ABOUT THE POSSIBILITY TO MEASURE THE CIRCULAR POLARIZATION OF HIGH-ENERGY PHOTON IN REACTION $\gamma + e^- \to e^+ + e^- + e^-$

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Two possibilities of the measuring high-energy photon circular polarization by means of the process $\gamma + e^- \to e^+ + e^- + e^-$ are investigated. The first one is connected with the measurement of polarization asymmetry of the cross section when the initial electron beam is longitudinally polarized. The second possibility related with the measurement of the created-positron (or electron) polarization. Just this polarization does not decrease when the photon energy grows up and can be used for effective determination of the photon circular polarization degree.

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1. INTRODUCTION

It is well known that the azimuthal asymmetry in the process of triplet production

$$\gamma(k) + e^-(p) \to e^-(k_1) + e^+(k_2) + e^-(p_1) \qquad (1)$$

by the high-energy polarized photons on the atomic electrons can be used to measure the photon linear polarization degree (see review [1] and references therein). This single-spin effect lies on theoretical footing of polarimeters where the different angular and energy distributions are used [2].

The circular photon polarization in the region of small and intermediate energies can be probed by the effects due to double-spin correlation in Compton scattering. For example, in Ref. [3] the corresponding possibility is considered, connected with the Compton cross-section asymmetry at scattering of photon on polarized electrons. In principle, one can also measure the polarization of the recoil electron. The double-spin effects may be used to create polarized electron beams using the laser photons [4].

At high energies of photons the use of Compton scattering is not efficient because the Compton cross-section decreases with the growth of an energy. If the photon energy is large, the cross-section of the pair production becomes larger than the Compton scattering one. To estimate the respective energy one can use the asymptotic formulas for the total cross-sections [5]:

$$\sigma_C \approx \frac{2\pi r_0^2}{x}\ln x\,, \quad \sigma_{pair} \approx \frac{28\alpha r_0^2}{9}\ln x\,, \qquad (2)$$

$$x = \frac{s}{m^2}\,, \quad s = (k+p)^2\,, \quad \alpha = \frac{1}{137}\,,$$

where r_0 is the classical radius of electron and m is the electron mass. In the rest system of the initial electron ($s \approx 2\omega m$) the photon energy ω has to be larger than about $80m$. Thus, to measure the circular polarization of photons with the energies more than $100m$ it is advantageous to use the process (1) rather than Compton scattering.

The cosmic rays can contain very high-energy photon component, and analysis of their polarization is very important to understand the remarkable features of the cosmologically distant gamma ray bursts.

In the case of the circular polarization of the photon, the cross-section of the process (1) is sensitive to it if either the initial electron is polarized or the polarization of the created electron (positron) is measured. Below we consider both respective experimental setups which can be realized in the scattering of the photons on unpolarized atomic electron or in the collision of photons with the beams of polarized electrons.

In our calculation, at the high energies, we take into account only so-called Borselino diagrams [6] which correspond to the one-photon exchange in the t-channel between the target electron and created electron-positron pair.

2. DIFFERENTIAL CROSS-SECTION

The high-energy differential cross-section of the process (1) in the case of polarized photon and longitudinally polarized initial electron beam can be written in the form:

$$d\sigma = \frac{e^6}{2(2\pi)^5 s q^4} V^{\mu\nu} B_{\mu\nu} d\Phi\,, \qquad (3)$$

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$$d\Phi = \frac{d^3k_1}{2E_1}\frac{d^3k_2}{2E_2}\frac{d^3p_1}{2\varepsilon_1}\delta(k+p-p_1-k_1-k_2)\ ,$$

where $s=(k+p)^2$ is squared total energy in the reaction c.m.s. and ε_1 is the energy of electron with 4-momentum p_1. The tensor $B_{\mu\nu}$ is defined by the electron current j_μ:

$$B_{\mu\nu} = j_\mu j_\nu^*\ ,\quad j_\mu = \bar{u}(p_1)\gamma_\mu u(p)\ , \tag{4}$$

and in the case of polarized initial electron:

$$B_{\mu\nu} = \frac{1}{2}Tr(\hat{p}_1+m)\gamma_\mu(\hat{p}+m)(1-\gamma_5\hat{S})\gamma_\nu\ ,$$

where S_μ is its polarization 4-vector. Taking the trace over the spinor indices we have

$$B_{\mu\nu} = q^2 g_{\mu\nu} + (2pp_1)_{\mu\nu} - 2im(\mu\nu qS)\ , \tag{5}$$

where the following notation is used: $(ab)_{\mu\nu} = a_\mu b_\nu + a_\nu b_\mu$, $(\mu\nu qS) = \epsilon_{\mu\nu\lambda\rho}q_\lambda S_\rho$, $\epsilon_{1230}=1$.

The tensor $V_{\mu\nu}$ is defined by the electromagnetic current J_μ:

$$V_{\mu\nu} = J_\mu J_\nu^*\ ,\quad J_\mu = \bar{u}(k_1)\Big[\gamma_\lambda\frac{\hat{k}_1-\hat{k}+m}{-2(kk_1)}\gamma_\mu + \tag{6}$$

$$+\gamma_\mu\frac{\hat{k}-\hat{k}_2+m}{-2(kk_2)}\gamma_\lambda\Big]v(k_2)A_\lambda\ ,$$

where 4-vector A_λ can be chosen as a column

$$A_\lambda = \begin{pmatrix} e_{1\lambda} \\ e_{2\lambda}\end{pmatrix} \tag{7}$$

in the photon spin space. For the photon polarization 4-vectors we choose

$$e_{1\lambda} = \frac{1}{N}\big[\chi_1 k_{2\lambda} - \chi_2 k_{1\lambda}\big]\ ,\quad e_{2\lambda} = \frac{1}{N}(\lambda k k_1 k_2)\ , \tag{8}$$

$$e_1^2 = e_2^2 = -1\ ,\quad (e_1k) = (e_2k) = (e_1e_2) = 0\ ,$$

where the following short notation is used:

$$N^2 = \big[2\chi_1\chi_2\chi - m^2(\chi_1^2+\chi_2^2)\big]\ ,$$

$$\chi_1 = (kk_1)\ ,\quad \chi_2 = (kk_2)\ ,\quad \chi = (k_1k_2)\ .$$

If the photon is polarized and the polarization of created electron is measured, one has:

$$V_{\mu\nu} = Tr(\hat{k}_1+m)\frac{1}{2}(1-\gamma_5\hat{S}_1)\Big[\gamma_\lambda\frac{\hat{k}_1-\hat{k}+m}{-2(kk_1)}\gamma_\mu +$$

$$+\gamma_\mu\frac{\hat{k}-\hat{k}_2+m}{-2(kk_2)}\gamma_\lambda\Big](\hat{k}_2-m)\Big[\gamma_\nu\frac{\hat{k}_1-\hat{k}+m}{-2(kk_1)}\gamma_\rho +$$

$$+\gamma_\rho\frac{\hat{k}-\hat{k}_2+m}{-2(kk_2)}\gamma_\nu\Big]\varrho_{\lambda\rho} = T_{\mu\nu\lambda\rho}\varrho_{\lambda\rho}\ . \tag{9}$$

Here S_1 is the 4-vector of created electron and $\varrho_{\lambda\rho}$ is the spin density matrix of the polarized photon:

$$\varrho_{\lambda\rho} = \frac{1}{2}A_\lambda^+\,(I+\vec{\xi}\vec{\sigma})\,A_\rho\ , \tag{10}$$

where $\vec{\sigma}$ represents the Pauli matrices and 3-vector $\vec{\xi} = (\xi_1\,,\xi_2\,,\xi_3\,)$ has the photon Stock's parameters as its components. If polarization of the created electron is not measured one has to eliminate $(1-\gamma_5\hat{S}_1)/2$ in the r.h.s. of Eq. (9).

When calculating the non-decreasing (with the energy growth) contribution into the unpolarized part of the cross-section one ought to account for terms proportional to s^2 in the contraction $T_{\mu\nu\lambda\rho}(e_{1\lambda}e_{1\rho}+e_{2\lambda}e_{2\rho})B_{\mu\nu}$, which arise due to scalar products (k_1p), (k_2p), and (kp) . Then we have:

$$T_{\mu\nu\lambda\rho}(e_{1\lambda}e_{1\rho}+e_{2\lambda}e_{2\rho})B_{\mu\nu} = -16\Big[\frac{4m^2}{\chi_1\chi_2}(k_1p)(k_2p) +$$

$$(k_1p)^2\Big(\frac{q^2}{\chi_1\chi_2} - \frac{2m^2}{\chi_2^2}\Big) + (k_2p)^2\Big(\frac{q^2}{\chi_1\chi_2} - \frac{2m^2}{\chi_1^2}\Big)\Big]\ . \tag{11}$$

To calculate the high-energy cross-section of the process (1) it is convenient to introduce so-called Sudakov's variables [7]. These variables define an expansion of the final 4-momenta on the longitudinal and transversal components relative to the 4-momenta of the initial particles. For the process (1)

$$k_2 = \alpha p' + \beta k + k_\perp\ ,\quad q = \alpha_q p' + \beta_q k + q_\perp\ , \tag{12}$$

$$p' = p - \frac{m^2}{s}k\ ,\quad s = 2(kp),\quad p'^2 = 0,$$

$$d^4k_2 = \frac{s}{2}d\alpha d\beta d^2k_\perp,\quad d^4q = \frac{s}{2}d\alpha_q d\beta_q d^2q_\perp\ ,$$

where 4-vectors $k_\perp$ and $q_\perp$ are the space-like ones, so $k_\perp^2 = -\mathbf{k}^2$, $q_\perp^2 = -\mathbf{q}^2$, and $\mathbf{k}$ and $\mathbf{q}$ are two-dimension Euclidian vectors.

The phase space of the final particles can be written as

$$d\Phi = \frac{1}{4s\beta(1-\beta)}d\beta d^2\mathbf{k} d^2\mathbf{q}\,. \tag{13}$$

The variable β is the photon energy fraction that is carried out by the positron $\beta = E_2/\omega$. In terms of the Sudakov's variables, the independent invariants are expressed as follows:

$$\chi_1 = \frac{m^2+(\mathbf{k}+\mathbf{q})^2}{2(1-\beta)},\quad \chi_2 = \frac{m^2+\mathbf{k}^2}{2\beta},\quad q^2 = -\mathbf{q}^2. \tag{14}$$

Using Eq. (11) we easily obtain the well-known result for unpolarized differential cross-section

$$d\sigma = \frac{2\alpha^3}{\pi^2\mathbf{q}^4}\Big[2m^2\beta(1-\beta)\Big(\frac{1}{m^2+(\mathbf{k}+\mathbf{q})^2} - \tag{15}$$

$$\frac{1}{m^2+\mathbf{k}^2}\Big)^2 + \frac{\mathbf{q}^2[1-2\beta(1-\beta)]}{[m^2+(\mathbf{k}+\mathbf{q})^2][m^2+\mathbf{k}^2]}\Big]d\beta d^2\mathbf{k} d^2\mathbf{q}\ .$$

This form of the differential cross-section allows the integration over the positron perpendicular momentum where the upper limit of integration can be supposed to equal to infinity. For chosen accuracy [8]:

$$d\sigma = \frac{2\alpha^3}{\pi\mathbf{q}^4}\Big\{\big[1-2\beta(1-\beta)\big]\Psi_1 + 2\beta(1-\beta)\Psi_2\Big\}d\beta d^2\mathbf{q}\ ,$$

$$\Psi_1 = \frac{1}{x}\ln\frac{x+1}{x-1},\quad \Psi_2 = 1 - \frac{2m^2}{\mathbf{q}^2}\Psi_1, \tag{16}$$

$$x = \sqrt{1 + \frac{4m^2}{\mathbf{q}^2}}\ .$$

For the pair creation in the process (1) by the high-energy photon and the relativistic initial electron with the energy $E >> m$ at back-to-back collision, the scattered electron can be detected, in principle, by means of the circular detector which sums all events with $\theta_{min} < \theta < \theta_{max}$, where the scattering electron angle $\theta = |\mathbf{q}|/E$. In this experimental setup the differential cross-section (16) ought to be integrated over the detector aperture. For analytical integration it is convenient to introduce new variable $\mathbf{q}^2/m^2 = 4\,\mathrm{sh}^2 z$, so that:

$$\Psi_1 = 2z\,\mathrm{cth}\,z,\ \Psi_2 = 1 - \frac{z}{\mathrm{sh}\,z\,\mathrm{ch}\,z},\ \frac{d\mathbf{q}^2}{\mathbf{q}^4} = \frac{\mathrm{ch}\,z dz}{2m^2\,\mathrm{sh}^3 z}$$

and the integration of the Eq. (16) with respect to azimuth angle and new variable z leads to following positron spectrum for the unpolarized case:

$$\frac{d\sigma}{d\beta} = 2\alpha r_0^2\big\{A(z_0)-A(z_1)+\beta(1-\beta)\big[B(z_0)-B(z_1)\big]\big\}, \tag{17}$$

where z_0 and z_1 are the minimal and maximal values of z and functions $A(z)$ and $B(z)$ are

$$A(z) = 2z\,\mathrm{cth}\,z - 2\ln(2\,\mathrm{sh}\,z)\ , \tag{18}$$

$$B(z) = \frac{2}{3\,\mathrm{sh}^2 z} - 2z\,\mathrm{cth}\,z - \frac{2}{3}z\,\mathrm{cth}^3 z + \frac{8}{3}\ln(2\,\mathrm{sh}\,z).$$

When writing the latter formulae we fixed the integration constant in such a way that both $A(z),\ B(z) \to 0$ if $z \to \infty$. This choice is specified by behavior of the cross-section (16) at large $|\mathbf{q}^2/m^2|$.

The total cross-section in such experimental setup can be derived by elementary integration over the positron energy fraction:

$$\sigma{=}2\alpha r_0^2\big[C(z_0){-}C(z_1)\big],\ \ C(z){=}A(z){+}\frac{B(z)}{6}\ . \tag{19}$$

Note, that in the pair production by the photon on the stationary target with arbitrary mass M the quantity $\mathbf{q}^2$ is connected with mass M and energy W of the recoil particle in the laboratory system:

$$\mathbf{q}^2 = 2M(W - M)\,,\quad W = \sqrt{M^2 + l^2}\,,$$

where l is the absolute value of the recoil momentum. It means that in the case of the atomic electron target $l = m\,\mathrm{sh}(2z)\,, (M = m)$, and for the very heavy target $l = 2m\,\mathrm{sh}(z), (M >> m)$. For the stationary target it is possible to investigate such experimental setup when detector records all events with $l > l_0\,,\ l_0 \sim m$. In this case we can formally suppose the upper limit of integration in Eq. (16) to be equal to infinity. To write the corresponding results it is enough to eliminate $A(z_1), B(z_1)$ and $C(z_1)$ in Eqs. (17) and (19).

On the other hand, one can study the angular distribution of the recoil electrons. It is easy to see that in this case the angle ϑ between the photon 3-momentum $\mathbf{k}$ and the recoil electron one $\mathbf{p}_1$ is defined by the relation [9] $\sin^2\vartheta = 4m^2/(4m^2 + \mathbf{q}^2)$. It means that large $\mathbf{q}^2$ correspond to small recoil angles ϑ and and vice-versa. In this case $\mathrm{sh}\,z = \mathrm{ctg}\,\vartheta$.

3. CROSS-SECTION ASYMMETRY AND CREATED ELECTRON POLARIZATION

To evaluate either asymmetry of the cross-section or the created electron polarization one has to calculate the part of cross-section that depends on polarization states either of the initial electron or of the created one. For this goal it is convenient to use the covariant form of the electron polarization 4-vectors which enter in Eqs. (5) and (9):

$$S = \frac{(pk)p - m^2k}{m(pk)},\quad S_1 = \frac{(kk_1)k_1 - m^2k}{m(kk_1)}. \tag{20}$$

It means that in the rest frame of the initial electron $S = (0, -\mathbf{k}/|\mathbf{k}|)$, and in the rest frame of the created one $S_1 = (0, -\mathbf{k}/|\mathbf{k}|)$.

The asymmetry of the cross-section in considered process is defined by the ratio:

$$A = -i\xi_2\frac{T_{\mu\nu\lambda\rho}(e_{1\lambda}e_{2\rho} - e_{1\rho}e_{2\lambda})B^{(a)}_{\mu\nu}\,d\Phi}{T_{\mu\nu\lambda\rho}(e_{1\lambda}e_{1\rho} + e_{2\lambda}e_{2\rho})B^{(s)}_{\mu\nu}\,d\Phi}\,, \tag{21}$$

where $B^{(s)}_{\mu\nu}$ and $B^{(a)}_{\mu\nu}$ are the symmetric and antisymmetric parts of the tensor $B_{\mu\nu}$, respectively. The direct calculation for the numerator gives

$$8\xi_2(\mu\nu qp)\Big\{\Big[m^2\Big(\frac{1}{\chi_1^2} + \frac{1}{\chi_2^2}\Big) - \frac{q^2}{2\chi_1\chi_2}\Big](\mu\nu kq) - -\frac{(\mu\nu k_1q)}{\chi_1} - \frac{(\mu\nu k_2q)}{\chi_2}\Big\}\,. \tag{22}$$

Because at the used accuracy $(\mu\nu qp)(\mu\nu kq) = q^2s,\ (\mu\nu qp)(\mu\nu k_1q) = q^2(1-\beta)s,\ (\mu\nu qp)(\mu\nu k_2q) = q^2\beta s$, the respective electron polarization dependent part of the differential cross-section $d\sigma_2$ is:

$$d\sigma_2 = -\frac{2\alpha^3\xi_2}{s\mathbf{q}^2\pi^2}\Big\{2m^2\Big[\frac{1-\beta}{\beta[(\mathbf{k}+\mathbf{q})^2 + m^2]^2} + \frac{\beta}{(1-\beta)[\mathbf{k}^2 + m^2]^2}\Big] + \frac{\mathbf{q}^2}{[(\mathbf{k}+\mathbf{q})^2 + m^2][\mathbf{k}^2 + m^2]} - \frac{1-\beta}{\beta[(\mathbf{k}+\mathbf{q})^2 + m^2]} - \frac{\beta}{(1-\beta)[\mathbf{k}^2 + m^2]}\Big\}d\beta d^2\mathbf{k}d^2\mathbf{q}\ . \tag{23}$$

Note that if the initial electron is polarized in its rest frame opposite to the direction of recoil electron 3-momentum, one has to divide the r.h.s. of Eq. (23) by $\sqrt{1 + 4m^2/\mathbf{q}^2}$.

The ratio $d\sigma_2/d\sigma$, which define the cross-section asymmetry is of the order $\mathbf{q}^2/s$, i.e. it is parametrically small. On the other hand, $d\sigma_2$ increases near the edges of the positron spectrum due to terms containing $1/\beta$ and $1/(1-\beta)$. This effect is absent in polarization-independent part of the cross-section. Integration of these terms over β leads to large logarithmic contribution $\ln(\omega/m) \approx (1/2)\ln(s/m^2)$. Nevertheless, the method to determine the photon circular polarization based on the measured cross-section asymmetry in process (1) cannot be efficient at high energies because of above mentioned smallness of the ratio $d\sigma_2/d\sigma$.

Consider now another possibility based on the measurement of the created electron polarization. In this case we have to calculate:

$$P = -i\xi_2 \frac{T^{(pol)}_{\mu\nu\lambda\rho}(e_{1\lambda}e_{2\rho} - e_{1\rho}e_{2\lambda})B^{(s)}_{\mu\nu}d\Phi}{T_{\mu\nu\lambda\rho}(e_{1\lambda}e_{1\rho} + e_{2\lambda}e_{2\rho})B^{(s)}_{\mu\nu}d\Phi}, \qquad (24)$$

where $T^{(pol)}_{\mu\nu\lambda\rho}$ is part of the tensor $T_{\mu\nu\lambda\rho}$ (see Eq. (9)) that depends on the created electron polarization 4-vector S_1. The numerator in the r.h.s. of Eq. (24) can be written as follows:

$$16m\xi_2\Big\{\Big[\frac{(k_2p)}{\chi_1} - \frac{(k_1p)}{\chi_2}\Big]$$
$$\times\Big[\frac{\chi_1+\chi_2}{\chi_1\chi_2}\big[(k_2p)(kS_1) + \chi_1(pS_1)\big]$$
$$-\frac{(kp)(k_2S_1)}{\chi_2} + \frac{q^2(\chi_2-\chi_1)(kp)(pS_1)}{2\chi_1\chi_2^2}\Big]\Big\}. \qquad (25)$$

The necessary scalar products read:

$$2m(pS_1) = s\big[1-\beta-m^2/\chi_1\big],$$

$$m(kS_1) = \chi_1, \quad m(k_2S_1) = (k_1k_2) - m^2\chi_2/\chi_1),$$

and expression in the braces in the r.h.s. of Eq. (25) becomes very simple:

$$\frac{s^2q^2}{8\chi_2}\Big[\frac{1-2\beta}{\chi_1} - \frac{m^2}{\chi_1}\Big(\frac{1}{\chi_1} - \frac{1}{\chi_2}\Big)\Big].$$

Now the integration with respect to the positron perpendicular momentum leads to the part of the differential cross-section which depends on the photon circular polarization degree:

$$d\sigma_2 = \frac{2\alpha^3\xi_2(1-2\beta)}{\mathbf{q}^4x^2}\big[\Psi_2 - \Psi_1\big]d\beta d\mathbf{q}^2. \qquad (26)$$

The created electron polarization along direction $-\mathbf{k}/|\mathbf{k}|$ is defined by the relation:

$$P = P(\beta, \mathbf{q}^2, \xi_2) = 2d\sigma_2/d\sigma,$$

so that

$$P = \frac{\xi_2(1-2\beta)\big(\Psi_2-\Psi_1\big)}{x^2\big[(1-2\beta(1-\beta))\Psi_1 + 2\beta(1-\beta)\Psi_2\big]}. \qquad (27)$$

The corresponding distribution is antisymmetric relative to change $\beta \to 1-\beta$ and can vary inside wide interval. It means that the created electron polarization is very sensitive to the high energy photon circular polarization. For $\xi_2 = 1$ it is shown in Fig. 1.

If the recoil electrons are recorded by narrow circular detector we have to integrate over the detector aperture as described above. This procedure results:

$$P(\beta, \xi_2) = \xi_2 P(\beta),$$

$$P(\beta) = \frac{(1-2\beta)\big[D(z_0) - D(z_1)\big]}{A(z_0) - A(z_1) + \beta(1-\beta)\big[B(z_0) - B(z_1)\big]},$$
$$D(z) = 2z[\text{th}(z) - \text{cth}(2z)]. \qquad (28)$$

If the whole recoil momenta with $l > l_0$ are recorded then polarization $P(\beta)$ can be derived with the same rules as it is described at the end of Sec. 2, namely one has to eliminate $A(z_1), B(z_1)$ and $D(z_1)$ in Eq. (28) and use $l_0 = 2m\,\text{sh}(z_0)$. If the angular distribution of the recoil electron is measured than one has to use $\text{sh}\,z = \text{ctg}\,\vartheta$. In Fig. 2 and 3 we give function $P(\beta)$ as defined by Eq. (28) for different experimental setups.

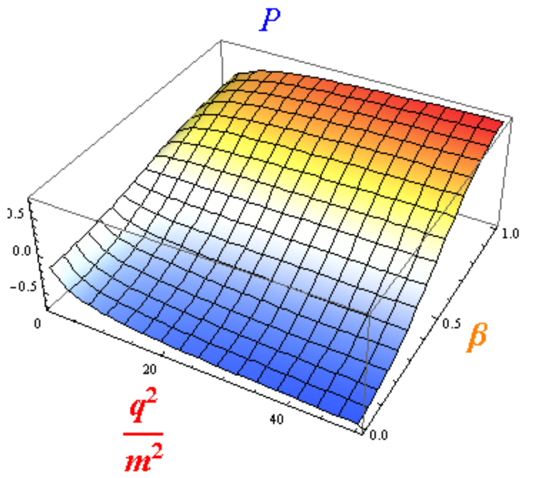

Fig. 1. *Double distribution for the created electron polarization calculated by means Eq. (27) for* $\xi_2 = 1$

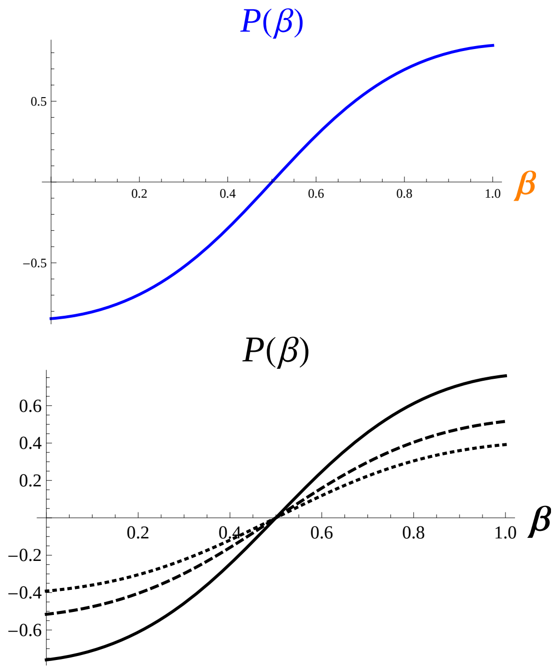

Fig. 2. *Function* $P(\beta)$ *at different values of the minimal recorded recoil electron momentum. The upper curve corresponds to back-to-back collision with detector aperture* $1^o < \theta < 6^o$*. The lower curves correspond to production on atomic electrons: the solid to* $l_0 = 1.1\,m$*, the dashed to* $l_0 = 2.1\,m$*, the dotted to* $l_0 = 17.1\,m$

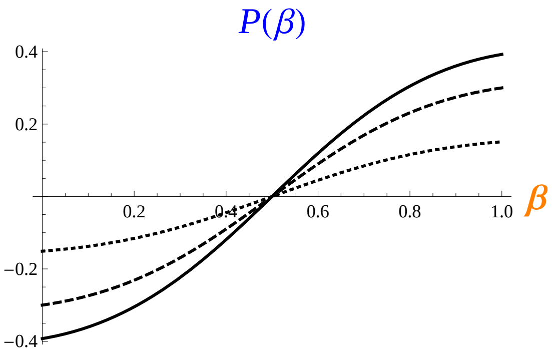

Fig. 3. *Function $P(\beta)$ at different values of the minimal scattering angles of the recoil electron at fixed value of the maximal one: $\theta_{max} = 63.6^o$. The solid line corresponds to $\theta_{min} = 5^o$, the dashed – to $\theta_{min} = 30^o$, and the dotted –to $\theta_{min} = 60^o$*

4. CONCLUSIONS

The double spin correlations in the process (1) allow to probe the high-energy photon circular polarization. In the region $|q^2| \geq \delta m^2$, where δ is of the order one, the pair production on the longitudinally polarized electron beam cannot give efficient measure for the circular polarization of the high-energy photons and the created electron polarization is large and does not decrease with the photon energy. Therefore the latter can be used, in principle, to determine the circular polarization degree of high-energy photon.

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О ВОЗМОЖНОСТИ ИЗМЕРЕНИЯ ЦИРКУЛЯРНОЙ ПОЛЯРИЗАЦИИ ФОТОНА ВЫСОКОЙ ЭНЕРГИИ В РЕАКЦИИ $\gamma + e^- \to e^+ + e^- + e^-$

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Проанализированы две возможности определения степени циркулярной поляризации высокоэнергетического фотона в процессе $\gamma + e^- \to e^+ + e^- + e^-$. Первая связана с измерением поляризационной асимметрии сечения, когда начальный пучок электронов обладает продольной поляризацией. Вторая – с измерением поляризации образованного позитрона (или электрона). Показано, что в последнем случае поляризация не убывает с ростом энергии фотона и может быть использована для эффективного определения степени его циркулярной поляризации.

ПРО МОЖЛИВІСТЬ ВИМІРЮВАННЯ СТУПЕНІ ЦИРКУЛЯРНОЇ ПОЛЯРИЗАЦІЇ ФОТОНА ВИСОКОЇ ЕНЕРГІЇ У РЕАКЦІЇ $\gamma + e^- \to e^+ + e^- + e^-$

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Проаналізовано дві можливості визначити ступінь циркулярної поляризації фотона високої енергії у реакції $\gamma + e^- \to e^+ + e^- + e^-$. Перша пов'язана із вимірюванням асиметрії перерізу, коли початковий пучок електронів має поздовжню поляризацію. Друга – із вимірюванням поляризації утворюваного позитрона (чи електрона). Виявлено, що в останньому випадку поляризація не зменшується з ростом енергії фотона і може бути використана для ефективного визначення його циркулярної поляризації.