https://doi.org/10.46813/2024-153-003

THE RESONANCE APPROACH FOR THE PROCESS OF THE PHOTO-TRIDENT IN THE FIELD OF A LINEARLY POLARIZED ELECTROMAGNETIC WAVE

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The process of the creation of an electron-positron pair at the scattering of a polarized high-energy photon (photo-trident) in the field of a monochromatic linearly polarized electromagnetic wave was investigated in the framework of the resonance approximation. This approximation allows to neglect the interference of amplitudes, i.e. resonance for each amplitude occurs in different kinematic regions. Despite these simplifications the expression for the probability for the investigated process, which has a second order in the fine structure constant, is sufficiently cumbersome. That is a consequence of the polarization properties of the intermediate state. And only for the case of linear polarization of the wave and an unpolarized initial photon, the probability of a photo-trident is factorized into the product of the probabilities of the first-order subprocesses into which the sequence of the studied process is divided.

PACS: 12.20.-m, 34.80.-i

INTRODUCTION

The process of formation of an e+e pair during scattering of a laser beam on an electron beam (trident process) was observed in the SLAC E-144 experiment [1]. New studies of this process may be conducted in the upcoming experiments LUXE at DESY [2] and E320 at SLAC [3]. The main difficulties of the theoretical description of processes of the 2nd order process in the fine structure constant are the complexity and cumbersomeness of expressions for the probability. Therefore, various approximations are used to describe such processes. Thus, in our work, the resonance approximation is used to study the process of formation of an electron-positron pair during the scattering of high-energy photons on the laser beam (photo-trident) (Fig. 1). This process adds to the results of the experiment with the trident process, i.e. high-energy photons will arise as a result of the most likely process of photon emission by an electron when scattered on a laser wave. As a result of the photo-trident process, these photons can form an electron-positron pair, which makes a certain contribution to the trident process research experiment. Note that the studied process is described by two diagrams: the first diagram corresponds to the case when a positron is formed in the first half of the process, and the second to the final electron. The resonant approximation, which will be used to solve the problem, lies in the assumption that the main contribution to the process is made by intermediate states close to the mass shell. Divergences arising in the probability are eliminated by adding an imaginary additive to the mass of an intermediate particle – the width of the intermediate state, which is determined by the full probability of a decay of the intermediate state due to one-photon radiation. Note that in this approximation the interference of amplitudes can be neglected, i.e. resonance occurs in different kinematic regions. To use the resonance approximation, the amplitude of the process is recorded as a double sum of partial amplitudes, which corresponds to the number of the laser field photons that took part in the process in the 1st and 2nd vertices. The main difficulty that arises when finding an expression for the partial probability (the square of the partial amplitude) is related to the calculation of a spur (trace) from the product of 8 or more Dirac matrices, consequently results are so cumbersome therefore unsuitable for further analysis. We propose a method that allows you to reduce the probability calculation to finding the probabilities of the 1st-order processes. In particular, for the 1st diagram, this is the absorption of the initial photon with the formation of an electron-positron pair and the process of scattering of the intermediate electron in the field of a laser wave with the emission of a finite photon, and the calculations must be carried out for a polarized intermediate state.

1. AMPLITUDE

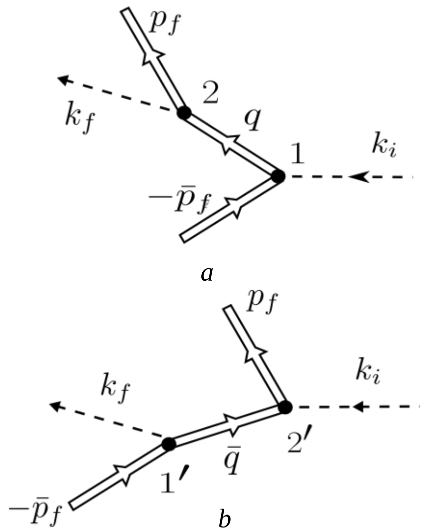

Fig. 1. Feynman's diagram

According to the diagram (see Fig. 1), the amplitude of the studied process has the form:

$$S_{fi}=-C\int\Psi_{p_f}(x_2)\left(\hat{e}_f^{*}G_q(x_2,x_1)\hat{e}_i e^{i(k_f x_2-k_i x_1)}+\right.$$
$$\left.+\hat{e}_i G_{\bar{q}}(x_2,x_1)\hat{e}_f^{*}e^{i(k_f x_1-k_i x_2)}\right)\Psi_{-\bar{p}_f}(x_1)d^4x_1d^4x_2,\ (1)$$

where $k_i=(\omega_i,k_i)$, $k_f=(\omega_f,k_f)$ are 4-momentums of the initial and final photons; $k=(\omega,k)$ is the wave vector; $p_f=(E_f,p_f)$, $\bar{p}_f=(\bar{E}_f,\bar{p}_f)$ – 4-momentums of the final electron and positron; q, $\bar{q}$– 4-momentums of the intermediate particles (note that in the general case: $q^2\neq m^2$, $\bar{q}^2\neq m^2$); e_i, e_f – 4-vectors of the polarizations of the initial and final photons; $C=ie^2 2\pi/\left(\sqrt{\omega_i\omega_f}V\right)$, V is the normalizing volume.

In the formula (1) the wave functions of particles $\Psi_p(x)$ and Green's function of intermediate $G(x_1,x_2)$ are given by the expressions:

$$\Psi_p(x)=B_p(\varphi)e^{iS_p(x)}\frac{u_p}{\sqrt{2E}},\qquad(2)$$

$$G_q(x_1,x_2)=-\int\frac{d^4q}{(2\pi)^4}B_q(\varphi_1)\frac{\hat{q}+m}{q^2-m^2}\times$$
$$\times B_q(\varphi_2)e^{i\left(S_q(x_1)-S_q(x_2)\right)},\qquad(3)$$

$$B_p(\varphi)=1-\frac{|e|}{2(kp)}\hat{k}\hat{A},\qquad(4)$$

$$S_p=-px+\frac{|e|}{(kp)}\int\left(\left(pA(\varphi)\right)+\frac{|e|}{2}A^2(\varphi)\right)d\varphi,\ (5)$$

where u_p is the bispinor of a free electron; $\varphi=(kx)=\omega(t-z)$ is the wave value.

To integrate by the 4-coordinates of the vertices in the amplitude (1) we separate the parts related to each of the vertices with taking into account the formulas:

$$\int\bar{B}_{p_f}(\varphi)\gamma^{\mu}B_{p_i}(\varphi)e^{i\left(k_f x-S_{p_f}(\varphi)+S_{p_i}(\varphi)\right)}d^4x=$$
$$=\sum_{l=-\infty}^{\infty}M_l^{\mu}\left(p_f,p_i\right)(2\pi)^4\delta^{(4)}\left(\tilde{p}_i-lk-\tilde{p}_f-k_f\right),\ (6)$$

where 4-row matrices M_l^{μ} are equal to:

$$M_l^{\mu}=L_l\gamma^{\mu}+\left(\frac{m^2}{8(kp_f)(kp_i)}B_l k^{\mu}-\frac{m}{2(kp_i)}D_l^{\mu}\right)\hat{k}+$$
$$+\frac{m}{2(\mathrm{k}\mathrm{p}_i)}\widehat{D}_l k^{\mu}+\frac{m\beta_-}{4}\widehat{D}_l\hat{k}\gamma^{\mu},\ \beta_{\mp}=\frac{1}{(kp_f)}\mp\frac{1}{(kp_i)},\ (7)$$

$$L_l=\sum_{s=-\infty}^{\infty}J_{l-2s}(y)J_s(b),\qquad(8)$$

$$D_l=D_+\mathrm{e}_x,\ D_+=\eta(L_{l+1}+L_{l-1}),\qquad(9)$$

$$B_l=\eta^2\left(2L_l+(L_{l+2}+L_{l-2})\right).\qquad(10)$$

Using formula (6), the amplitude (1) is equal to a double sum of partial components:

$$S_{fi}=\sum_{l,l'=-\infty}^{\infty}S^{(l,l')},\qquad(11)$$

$$S^{(l,l')}=(2\pi)^4C\left(\bar{u}_{p_f}\left(e_f^{*}M_{l-l'}(2)\right)\frac{\hat{q}+m}{q^2-m^2}\left(e_iM_{l'}(1)\right)u_{-p_f}+\right.$$
$$+\bar{u}_{p_f}\left(e_iM_{l-l'}(2')\right)\frac{\hat{q}+m}{q^2-m^2}\left(e_fM_{l'}(1')\right)u_{-p_f}\Big)\times$$
$$\times\delta^{(4)}\left(k_i+lk-\bar{p}_f-\tilde{\bar{p}}_f-k_f\right).\qquad(12)$$

Each partial process corresponds have the conservation laws:

$$q\ =\ p_f+k_f-(l-l')k=-\bar{p}_f+l'k+k_i,\quad(13)$$

$$\bar{q}=p_f-k_i-(l-l')k=-\bar{p}_f+l'k-k_f,\quad(14)$$

where symbolic notations are introduced to shorten the record: $2\equiv\left(p_f,q\right)$, $1\equiv\left(q,-\bar{p}_f\right)$, $2'\equiv\left(p_f,\bar{q}\right)$, $1'\equiv\left(\bar{q},-\bar{p}_f\right)$; hats above 4-vectors denotes their convolution with Dirac matrices: $\hat{a}=\left(a_{\mu}\gamma^{\mu}\right)$; γ^{μ} are Dirac's matrix; the quasi-momentums are marked with tildes above the 4-momentums:

$$\tilde{p}=p+\frac{1}{2}m^2\eta^2k.\qquad(15)$$

2. KINEMATICS OF RESONANT PROCESS

In the final state, we have 3 particles, which are described by 9-values. The 4-law of conservation (argument – function in expression (12)) allows to determine 4 of them. The remaining 5 values are independent variables, as which we will choose: the direction of electron propagation $\boldsymbol{n}_f$ (and the direction of positron propagation $\bar{\boldsymbol{n}}_f$ for the second diagram), the direction of final photon $\boldsymbol{\tau}_f$, the frequency of final photon ω_f, which is within:

$$0\leq\omega_f\leq\frac{l(kk_i)-2m^2}{\left([k_i+lk]\tau_f\right)}.\qquad(16)$$

The resonance condition additionally reduces the number of independent quantities by one. As which we will choose the frequency of the final photon ω_f.

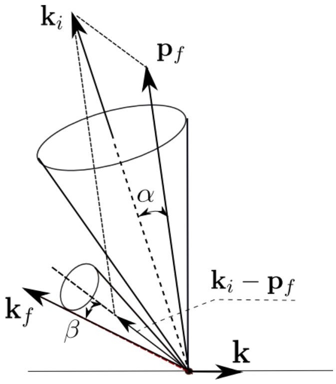

Рис. 2. Geometry of process

For $\eta\sim 1$ the number of photons of waves l, l' also is not big. Therefore, to overcome the threshold of the process, the ultrarelativistic energy of the incident photon is necessary, and therefore the energy of the created pair is also ultrarelativistic:

$$\frac{\omega_{f,res}}{\omega_i} = \frac{\left(1-\varepsilon_f\right)^2 u_1}{1+16u_1\left(1-\varepsilon_f\right) - \frac{\left(1+\delta_\alpha^2\right)}{\left(2\varepsilon_f\right)} + \delta_\beta^2}, \quad (17)$$

$$\varepsilon_f = \frac{E_f}{\omega_i}, \delta_\alpha = \frac{\omega_i \alpha}{m}, \delta_\beta = \frac{\left(\omega_i - E_f\right)\beta}{m}, u_1 = \frac{(kk_i)}{2m^2}, \quad (18)$$

where $\alpha = \angle\left(\boldsymbol{k}_i, \boldsymbol{p}_f\right)$, $\beta = \angle\left(\boldsymbol{k}_i - \boldsymbol{p}_f, \boldsymbol{\tau}_f\right)$ (Fig. 2).

3. PROBABILITY OF THE PROCESS IN THE RESONANCE APPROXIMATION

In the framework of the resonance approximation, everywhere except for the denominator in the probability, we will assume that the intermediate state is located on the mass shell: $q^2 = m^2$ is for the first diagram, $q^2 = m^2$ is for the second diagram. To eliminate resonance divergence in the denominator we use the Breit-Wheeler rule, in which the mass of the intermediate particle is complex:

$$m \to m_*, \qquad m_* = m - i\frac{\Gamma_i}{2}, \quad (19)$$

where the width of resonance Γ_i is determined by the probability of decay of the intermediate state:

$$\Gamma_i = \frac{E_i}{m} W. \quad (20)$$

For small intensities ($\eta^2 \ll 1$):

$$\Gamma_i \equiv \Gamma(u_1) = \frac{e^2 m}{4}\eta^2 F(u_1), \quad (21)$$

$$F(u_1) = \left(1 - \frac{4}{u_1} - \frac{8}{u_1^2}\right) ln(1+u_1) + \frac{1}{2} + \frac{8}{u_1} - \frac{1}{2(1+u_1)^2}. \quad (22)$$

In the case of significant intensities ($\eta \gtrsim 1$) we use

$$W = \sum_{l=1}^{\infty} W_l, \quad (23)$$

$$W_l = \int_0^{u_l} \frac{du}{(1+u)^2} \int_0^{2\pi} d\Psi \times \left(-2L_l^2 + \eta^2\left(2 + \frac{u^2}{1+u}\right)\left(A_1^2 - A_2 L_l\right)\right), \quad (24)$$

where $A_1 = D_+/2$, $A_2 = \left(L_l + \frac{1}{2}(L_{l+2} + L_{l-2})\right)/2$.

The differential probability per unit time in the resonance approximation for the 1st diagram is given by the expression:

$$\frac{dW_{res}^{(a)}}{T} = \frac{\mathrm{w}_0}{|q^2 - m^2|^2} H d\Gamma, \quad \mathrm{w}_0 = |C|^2 V, \quad (25)$$

$$H = \left|\bar{u}_{p_f}\left(e_f^* M_{l-l'}(2)\right)(\hat{q}+m)\left(e_i M_{l'}(1)\right) u_{-\bar{p}_f}\right|^2, \quad (26)$$

$$d\Gamma = \frac{d^3p_f d^3p_f d^3k_f}{\tilde{\bar{E}}_f \tilde{E}_f \omega_f} \delta^{(4)}\left(k_i + lk - p_f - \bar{p}_f - k_f\right). \quad (27)$$

Transforming of expression (26) in the standard way and summation on polarization of final electron and positron leads to the need to calculate the spur:

$$H = \mathrm{Sp}\left\{(\hat{p}_f + m)\left(e_f^* M_{l-l'}(2)\right)(\hat{q}+m)\left(e_i M_{l'}(1)\right) \times \left(\hat{\bar{p}}_f - m\right)\left(e_i^* \overline{M}_{l'}(1)\right)(\hat{q}+m)\left(e_f^* \overline{M}_{l-l'}(2)\right)\right\}. \quad (28)$$

Calculations can be greatly simplified by rewriting the expressions for expression (7) as follows:

$$\left(e_\nu M_l^\nu(p_f, p_i)\right) = = \hat{e} L_l + \frac{mD_+}{4}\left(\beta_+(e_x e) - i\beta_-(e_x e)\gamma^5\right)\hat{k} \quad (29)$$

but even in this case, we will have 8 terms containing the spur from the product of 8 Dirac γ-matrices, each of which will have 105 terms in turn. There will also be no less number of terms containing the spur from the product of γ^5 Dirac matrices by $6\,\gamma$ Dirac matrices. There are no ready-made formulas for calculating such spur in the literature.

For the calculation of expression (29), we have proposed a method that allows you to reduce the calculation of spurs to the calculations of much simpler spurs corresponding to subprocesses, the sequence of which can be divided into the investigated process. In the framework of this method, we introduce an orthogonal basis $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ such as:

$$\alpha_0^2 = 1, \alpha_j^2 = -1, j = 1,2,3. \quad (30)$$

Let`s take $\alpha_0 = q/m$, and the remaining 4-vectors will not be specified at this stage. A set of 4-row matrices: 1, α_1, α_2, α_3, $\alpha_1\alpha_2$, $\alpha_1\alpha_3$, $\alpha_2\alpha_3$, $\gamma^5\alpha_1$, $\gamma^5\alpha_2$, $\gamma^5\alpha_3$, γ^5 form a complete system of independent orthogonal 4-row matrices. Let's isolate the 4-row matrix corresponding to the first vertex in expression (28) and expand it by these set:

$$A = (\hat{q}+m)\left(e_i M_{l'}(1)\right)\left(\hat{\bar{p}}_f - m\right)\left(e_i \underline{M}_{l'}(1)\right) = = a + \sum_{j=0}^{3} b_j \hat{\alpha}_j + \sum_{i=0}^{2}\sum_{j=i+1}^{3} c_{ij}\hat{\alpha}_i\hat{\alpha}_j + + \sum_{j=0}^{3} d_j \hat{\alpha}_j \gamma^5 + f\gamma^5. \quad (31)$$

Expansion coefficients are:

$$a = \frac{1}{4}\mathrm{Sp}\{A\}, b_j = \alpha_j^2 \frac{1}{4}\mathrm{Sp}\{\hat{\alpha}_j A\}, \quad (32)$$

$$c_{ij} = \alpha_i^2 \alpha_j^2 \frac{1}{4}\mathrm{Sp}\{\hat{\alpha}_j \hat{\alpha}_i A\}, \quad (33)$$

$$d_j = \alpha_j^2 \frac{1}{4}\mathrm{Sp}\{\gamma^5 \hat{\alpha}_j A\}, \ f = \frac{1}{4}\mathrm{Sp}\{\gamma^5 A\}. \quad (34)$$

Let's introduce the notation

$$B(Z) = (\hat{p}_f + m)\left(e_f^* M_{l-l'}(2)\right) Z (\hat{q}+m) \times \times \left(e_f \overline{M}_{l-l'}(2)\right). \quad (35)$$

Taking into account expansion (31) and notation (35), the expression (28) takes the form:

$$H = \mathrm{Sp}\{B(1)\}\mathrm{Sp}\{A\} + \sum_{j=0}^{3}\alpha_j^2 \mathrm{Sp}\{B(\hat{\alpha}_j)\}\mathrm{Sp}\{\hat{\alpha}_j A\} + + \sum_{i=0}^{2}\sum_{j=i+1}^{3} c_{ij}\alpha_i^2\alpha_j^2 \mathrm{Sp}\{B(\hat{\alpha}_i\hat{\alpha}_j)\}\mathrm{Sp}\{\hat{\alpha}_j\hat{\alpha}_i A\} +$$

$$+\sum_{j=0}^{3}\alpha_j^2\mathrm{Sp}\{B(\hat{\alpha}_j\gamma^5)\}\mathrm{Sp}\{\gamma^5\hat{\alpha}_j A\}+$$
$$+\mathrm{Sp}\{B(\gamma^5)\}\mathrm{Sp}\{\gamma^5 A\}. \quad (36)$$

Let's use equalities:

$$\hat{\alpha}_0 A = A,\ B(\hat{\alpha}_0)=B,\ \gamma^5\hat{\alpha}_0 A=\gamma^5 A, \quad (37)$$

$$B(\hat{\alpha}_0\gamma^5)=-B(\gamma^5),\ B(\hat{\alpha}_0\hat{\alpha}_j)=-B(\hat{\alpha}_j). \quad (38)$$

Taking into account that for the vectors forming the basis (30): $\hat{\alpha}_0\hat{\alpha}_1\hat{\alpha}_2\hat{\alpha}_3=i\gamma^5$ we will get:

$$\hat{\alpha}_1\hat{\alpha}_2(\hat{q}+m)=-i\gamma^5\hat{\alpha}_3(\hat{q}+m), \quad (39)$$

$$\hat{\alpha}_1\hat{\alpha}_3(\hat{q}+m)=i\gamma^5\hat{\alpha}_2(\hat{q}+m), \quad (40)$$

$$(\hat{q}+m)\hat{\alpha}_2\hat{\alpha}_3=-i\gamma^5\hat{\alpha}_1(\hat{q}+m). \quad (41)$$

As a result, we get

$$\sum_{i=0}^{2}\sum_{j=i+1}^{3}\mathrm{Sp}\{B(\hat{\alpha}_i\hat{\alpha}_j)\}\mathrm{Sp}\{\hat{\alpha}_j\hat{\alpha}_i A\}=$$
$$=-\sum_{j=1}^{3}\mathrm{Sp}\{B(\hat{\alpha}_j\gamma^5)\}\mathrm{Sp}\{\gamma^5\hat{\alpha}_j A\}. \quad (42)$$

Hence

$$H=BA+\sum_{j=1}^{3}D_jC_j, \quad (43)$$

$$A=\frac{1}{4}\mathrm{Sp}\{(\hat{q}+m)(e_iM_{l'}(1))(\hat{\bar{p}}_f-m)(e_i^*M_{l'}(1))\}, \quad (44)$$

$$B=\frac{1}{4}\mathrm{Sp}\left\{(\hat{p}_f+m)\left(e_f^*M_{l-l'}(2)\right)\times\right.$$
$$\left.\times(\hat{q}+m)\left(e_fM_{l-l'}(2)\right)\right\}, \quad (45)$$

$$C_j=\frac{1}{4}\mathrm{Sp}\{\gamma^5\hat{\alpha}_j(\hat{q}+m)(e_iM_{l'}(1))\times$$
$$\times\left(\hat{\bar{p}}_f-m\right)\left(e_i^*M_{l'}(1)\right), \quad (46)$$

$$D_j=\frac{1}{4}\mathrm{Sp}\{(\hat{p}_f+m)\left(e_f^*M_{l-l'}(2)\right)\gamma^5\hat{\alpha}_j\times$$
$$\times\left((\hat{q}+m)\left(e_f\overline{M}_{l-l'}(2)\right)\right), \quad (47)$$

where A determines the probability of the 1st-order process: the production of an electron-positron pair by an initial photon; B is the probability of the 1st-order process: the scattering of an intermediate electron by a wave with the emission of a final photon.

Note that the probability of the 1st sub-process contains a factor similar to the expression (29). That is:

$$h(1)=\frac{1}{2}\mathrm{Sp}\{(\hat{q}+m)(1-\sigma\gamma^5\hat{\alpha}_j)(e_iM_{l'}(1))\times$$
$$\times\left(\hat{\bar{p}}_f-m\right)\left(\overline{e_iM_{l'}(1)}\right)\}. \quad (48)$$

For the 2nd subprocess, a similar expression $h(2)$ can be obtained by substituting in the formulas (48): $1\equiv(q,-\bar{p}_f)\rightarrow 2\equiv(p_f,q),\sigma\rightarrow-\sigma$.

Comparing (46) with (48) and (47) with $h(2)$, we see that the three 4-vectors α_1, α_2, α_3 of the basis (30) can be interpreted as the spin space in which the spin vector of the intermediate state is located. The first term in expression (46) corresponds to the unpolarized intermediate state, the other three determine the effects associated with the polarization of the intermediate state.

In this article, we are not interested in the polarization properties of the incident photon. In this case, we use the formula:

$$e_{i,\mu}e_{i,\nu}^*\rightarrow-\frac{g_{\mu\nu}}{2}. \quad (49)$$

As a result, expressions (44), (45) take on the following form:

$$A=-\frac{1}{2}\frac{1}{4}\mathrm{Sp}\left\{(\hat{q}+m)M_{l'}(1)\left(\hat{\bar{p}}_f-m\right)\overline{M_{l'}^{\mu}(1)}\right\}, \quad (50)$$

$$C_j=-\frac{1}{4}\mathrm{Sp}\left\{\gamma^5\hat{\alpha}_j(\hat{q}+m)M_{l',\mu}(1)(\hat{\bar{p}}_f-m)\overline{M_{l'}^{\mu}(1)}\right\}. \quad (51)$$

The function A coincides with the results given in [4]. The result of the calculation of C_j:

$$C_j=m\left(\frac{1}{4}\mathrm{Sp}\left\{\gamma^5\hat{\alpha}_j\hat{q}M_{l',\mu}(1)\overline{M_{l'}^{\mu}(1)}\right\}-\right.$$
$$\left.-\frac{1}{4}\mathrm{Sp}\left\{\gamma^5\hat{\alpha}_jM_{l',\mu}(1)\hat{\bar{p}}_f\overline{M_{l'}^{\mu}(1)}\right\}\right)=0. \quad (52)$$

Hence

$$H=BA, \quad (53)$$

where A determines the probability of the 1st-order process: the production of an electron-positron pair by an initial unpolarized photon (50); B is the probability of the 1st-order process: the scattering of an intermediate electron by a wave with the emission of a final polarized photon (50).

Therefore, the terms in the probability corresponding to the polarization effects associated with the intermediate state for the linear polarized electromagnetic wave and the unpolarized incident photon vanish, and we state that in the resonance approximation the probability of a phototrident is factorized by the product of the probabilities of subprocesses of the 1st order. So for the first diagram in Fig. 1, that is the production of an electron-positron pair by an initial unpolarized photon and the scattering of an intermediate electron by a wave with the emission of a final polarized photon.

CONCLUSIONS

It is shown that the process of the formation of an electron-positron pair during the scattering of a high-energy photon in the field of an electromagnetic wave (phototrident) can proceed in a resonant way, associated with coming of an intermediate particle to the mass shell, and the condition of the resonance is revealed, as a condition for the frequency of the final photon.

A calculation method is proposed that allows to simplify finding the probability of 2nd-order processes in the resonance approximation, reducing the problem to calculating the probabilities of 1st-order subprocesses that take into account the polarization of the intermediate state.

In the resonance approximation, an expression for the probability of the phototrident process in the field of a linearly polarized monochromatic wave in the case of an unpolarized incident photon is obtained.

The probability of the studied process in the resonance approximation is factored by the product of the probabilities of the first-order subprocesses.

The polarization properties of the intermediate state for a linearly polarized electromagnetic wave and an unpolarized incident photon do not appear.

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Article received 25.09.2024

РЕЗОНАНСНЕ НАБЛИЖЕННЯ ДЛЯ ПРОЦЕСУ НАРОДЖЕННЯ ЕЛЕКТРОН-ПОЗИТРОННОЇ ПАРИ ПРИ РОЗСІЮВАННІ ВИСОКОЕНЕРГЕТИЧНОГО НЕПОЛЯРИЗОВАНОГО ФОТОНА НА ПОЛІ ЛІНІЙНО ПОЛЯРИЗОВАНОЇ ЕЛЕКТРОМАГНІТНОЇ ХВИЛІ

О.І. Ворошило, В.М. Недорешта

У рамках резонансного наближення досліджено процес народження електрон-позитронної пари при розсіянні неполяризованого високоенергетичного фотона (фототризуб) у полі монохроматичної лінійно поляризованої електромагнітної хвилі. Таке наближення дозволяє знехтувати інтерференцією амплітуд, тому що для кожної із діаграм резонанс виникає у різних кінематичних областях. Незважаючи на ці спрощення, вираз для ймовірності для досліджуваного процесу, який має другий порядок за сталою тонкої структури, є досить громіздким. Це є наслідком поляризаційних властивостей проміжного стану. І лише для випадку лінійної поляризації хвилі та неполяризованого початкового фотона ймовірність фототризубу факторизується на добуток ймовірностей підпроцесів першого порядку, на послідовність яких розбивається досліджуваний процес.