



**HAL**  
open science

# Absorption of high-energy cosmic photons through double pair production in photon-photon collisions

R. Brown, K. Mikaelian, R. Gould

► **To cite this version:**

R. Brown, K. Mikaelian, R. Gould. Absorption of high-energy cosmic photons through double pair production in photon-photon collisions. *Journal de Physique Colloques*, 1974, 35 (C2), pp.C2-124-C2-124. 10.1051/jphyscol:1974233 . jpa-00215543

**HAL Id: jpa-00215543**

**<https://hal.science/jpa-00215543>**

Submitted on 4 Feb 2008

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

(where  $X$  is any  $C = +$  state) or

$$p + p \rightarrow X_1 + \gamma^* + X_2 + \gamma^* \rightarrow X_1 + X_2 + \mu^+ + \mu^-$$

(where  $X_1, X_2$  are hadron states) is reviewed in some detail. Both the theoretical aspects and the experimental feasibility of various processes are discussed especially for experimentalists' convenience.

#### Absorption of high-energy cosmic photons through double pair production in photon-photon collisions

R. W. BROWN and K. O. MIKHAELIAN

Department of Physics,  
Case Western Reserve University,  
Cleveland, Ohio 44106, USA

and

R. J. GOULD

Department of Physics,  
University of California at San Diego,  
La Jolla, California 92037, USA

**Abstract.** — At photon energies above

$$7.2 \times 10^{20} \text{ eV},$$

absorption by  $\gamma + \gamma' \rightarrow 2e^+ + 2e^-$  dominates that from the lower-order process  $\gamma + \gamma' \rightarrow e^+ + e^-$  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  $10^{14}$  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 ( $\gamma + \gamma' \rightarrow$  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

P. GENSINI

Istituto di Fisica dell'Università, Lecce

**Abstract.** — We have considered two problems posed by dispersive approaches to  $\gamma\gamma \rightarrow \pi\pi$  and  $\gamma\gamma \rightarrow K\bar{K}$  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 subtraction 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

C. J. BROWN and D. H. LYTH

University of Lancaster,  
Department of Physics,  
Lancaster, UK

**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  $e\bar{e} \rightarrow e\bar{e} +$  hadrons which was noted by Bonneau *et al.* is resolved.

#### Particular cases of particle production in inelastic lepton (anti) lepton scattering

G. BONNEAU and F. MARTIN

Laboratoire de Physique Théorique  
et des Hautes Energies, Paris, France

**Abstract.** — As in a previous paper we consider the inclusive reactions  $e + e \rightarrow e + e +$  anything in the two photon exchange approximation. We present the complete calculation of the differential cross section  $d\sigma/dW^2$  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 ( $\pi^0, \eta$  and  $\eta'$ ) productions.

#### A suggestion for investigating electron-muon and electron-pion scattering with electron-positron colliding beams

C. CARIMALO, P. KESSLER and J. PARISI

Laboratoire de Physique Atomique,  
Collège de France, Paris, France

**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