Resonant Spontaneous Bremsstrahlung in the Scattering of Ultrarelativistic Electrons on Nuclei in a Strong Light Field

S P Roshchupkin[1], A V Dubov[1], V V Dubov[1], and S S Starodub[2]

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

[2]*Department of Quantum Electrodynamics of Strong Fields, Institute of Applied Physics, National Academy of Sciences of Ukraine, Sumy, Ukraine. Contact Phone: +380542222794*

Contact Email: serg9rsp@gmail.com

The report theoretically studies the resonant process of spontaneous bremsstrahlung in the scattering of ultrarelativistic electrons with energies $E_i \lesssim 10^2$ GeVon nuclei in strong laser fields with an intensity up to $I \sim 10^{24}$ Wcm^{-2}. The laser field is considered as a plane circularly polarized monochromatic wave. The Oleinik resonances are considered when an intermediate electron in the wave field enters the mass shell. As a result, the initial second-order process by the fine structure constant is effectively reduced to two first-order processes: the laser-stimulated Compton effect and the scattering of an intermediate electron on the nucleus modified by the laser field. The resonant kinematics of this process in a strong laser field is studied in detail. A significant dependence of the resonant frequency of a spontaneous gamma-quantum on its outgoing angle relative to the momenta: the initial electron (for channel A) or the final electron (for channel B) is shown. In the problem, there is a characteristic number of photons of the wave

$$(r_\eta)\,,$$

which is proportional to the intensity of the laser wave $r_\eta \sim I$. In this paper, we will be interested in resonant frequencies comparable to the energy of the initial electron. Therefore, we will assume that the number of absorbed laser photons ($r = 1, 2, 3, \ldots$) is comparable to or greater than the characteristic parameter ($r \gtrsim r_\eta \sim I$). A resonant differential cross section is obtained with simultaneous registration of the frequency and outgoing angle of the spontaneous gamma-quantum relative to the momenta: the initial electron (for channel A) or the final electron (for channel B). The resonant cross section in strong fields with a fixed number of absorbed laser photons has pronounced two peaks. As the wave intensity increases, the angular width of the peaks narrows. The resonant differential cross section for the average fields $\left(I \sim 10^{18}\ \text{Wcm}^{-2}\right)$ takes the largest value and can be the value of

$$d\sigma_{res}^{\max} \lesssim 10^{17}\ \left(Z^2 \alpha r_e^2\right).$$

As the wave intensity increases, the resonant differential cross section decreases. So, for the intensity of the laser wave $I \sim 10^{20}$ Wcm^{-2}, the resonant differential cross section is

$$d\sigma_{res}^{\max} \lesssim 10^{12}\ \left(Z^2 \alpha r_e^2\right),$$

and for $I \sim 10^{24}$ Wcm^{-2}, we get

$$d\sigma_{res}^{\max} \lesssim 10^{4}\ \left(Z^2 \alpha r_e^2\right).$$

This theoretical research predicts a number of new physical effects and can be tested in international research project ELI (Extreme Light Infrastructure, Czech Republic).