CORRESPONDENCE OF THE CLASSICAL RADIATION REACTION TO THE QUANTUM THEORY IN THE STRONG EXTERNAL FIELDS

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Crystallographic axes and planes provide electrostatic fields strong enough ($\sim 10^3 \div 10^4$ eV/Å) to provide an intense gamma radiation by ultrarelativistic electron (positron) beams moving nearly parallel to these crystallographic directions (channeling radiation - CR). Classical radiation reaction (RR) effects, predicted by the Landau - Lifshitz equation (LL), have recently been studied both experimentally [1] and theoretically [2]. We show that electron's transverse energy damping due to the RR comes from the transitions between the transverse quantum states at relatively low energies, when $\eta = \gamma U_0/mc^2 \ll 1$, and corresponds to the "Schott" term in the classical LL equation for the RR force. $U_0 \sim (20 - 100)$ eV here is a continuous potential depth of the crystal axes (planes), γ in the electron's Lorentz-factor, mc^2 is it's rest mass. It happens for energise less than 10–50 Gev. In the opposite limit of high energies, when $\eta \gg 1$, the transverse energy damping is proportional to the total energy damping and can be calculated within the frame of the quasiclassical Baier-Katkov method which takes into account the quantum recoil due to radiation and influence of spin. The classical analogue of this is the "Lienard" term in the LL equation.

[1] Nielsen C F e a 2020 *Phys. Rev. D* **102** 052004
[2] Khokonov M K 2019 *Phys. Lett. B* **791** 281