Quark - Antiquark exchange in $\gamma^* \gamma^*$ scattering

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Abstract

The talk is based on a work done in collaboration with Jochen Bartels (`hep-ph/0308181`).

We have considered quark-antiquark exchange in $\gamma^* \gamma^*$ scattering. For the flavor non-singlet channel we have obtained a closed expression for the cross section $\sigma^{\gamma^* \gamma^*}$, valid within the double logarithmic accuracy of pQCD. The result depends on the relevant scales $s \gg Q^2 \geq \mu_0^2$. The infrared cutoff μ_0 is introduced into the analysis as the momentum scale below which nonperturbative physics starts.

One of the central observations is the role of this infrared cutoff μ_0 in the high energy behavior of the total cross section. For large photon virtualities Q^2, there is a region in energy where the internal transverse momenta lie in the hard region, and the result does not depend upon the infrared cutoff. In this region the perturbative analysis is reliable.

We have derived and solved a Bethe-Salpeter-type equation for the scattering amplitude. We have discovered the two distinct kinematical regions: in the first region the resulting amplitude is purely perturbative and is not influenced by the nonperturbative scale μ_0, whereas in the second region, the amplitude is infrared sensitive.

The resummed quark ladder serves as a model for a 'perturbative secondary Reggeon'. It is remarkable that the resulting intercept $\omega_0 \sim 0.5$ is very close to the one known from the high energy phenomenology. The large intercept is due to the fact that the leading contribution is double logarithmic and $\omega_0 \sim \sqrt{\alpha_s}$.

The study of the quark ladder has an obvious phenomenological motivation. The LEP data on $\gamma^* \gamma^*$ are at energies at which the quark box (QPM) still gives a dominant contribution to the cross section. We have shown that the gluon radiation leads to a significant enhancement of the quark box and hence needs to be accounted for.