Gamma-ray sources based on nonlinear Compton scattering and their optimization

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Inverse Compton Scattering (ICS) is a valuable source of X- and gamma-rays for various applications in medicine, materials science and nuclear physics [1]. Growing interest in such sources is driven by the fast technological progress in both lasers and compact plasma wakefield based electron accelerators. Main advantage of ICS sources over, for example, commonly used bremsstrahlung sources is their ability to provide a very narrow bandwidth (<1%) photon spectrum, albeit with a very low conversion efficiency. One way to dramatically increase the total photon yield, is to increase the laser photon density, i.e. increase the laser pulse peak intensity. Unfortunately, scattering laser intensity is strongly limited by the fact that the generated spectrum can be nonlinearly broadened due to the ponderomotive force, and a bandlike structure can appear in the fundamental frequency as well as its harmonics [2,3] even for rather low values of laser pulse intensity. For example, such *moderate* laser pulse intensities as 1016 W/cm2 already lead to broadening on the order of 2-4% considering 1 micrometer laser wavelength.

In this contribution, recent progress in nonlinear ICS will be discussed, analytical and numerical results of photon energy-angular spectrum calculation will be presented. Main focus will be on various methods to significantly enhance the photon yield of the photon sources mainly based on laser pulse frequency manipulation. By using novel geometrical method of spectrum calculation, we show the appearance of high-order caustics related to the catastrophe theory [4] in the case of laser pulses with linear chirp. It is also demonstrated, that the nonlinear broadening can be completely removed by proper nonlinear chirping [5,6]. We will compare different approaches for the photon spectrum calculation based on purely classical description with or without the radiation reaction and also based on strong-field quantum electrodynamics. Some of the fundamental aspects of interaction of single electron with electromagnetic waves will be addressed.

References.

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