The Resonant Effect of the Generation of an Ultrarelativistic Electron-Positron Pair by a High-Energy Gamma Quantum in the Field of the Nucleus and a Strong Laser Wave

S P Roshchupkin[1], N R Larin[1], and V V Dubov[1]

[1] *Department of Theoretical Physics, Peter the Great St.Petersburg Polytechnic University, St.-Petersburg, Russia.*
Contact Phone: +78122971616
Contact Email: serg9rsp@gmail.com

The report theoretically studies the resonant generation of ultrarelativistic electron-positron pairs by high-energy gamma quanta with energies $\omega_i \lesssim 10^2$GeV in the nucleus field and a strong laser wave with intensities up to $I \sim 10^{24}$Wcm^{-2}. The laser field is considered as a plane circularly polarized monochromatic wave. The Oleinik resonances are concerned when an intermediate electron or positron enters the mass shell within the field of a laser wave. As a result, the initial second-order process effectively reduces into the two first-order processes in the fine structure constant: laser-stimulated Breit-Wheeler process and the process of the intermediate electron (positron) scattering on the nucleus modified by the laser field. The resonant kinematics of considered process in strong laser fields is studied in detail. A significant dependence of the electron-positron pair energy on the positron outgoing angle (channel A) or the electron outgoing angle (channel B), as well as on the number of absorbed wave photons, is shown. In this problem, there is a crucial parameter r_η that depends on the laser wave intensity and determines the minimum number of absorbed photons $r_{\min} = \lceil r_\eta \rceil \sim I$. The minimum number of absorbed photons increases proportionally to the laser field intensity. A resonant differential cross section is obtained with simultaneous registration of the electron-positron pair energy and the positron (channel A) or electron (channel B) outgoing angle. The resonant differential cross section for the moderate fields $\left(I \sim 10^{18}\text{Wcm}^{-2}\right)$ has the distinct maximum and reaches the magnitude $d\sigma_{res}^{\max} \lesssim 10^{20}\left(Z^2\alpha r_e^2\right)$. With the increasing of laser wave intensity, the resonant differential cross section decreases. In turn, for the laser intensity of $I \sim 10^{20}$Wcm^{-2} the resonant differential cross section is $d\sigma_{res}^{\max} \lesssim 10^{16}\left(Z^2\alpha r_e^2\right)$, for $I \sim 10^{22}$Wcm^{-2} it reaches the value $d\sigma_{res}^{\max} \lesssim 10^{9}\left(Z^2\alpha r_e^2\right)$, and for $I \sim 10^{24}$Wcm^{-2} the corresponding magnitude is $d\sigma_{res}^{\max} \lesssim 10\left(Z^2\alpha r_e^2\right)$. This theoretical research predicts several novel physical effects which can be verified with use of the contemporary laser radiation facilities (*e.g.*, Extreme Light Infrastructure, Czech Republic).