Diffractive Electromagnetic Processes from a Regge Point of View

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Motivation: Energy dependence of diffractive e m processes in Hera range: $T = W^{2\lambda}$
For VM production: \( \lambda_Y > \lambda_{J/\psi} > \lambda_\rho \)

Can in Hera Range be very well fitted by two pomerons.

Donnachie Landshoff ...

LHCb, Alice: \( J/\psi \) production in TeV region obtain the same single \( \lambda \) as obtained from HERA data.

Policy: Believe experimentalists

Consequence:
1) Dominance by a single Regge pole

2) Position on pole depends on scale

No contradiction to general principles.

Loss of predictivity. But:
Assume: Position depends only on scale of process.

Even if there are particle poles on the pomeron trajectory for \( t > 0 \), it can be accommodated:

For hadronic scale (determined by confinement): Usual soft pomeron

for smaller scales: deviations for negative \( t \)
Procedure:

From Hera data:

\[ \lambda(Q^2) = \alpha_P(0) - 1 = 0.0481 \log \left( \frac{Q^2 + 0.554}{0.0855} \right), \]

adjusted for \[ \alpha_P(0) = 1.09 \]

**Relate \( Q^2 \) with hadronic size of photon → \( \lambda \left( Q^2(\bar{b}^2) \right) \)**

\[
\rho_{\gamma^*\gamma^*;\pm 1}(Q^2, u, b_{\perp}) = \epsilon_\gamma^2 \frac{6\alpha}{4\pi^2} b_{\perp} \\
\left[ (Q^2u(1-u) + m_f^2)(u^2 + (1-u)^2) K_1^2(eb_{\perp}) + m_f^2 K_0^2(eb_{\perp}) \right],
\]

\[
\rho_{\gamma^*\gamma^*;0}(Q^2, u, b_{\perp}) = \epsilon_\gamma^2 \frac{12\alpha}{4\pi^2} b_{\perp} Q^2 u^2(1-u)^2 K_0^2(eb_{\perp})
\]

**Determine hadronic size of overlap VM - \( \gamma^* \)**

\[
\rho_{\gamma^*,\gamma^*;\pm 1}(Q^2, u, b_{\perp}) = \epsilon_V \frac{\sqrt{6\alpha}}{2\pi} b_{\perp} \phi_{\omega}(u, b_{\perp}) \\
\left[ 4\epsilon b_{\perp} \omega^2(u^2 + (1-u)^2) K_1(eb_{\perp}) + m_f^2 K_0(eb_{\perp}) \right],
\]

\[
\rho_{\gamma^*,\gamma^*;0}(Q^2, u, b_{\perp}) = 16\epsilon_V \frac{\sqrt{3\alpha}}{2\pi} b_{\perp} \omega Q u^2(1-u)^2 K_0(eb_{\perp}) \phi_{\omega}(u, b_{\perp})
\]

**Compare \( \lambda(\bar{b}_{VM}) \) with \( \lambda(\bar{b}_{\gamma^*}) \)**
\[ \delta = 4 \lambda \]

Simple AdS model for Regge slope:

\[ \alpha'_p = \alpha' \frac{\bar{b}^2}{b^2_{\text{conf}}} \]

More detailed comparison later
Alternative model: Energy dependent dipole cross section.

\[ T_{0,\text{pol}} = iW^2 \int_{0}^{\infty} db_{\perp} \int_{0}^{1} du b_{\perp} \sigma_{\text{pol}}(b_{\perp}, u, W) \rho_{\text{pol}}(Q^2, u, b_{\perp}). \]

\[ \sigma_{\text{pol}}(b_{\perp}, u, W) = \sigma_{\text{dip}}(b_{\perp}, u)(W/W_0)^2 \beta_{\text{pol}}(b_{\perp}, u). \]

From data: \( \beta_{\text{pol}} = \beta_{\text{pol}}(\zeta) \)

\[ \zeta = \sqrt{u(1-u)} b_{\perp} \]

\[ \tilde{\beta}_T(\zeta) = 0.0481 \log \left[ \frac{10.47}{\zeta^2} + 6.541 \right] \]

\[ \tilde{\beta}_L(\zeta) = 0.0481 \log \left[ \frac{17.68}{\zeta^2} + 6.530 \right] \]

<table>
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<tr>
<th>( Q^2 ) GeV(^2 )</th>
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The two models give very similar results.

But different singularities in angular momentum plane:
scale dependent Regge pole

\[ T_a = W^{2\lambda(b)} \]

Energy dependent dipole cross section

\[ \sigma_{\text{dip}}(b, u)(W/W_0)^{2\beta_{\text{pol}}(\zeta)} \]

asymptotic behaviour

\[ T_a \sim \left( \frac{W}{W_0} \right)^{\beta_0} L^{-\frac{(4-\epsilon)}{n}} \cdot L = \log \frac{W}{W_0} \]

\[ \beta_0 \text{ is maximum of } \beta(\zeta) \]

Behaviour for finite W depends crucially on form of \( \beta(\zeta) \)