"Quark parton model, light-cone expansions and virtual \(\gamma\gamma\)-scattering”
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introduction is, in particular, due to some errors or inaccurate statements when using this method in some papers, and too complicated formulas and methods used in other ones. Apart from the known formulas, a number of new results which are useful for experiment are provided, e. g. a simple and convenient method of estimation of the approximation accuracy. A special appendix is devoted to an analysis of a few errors and inaccurate statements contained in papers of Brodsky, Kinoshita and Terazawa (1970), Greco (1971), Cheng and Wu (1971), Bonneau, Gourdin and Martin (1972), etc.

« Hadron production in electron-positron storage rings », a review
V. M. BUDNEV, I. F. GINZBURG,
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Abstract. — This review is devoted to the three general problems: 1. Physics of the process \( \gamma \gamma \rightarrow h \) (hadrons). 2. Methods of extracting the information on the process \( \gamma \gamma \rightarrow h \). 3. The other channels of the hadron production and background.

In the section concerning physics of the process \( \gamma \gamma \rightarrow h \), we limit ourselves to a short consideration of interesting reaction channels and domains of variables (photon « masses » and their summary energy) and review the principal theoretical ideas. The problem of extracting the information on the process \( \gamma \gamma \rightarrow h \) is a central one in the review. Different versions of the experimental set-ups both associated with recording the scattered electrons and without it are considered here in detail. The simple approximate expressions are obtained for corresponding contributions to the cross section. In conclusion, various sources of the background are listed and the corresponding estimates are given.

« The \( \pi \)-meson production in \( e^+ e^- \)-collisions »
V. M. BUDNEV, A. N. VALL
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Abstract. — Here a general solution of the dispersion equation for the s-wave amplitude of the \( \gamma \gamma \rightarrow \pi \pi \) process has been obtained for the case \( \delta(\infty) = \pi \). An arbitrary constant of the solution is fixed by the PCAC requirement.

« Production of pion and muon pairs in \( e^+ e^- \) colliding beams, going out of the limits of equivalent photon approximation »
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Abstract. — The reactions
\[
e^\pm e^- \rightarrow e^\pm e^- \pi^\pm \pi^- (\mu^+ \mu^-)
\]
are considered here in such a set-up, where only pions (muons) are recorded and \( k_i \) total transverse momentum of the pair is not too small (roughly speaking \( m_e \ll k_i^2 \ll m_e^2 \); this domain gives the main contribution to the cross section). In the paper the differential cross sections have been obtained with accuracy of \( \frac{k_i^2}{m_e^2} \left( \ln \frac{k_i^2}{m_e^2} \right)^{-1} \). The amplitudes with the one scalar photon have to be taken into account in this approximation. Besides, the charge asymmetry appears here due to the interference of the two-photon and bremsstrahlung diagrams. It is shown what information on the amplitudes of the reaction and the pion electromagnetic form factor can be obtained from experiment in the given set-up.

« Quark parton model, light-cone expansions and virtual \( \gamma \gamma \)-scattering »
V. L. ChERNYAK, V. G. SERBO
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Abstract. — Here a model like that of Landshoff and Polkinghorne is presented. Within it a method is formulated which allows one for producing an arbitrary number of currents to obtain an expansion when one of the distances is small. The model is applied to the study of the forward \( \gamma \gamma \)-scattering in the region of deep virtuality of one of the photons: \( -q_1^2 \gg m_0^2 \), \( q_2^2 \) is arbitrary (\( q_1 \) and \( q_2 \) are photon momenta)
\[
(q_1 + q_2)^2 = s \ m_0 \sim 1 \ \text{GeV}.
\]
For the absorptive part of the amplitude the following results have been obtained:

a) In the region \( m_0^2 \ll s \ll p^2 \), \( q_1^2 \) the contribution of the box-diagram is dominant, and therefore amplitude is known. The eight independent invariant amplitudes of the process reduce to the two unknown functions in all the other cases. These last ones depend on two combinations of three independent variables \( s, q_1^2 \) and \( q_2^2 \) only.

b) In the region \( s_0 \sim m_0^2 \) these combinations are \( s/m_0^2 \) and \( (q_1^2 - q_2^2)/(q_1^2 + q_2^2) \).
c) In the region \( s \geq q_1^2 \), \( q_2^2/m_0^2 \) these combinations are \( s/q_1^2 \) and \( q_2^2/m_0^2 \).

At \( q_2^2/m_0^2 \gg 1 \) the dependence on only argument \( s/m_0^2 \) is left and at \( s/m_0^2 \gg 1 \) the Regge behaviour takes place.

The two-photon process for particle production
in colliding beam experiments (*)

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Abstract. — A comparison is made, for various two-photon processes (\( ee \rightarrow e\pi^0, e\mu^+\mu^-; e\pi^+\pi^- \)), between an exact calculation on the one hand and two alternative forms of the equivalent photon approximation (namely, the Low formula and the Dalitz-Yennie formula) on the other hand. Angular distributions of the particles produced are considered, as well as total cross sections.

Corrections to equivalent photon approximation
for two-photon processes in colliding beams (*)

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Abstract. — The cross section for the two-photon process \( ee \rightarrow e\gamma \) in colliding electron beams, in the limit \( E \rightarrow \infty \) with \( E^2/s \) fixed (\( E \) being the energy per beam of the colliding electrons of mass \( m \), and \( \sqrt{s} \) the invariant mass of the state \( \Gamma \)) is well known to have a leading term of order \((\ln(4E^2/m^2))^2\). This leading term is given correctly by the well-known Weizsacker-Williams approximation or the equivalent photon approximation. There are sizeable corrections coming from non-leading terms of which the first one, namely, the term of order \((\ln(4E^2/m^2))^3\) has been obtained for an arbitrary hadronic final state \( \Gamma \). The approximations made in getting the Weizsacker-Williams result and the correction terms due to each of them have been exhibited.

The parton model for scattering

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Abstract. — The parton model for the process \( \gamma\gamma \rightarrow \gamma\gamma \) into hadrons is considered. The total cross section in the kinematic region \( s \gg q_1^2, q_2^2 \) is obtained to be a function of a single variable :

\[
\sigma_{\gamma\gamma} = \phi(s/q_1^2, q_2^2), \quad s = q_1^2 + q_2^2,
\]

where \( \phi \) is the photon 4-momenta.

Two-photon processes for particle production
at high energies (*)

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Abstract. — The literature of the past three years on the two-photon process for particle production \( e^+e^- \rightarrow e^+e^- + \gamma + e^- + \gamma \rightarrow e^+e^- + X \)