Coherent Radiation from Relativistic Lepton Beams in Intense Laser Fields

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The generation of coherent radiation from relativistic particle beams interacting with intense laser fields is a cornerstone of advanced light source development, with applications in precision measurement, fundamental physics, and ultrafast science. This work derives the analytical conditions necessary for the emission of coherent radiation, including coherent frequency combs, from a lepton beam colliding with a laser pulse modeled as a plane wave. Notably, we show the advantageous role of employing few-cycle laser pulses in relaxing the stringent monoenergeticity requirements for coherent emission [1]. Furthermore, we demonstrate that for quasineutral electron-positron beams, the symmetry between electrons and positrons stabilizes the system, enabling the rapid formation of dense microbunches over a distance of just ten micrometers. This facilitates the emission of broadband coherent extreme ultraviolet (XUV) light, which, in the temporal domain, corresponds to a train of attosecond pulses with an 8-as duration and at 92-as intervals [2]. Lastly, we discuss the fundamental role of interparticle fields in inducing microbunching and ensuring energy-momentum conservation, particularly during coherent emission [3].

References

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