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It is shown that the recent DESY experiment in which a photon was produced by interaction of a high-energy photon with a nucleus can be interpreted as the process $\gamma Z \rightarrow Ze^+e^-\gamma$. Expressions are presented for the angular distribution of the photons emitted in this process.

An experiment was recently performed with the DESY accelerator [1], in which elastic and inelastic scattering of a high-energy photon ($\omega_0 \gg m_e$) in the field of a nucleus was investigated. The hypothesis assumed in [1] was that the experimentally observed excess of photons with frequencies $\omega < \omega_0$ is due to the disintegration of the photon into two photons in the field of the nucleus

$$\gamma + Z \rightarrow \gamma\gamma + Z. \quad (1)$$

As shown in [2], however, the calculation of the cross section of the process (1) under the conditions of the experiment of [1] ($\omega_0 = 1.7, 3.5, 6.1$ GeV, $\omega = 0.87 \omega_0$, photon emission angle in the lab $\theta = 1 - 3$ mrad) leads to a value smaller than the experimental one by approximately two orders of magnitude. Therefore the observed excess of photons having a frequency ω lower than the limiting value cannot be attributed to the process (1) in any way. On the other hand, by analyzing the background processes accompanying (1) (production of secondary photons by electrons and positrons produced in the medium, Compton and Delbruck scattering, the process $\gamma + Z \rightarrow \pi^0_{2\gamma} + Z$), the authors did not take into account the possibility of photon emission following production of the e^+e^- pair in the single-act process

$$\gamma + Z \rightarrow e^+e^-\gamma + Z, \quad (2)$$

which is illustrated by the diagram of Fig. 1. The cross section of this process, like the cross section of (1), is proportional to Z^2 in the Born approximation, but contains $\alpha = 1/137$ raised to one less power.

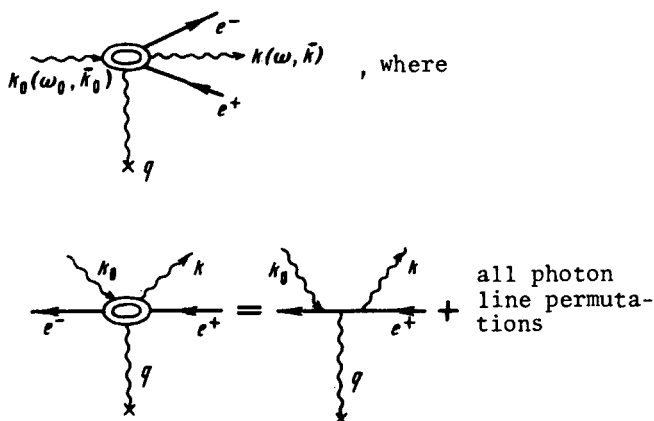


Fig. 1

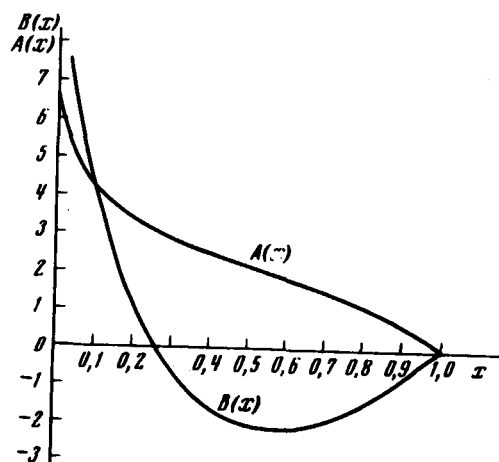


Fig. 2

At high energies ($\omega_0 \gg m_e$), the cross section of the process (2) can be calculated with logarithmic accuracy with the aid of the method of equivalent photons

$$d\sigma = \frac{Z^2 \alpha}{\pi} L \int \frac{ds}{s} \gamma d\sigma_{\gamma\gamma}(s, \gamma, \omega_0, \omega, \theta), \quad (3)$$

where $d\sigma_{\gamma\gamma}$ is the cross section of the process $\gamma\gamma \rightarrow e^+e^-\gamma$, $s_\gamma = (k_0 + q)^2$ is the invariant mass of the system $e^+e^-\gamma$. The quantity L , in the case of a screened Coulomb field, is given by

$$L = \int_{\Delta_{\min}^2}^{\Delta_{\max}^2} \frac{d\Delta^2}{\Delta^2} [1 - F(\Delta^2)]^2, \quad \Delta^2 = -q^2, \quad (4)$$

$F(\Delta^2)$ is the form factor of the atomic electrons.

To find the cross section $d\sigma_{\gamma\gamma}$ we use the results of [3] and obtain, after rather cumbersome calculations, an expression for the angular distribution of the photons emitted in the process (2). In the angle range $m_e/\omega \ll \theta \ll 1$ of interest to us, this distribution can be represented in the form

$$d\sigma / \frac{d^3k}{\omega} = \frac{Z^2 \alpha^4 x}{\pi^2 (k_\perp)^4} L \left\{ A(x) \ln \frac{k_\perp^2}{m_e^2} + B(x) \right\}, \quad (5)$$

$$k_\perp = \theta \omega_0 x, \quad x = \omega / \omega_0.$$

The quantities $A(x)$ and $B(x)$ are shown in Fig. 2. The analytic expressions for the functions $A(x)$ and $B(x)$, and also the details of the calculation of the cross section of the process (2), will be published elsewhere [4]. The solid curves of Fig. 3 show the photon emission cross sections calculated from formula (5) at $x = 0.87$ and $\omega_0 = 1.7, 3.4$, and 6.1 GeV, and at $\theta = 1 - 3$ mrad. The value of L was calculated with a form factor in the Thomas-Fermi model (e.g., [5]); $\Delta_{\min}^2 = (k_\perp^2 / 2\omega_0(1-x))^2$, and $\Delta_{\max}^2 = k_\perp^2$. The figure shows also the experimental results of [1]. We see that formula (5) agrees fairly well with the data of [1], although the experimental points are on the average 20 - 30% lower than the theoretical curves. It should be noted, however, that by modifying somewhat the procedure of separating the events, namely by recognizing that the photon emission cross section is proportional to $(1-x)$, the authors of [1] obtained for the corresponding cross sections values that were approximately 25% lower than those in Fig. 3.

In conclusion, we wish to emphasize that in our opinion the excess of photons with $x = 0.87$, which was observed in [1], can be attributed to the process (2) and has no bearing on the photon splitting (1).

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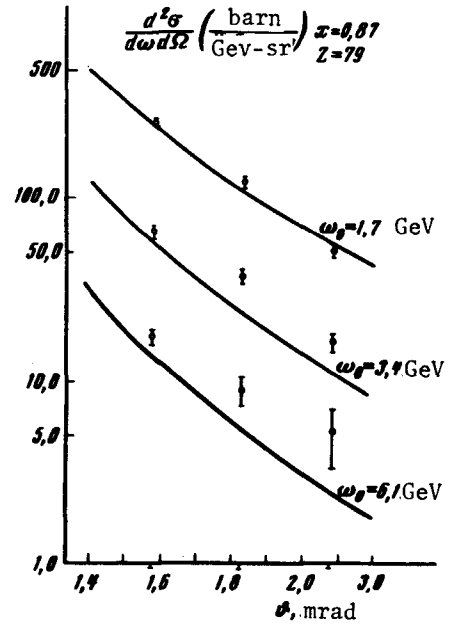


Fig. 3