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Depolarization of Radiation of High Energy Electron Bunch in a Strong Magnetic Field

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Synchotron radiation is widely used to generate intense beams of hard photons [1]. Of particular intrest is the case of electron propagation in a strong magnetic field comparable to the critical Schwinger field, $H_c \approx 4.41 \cdot 10^{13}$ G. In this regime, rapid radiative self-polarization, accompanied by intense emission, is expected to occur on a timescale of femtoseconds. Recently, the generation of a strong magnetic field of approximately $4 \cdot 10^9$ G has been proposed via the collision of a dense high-energy electron bunch with a solid target at a grazing angle [2,3].

In this contibution, we perform simulation of propagation of an bunch electron in a strong uniform magnetic field. Energy loss due to radiation and the consequent emission of multiple photons are taken into account. We numerically solve the balance equation to determine the time evolution of the spin-resolved energy distribution of the electron beam. This, in turn, allows us to evaluate the polarization of the emitted radiation as a function of time and photon energy.

We consider the dependence of radiation polarization on the dimensionless parameter $\varepsilon = (E/mc^2)(H/H_c)$, where E is the electron energy and H is the magnetic field strength. For $\varepsilon \ll 1$, we reproduce the well-known result that radiation is predominantly polarized perpendicular to the magnetic field [4]. However, when $\varepsilon \gg 1$, the spectral maximum shifts toward the emission of high-energy photons, resulting in a substantial decrease in radiation polarization. The most notable case arises for electrons with spins aligned parallel to the magnetic field. In this regime, significant or nearly complete depolarization of the synchrotron radiation is observed.

References

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