A suggestion for investigating electron-muon and electron-pion scattering with electron-positron colliding beams
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Absorption of high-energy cosmic photons through double pair production in photon-photon collisions  
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Abstract. — At photon energies above  
\[ 7.2 \times 10^{19} \text{ eV}, \]  
absorption by \( \gamma + \gamma' \to 2e^+ + 2e^- \) dominates that from the lower-order process \( \gamma + \gamma' \to e^+ + e^- \) for high-energy photons traversing a 2.8 K blackbody photon gas. Existence of the \( 2e^+, 2e^- \) process and the cosmic blackbody radiation thus guarantees that the universe is opaque for all photon energies above \( 10^{14} \text{ eV} \). The question of single-pair production in collisions with cosmic radio-wave photons is discussed, and the uncertainty in our knowledge of the important low-frequency end of the radio spectrum is emphasized. Other processes (\( \gamma + \gamma' \to \muons, \) hadrons, etc.) are discussed briefly, and it is concluded that they are of minor importance.

A treatment of meson pair production in \( \gamma\gamma \) collisions including inelasticity and current algebra  
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Abstract. — We have considered two problems posed by dispersive approaches to \( \gamma\gamma \to \pi\pi \) and \( \gamma\gamma \to \KK \) amplitudes, namely the introduction of inelastic unitarity and the ambiguity in partial wave dispersion relation subtractions. Introducing an \((R, \varphi)\) representation for \( \pi\pi \) amplitudes, we have transformed inelastic unitarity into an inhomogeneous Hilbert-Riemann problem, completely defined by one subtractions and by the knowledge of meson-meson partial amplitudes; subtractions have then been fixed imposing off-mass-shell current algebra limits both for one and two massless external mesons. Predictions on the \( S \) wave amplitudes have also been derived from the recent analysis of meson-meson scattering by Protopopescu et al.

The equivalent polarised-photon approximation  
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Abstract. — The equivalent photon approximation is studied for the case where the scattered electron is detected. The equivalent photon is then polarised. The region of validity is found to depend on the virtual photon scattering angle, rather than on the electron scattering angle, and this distinction is important. A discrepancy concerning the dependence on beam energy of the total cross section for \( ee \to ee + \) hadrons which was noted by Bonneau et al. is resolved.

Particular cases of particle production in inelastic lepton (anti) lepton scattering  
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et des Hautes Energies, Paris, France  

Abstract. — As in a previous paper we consider the inclusive reactions \( e + e \to e + e + \) anything in the two photon exchange approximation. We present the complete calculation of the differential cross section \( da/dW^2 \) for the production of a state of effective mass \( W \) and we give the expression of the total cross section. We apply this to the muon pair and the pseudoscalar meson \( (\pi^0, \eta \text{ and } \eta') \) productions.

A suggestion for investigating electron-muon and electron-pion scattering with electron-positron colliding beams  
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Abstract. — We show that it is possible, in principle, to study the scattering between an “almost real” muon or pion and an electron in an \( e^- e^+ \) colliding beam experiment where one large-angle electron and one large-angle muon or pion would be measured.
in the final state. In the muon case, the counting rate should be high enough to allow this experiment to be performed with electron-positron storage rings of the next generation.

**Nuclei as generators of quasi-real photons**

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**Abstract.** — An equivalent photon approximation is tested for the inelastic scattering of high-energy non-hadronic particles (leptons and photons) in the electromagnetic field of nuclei. Coherent, incoherent elastic and incoherent inelastic contributions are included. As for the coherent (Coulomb) term, various nuclei \( ^{235}\text{U}, ^{59}\text{Co}, ^{12}\text{C} \) with different types of form factors are considered. Four processes are considered: a) photoproduction of muon pairs; b) muon bremsstrahlung; c) muon trident production (term with the time-like photon only); d) neutrino-production of a vector boson. The comparison of the approximation with the exact calculation is made for \( d\sigma/dW \), where \( W \) is the invariant mass of the non-hadronic system produced. The approximation works well in general. As an application, we show the full calculation of the muon trident process (except for the correction due to the Pauli principle).