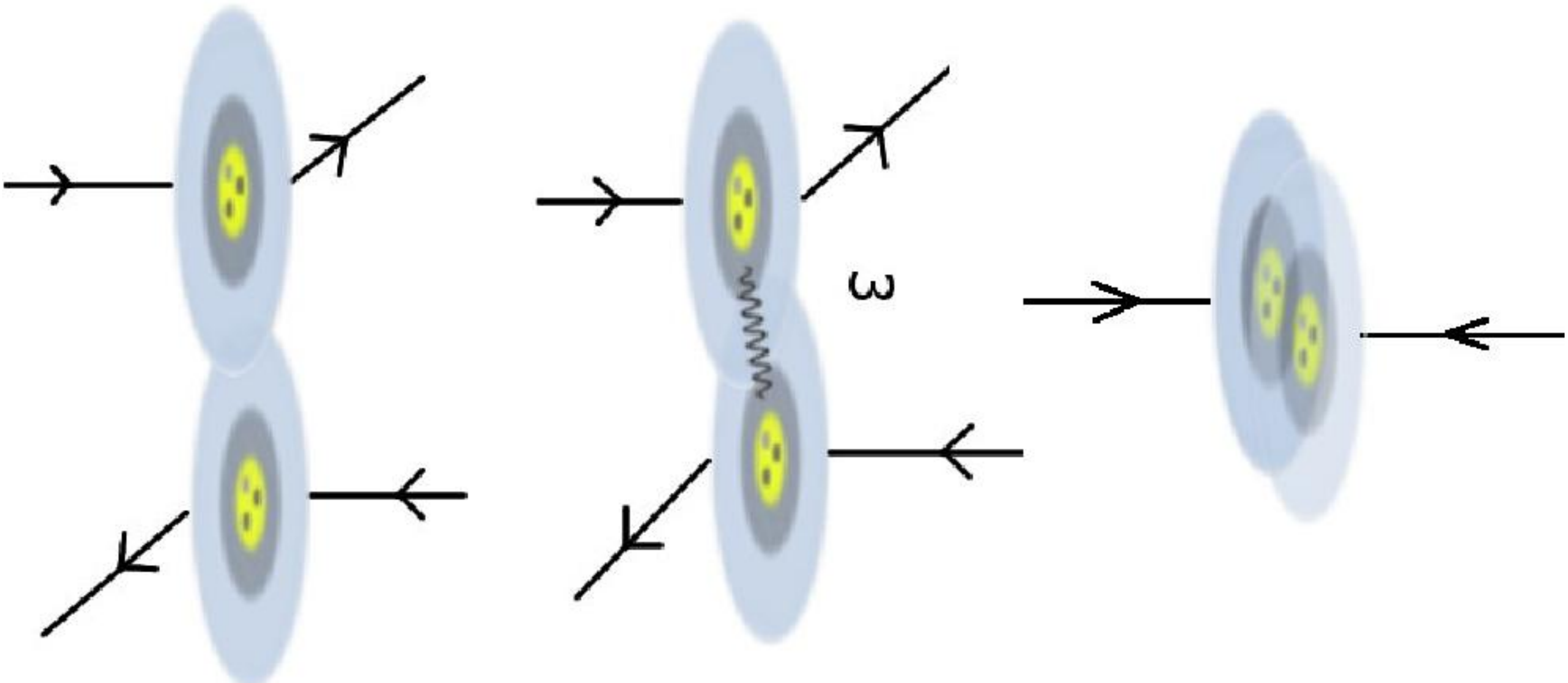


Physical picture of the proton – a Condensate-Enclosed Chiral-Bag

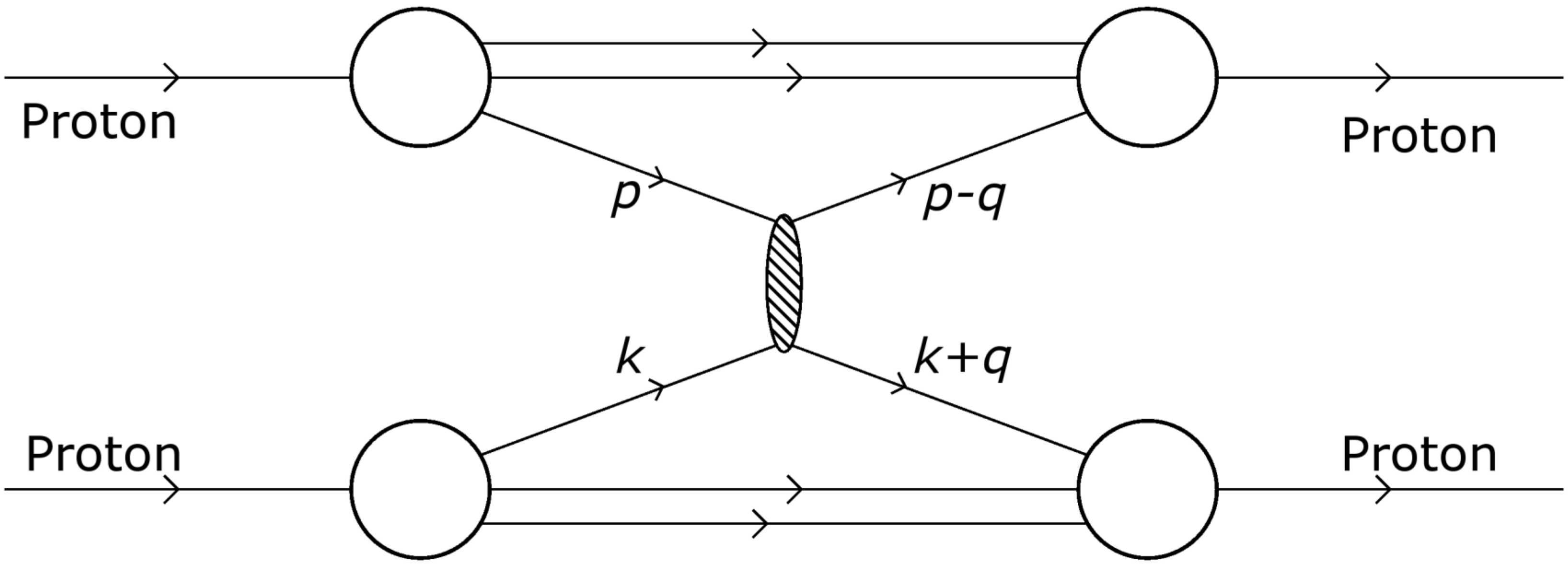


diffraction

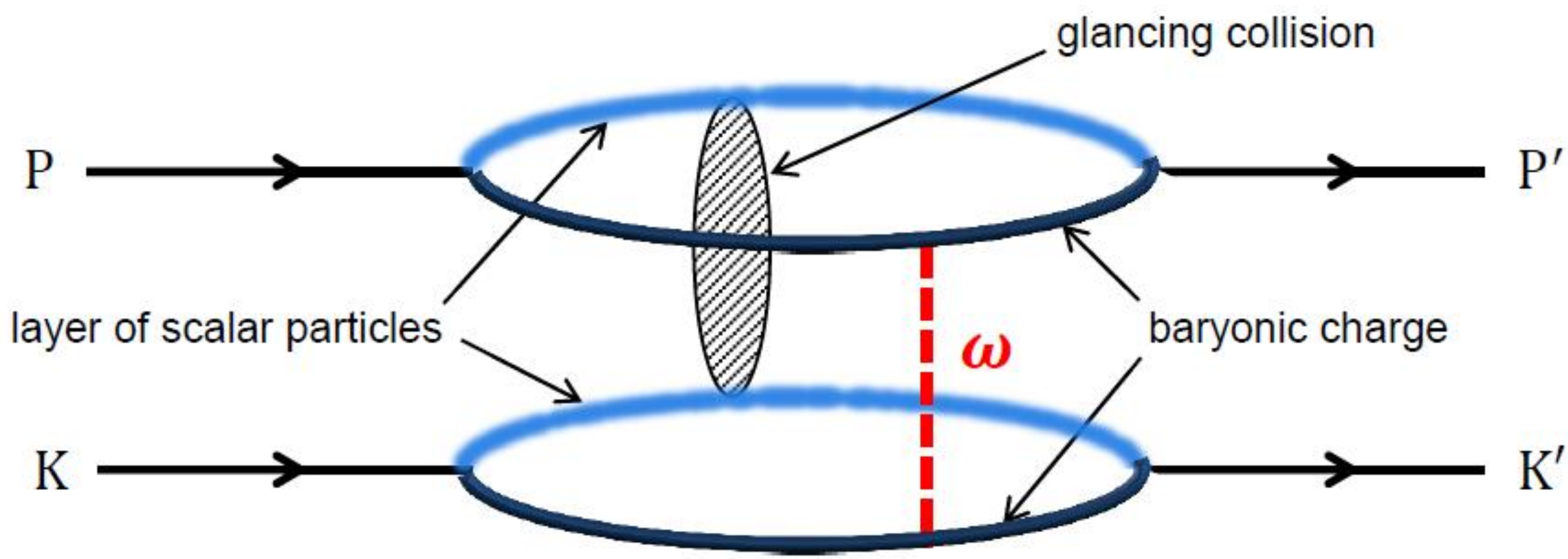
single ω-exchange

short-distance collision ($b \lesssim 0.1$ fm)

Elastic scattering processes



Hard collision of a valence quark from one proton with one from the other proton
(in momentum space)



Single ω-exchange accompanied by a glancing collision of scalar particles of one proton with that of the other (in momentum space)

The diffraction amplitude $T_D^+(s,t)$:

$$T_D^+(s,t) = i\,p\,W \int_0^\infty b\,db\,J_0(b\,q)\,\Gamma_D^+(s,b)$$

Represented by a profile function $\Gamma_D^+(s,b)$:

$$\Gamma_D^+(s,b) = g(s)\left[\frac{1}{1+\exp(b-R)\,/a} + \frac{1}{1+\exp(-(b+R)\,/a)} - 1\right]$$

$g(s)$ is a crossing-even function of s, $R = R(s) = R_0 + R_1(\ln s - i\,\frac{\pi}{2})$ and $a = a(s) = a_0 + a_1(\ln s - i\,\frac{\pi}{2})$

Changing $a(s)$ by $\hat{a}(s) = a_0 + a_1 \ln s$ in the integral over ζ, we obtain

$$T_D^+(s,t) = i\, p\, W\, [\boldsymbol{a_0} + \boldsymbol{a_1}\, (\mathbf{ln}\, \boldsymbol{s} - \boldsymbol{i}\, \tfrac{\boldsymbol{\pi}}{\mathbf{2}})]^2\, g(s) \int_0^\infty \zeta\, d\zeta\, J_0(\zeta\, q\, \hat{a})\, \frac{\sinh r}{\cosh r + \cosh \zeta}$$

and at high energy – $g(s)$ becomes a constant: $g_0 = (1 - \eta_0)\frac{1+e^{-r}}{1-e^{-r}}$

So $T_D^+(s,t)$ leads to

- $\sigma_{tot}(s) \sim (a_0 + a_1 \ln s)^2$, qualitative saturation of the Froissart-Martin Bound
- $\rho(s) = \pi\, a_1/(a_0 + a_1 \ln s)$, ratio of the real part over the imaginary part of the forward scattering amplitude asymptotically
- a crossing-even scattering amplitude, and therefore equal pp and p̄p total cross sections

Combined amplitude due to ω-exchanges and low-x gluon-gluon interaction:

$$T_{\omega+gg}(s,t) = \left[\left(\eta_0 + \frac{c_0}{\left(s\, e^{i\frac{\pi}{2}}\right)^{\sigma}}\right) + i\left(\lambda_0 - \frac{d_0}{s^2}\right)\right]\, i\, p\, W \int_0^{\infty} b\, db\, J_0(b\, q)\, \left[1 - e^{i\,(\chi_{\omega}(s,b)+\chi_{gg}(s,b))}\right]$$

The first two terms on the right-hand-side represent the screening effect.

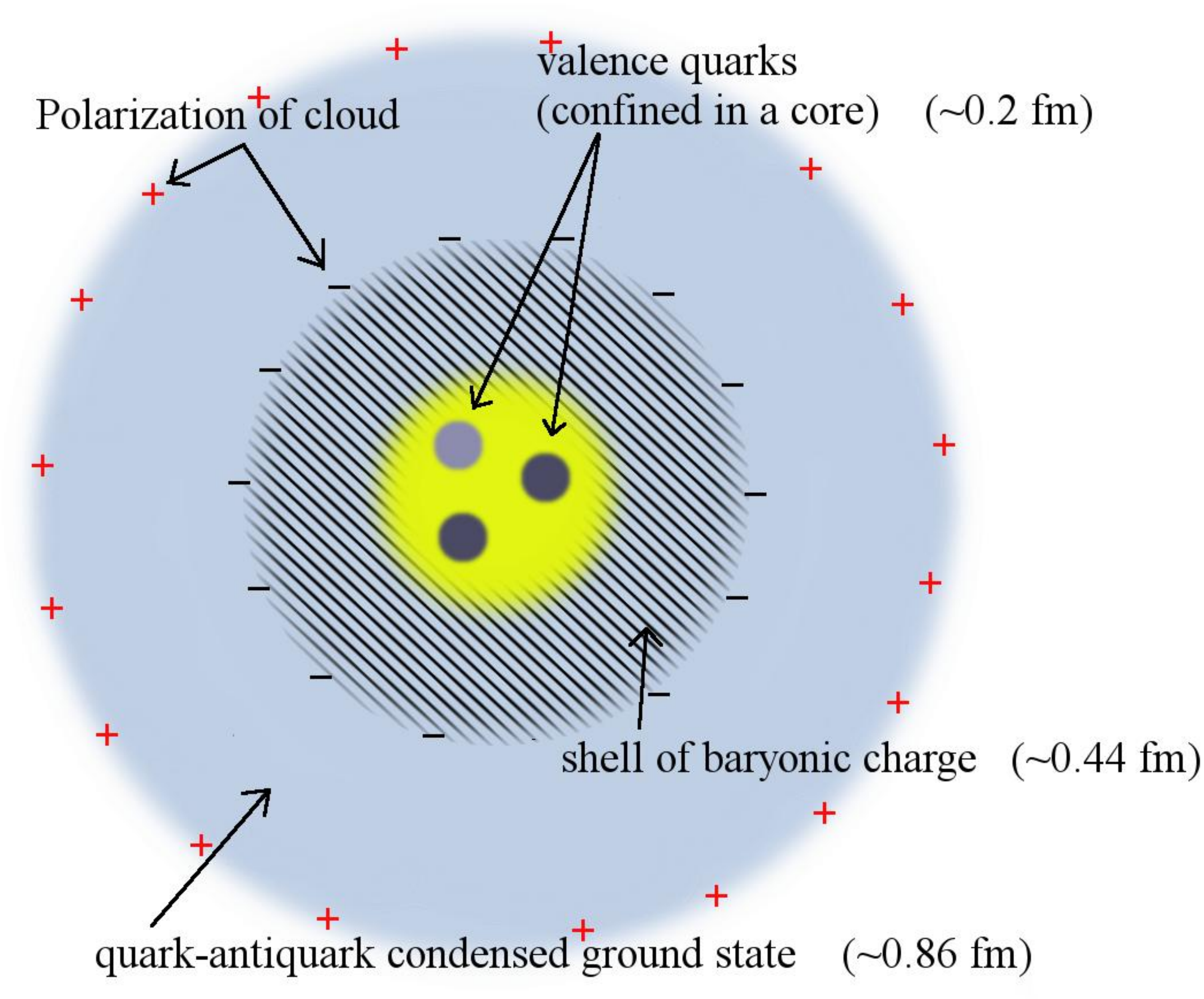
We approximate

$$T_{\omega+gg}(s,t) \simeq \left[\left(\eta_0 + \frac{c_0}{\left(s\, e^{i\frac{\pi}{2}}\right)^{\sigma}}\right) + i\left(\lambda_0 - \frac{d_0}{s^2}\right)\right]\, \left[T_{\omega}(s,t) + e^{i\,\chi_{\omega}(s,\tilde{b})}\, T_{gg}(s,t)\right]$$

$T_{\omega}(s,t)$ is the scattering amplitude due to multiple ω-exchanges;

$T_{gg}(s,t)$ is the gluon-gluon scattering amplitude.

$e^{i\,\chi_{\omega}(s,\tilde{b})}$ is an average value that shows the additional screening of the scattering amplitude $T_{gg}(s,t)$ because of the baryonic-charge shell.



Polarization of the cloud

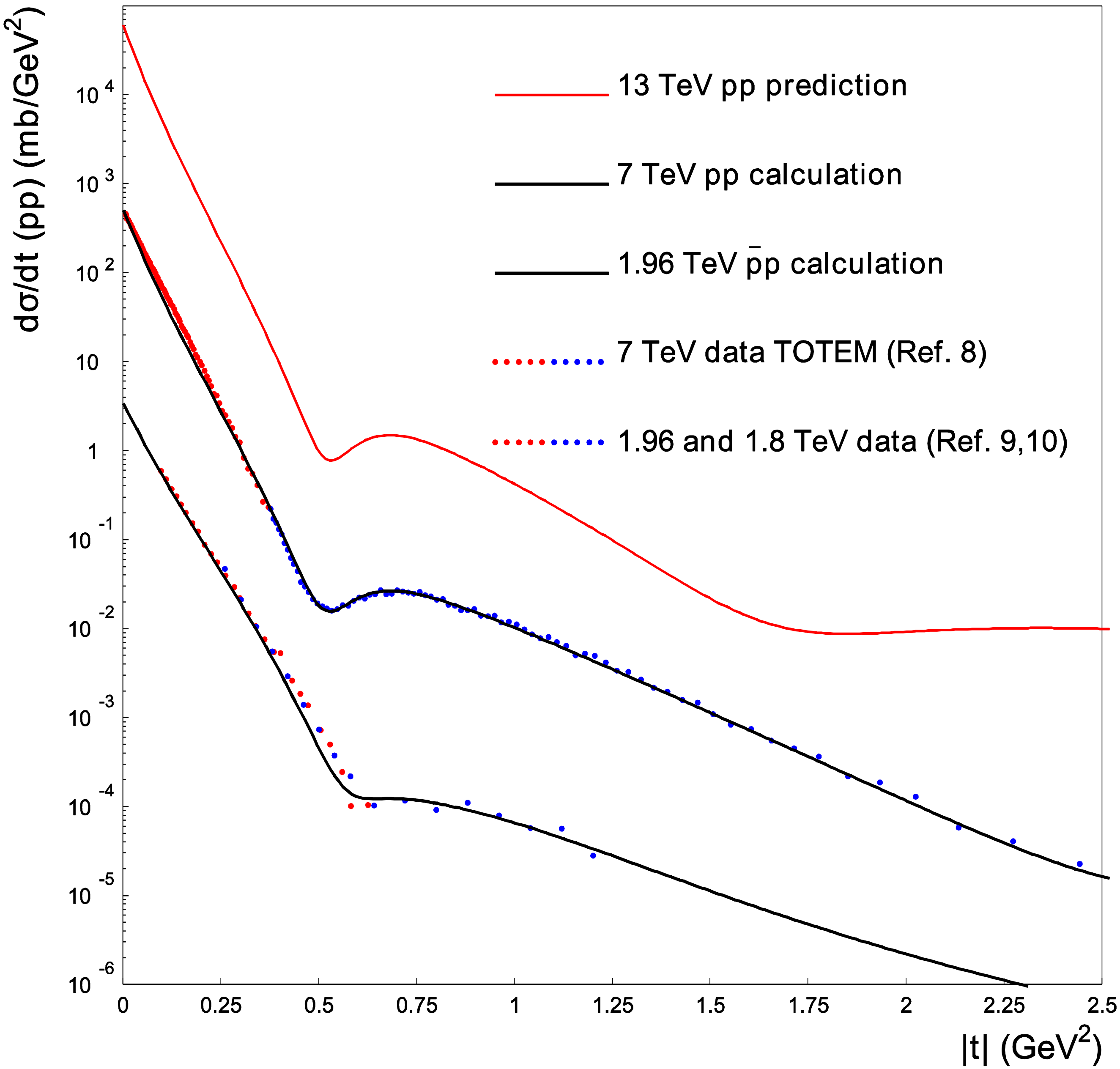
Polarization scattering amplitude $T_{pl}(s,t)$ expressed in terms of a profile function:

$$T_{pl}(s,t) = i\,p\,W\ \int_0^\infty b\,db\ J_0(b\,q)\,\Gamma_{Pl}^{+,-}(s,b); \qquad \text{(pp, }\bar{\text{p}}\text{p)}$$

and we find a suitable profile function:

$$\Gamma_{Pl}^{+,-}(s,b) = \pm\,A\,e^{-b^2/B^2}\,J_0(b\,C), \qquad \text{(pp, }\bar{\text{p}}\text{p)}$$

where A, B and C are three parameters.



Comparison of our $d\sigma/dt$ calculation at $\sqrt{s}$ = 7 TeV with the TOTEM Collab. measurements at LHC [8].
Comparison of our $d\sigma/dt$ calculation at $\sqrt{s}$ = 1.96 TeV with the D0 Collab. measurements[9]; also shown are 1.8TeV data[10].
Our $d\sigma/dt$ prediction at $\sqrt{s}$ = 13 TeV – which is being measured by the TOTEM Collaboration at LHC.

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