Radiation dominated nonlinear Compton scattering: signatures of quantum dynamics and attosecond gamma-ray bursts

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The advencement of laser technology opens avenue for investigation of nonlinear QED effects with relativistic electrons in all-optical setups. We have studied theoretically multiphoton inverse Compton scattering of a relativistic electron beam interacting with a counterpropagating superstrong short focused laser pulse. The interaction is in the quantum radiation-dominated regime, when the electron dynamics is significantly modified due to radiation. We consider the electron near-reflection regime of interaction when high-energy ultrashort gamma-ray bursts arise in the backward emission direction (with respect to the initial motion of the electrons), although using much longer electron and laser pulses [1]. The considered regime is proposed to employ for detection signatures of the quantum radiation reaction [2], and signatures of the stochasticity in the photon emission process [3]. Generally, the detection of various modifications of the radiation spectrum due to quantum radiation reaction and stochasticity requires accurate quantitative measurements. However, we have identified signatures of quantum radiation reaction and stochasticity for Compton angle-resolved radiation spectra which are easily detectable in an experiment due to distinct qualitative characteristics. The scheme relies on the nonlinearity nature of the interaction, the tightly focusing of the driving laser pulse, and the crucial effect of radiation reaction. All of these three ingredients are necessary to realize the applied specific regime of interaction.

References

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