Cusp structures in nonlinear Compton scattering

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The increasing interest in nonlinear Compton scattering from the practical point of view is dictated by the possibility of using it as a source of bright narrowband X- and γ- radiation. The theory of this process started with the classical works by Nikishov and Ritus back in 1960s [1]. The common framework assumes use of Furry picture and Volkov states for representing the scattering process. The fact that the most intense laser radiation comes in pulses strongly affected the most recent investigations on the subject. The difference between the case of pulsed radiation and monochromatic plane wave is very strong due to essential nonlinearity of the underlying process. From the classical point of view one can think of the motion of the electron in the presence of the plane wave as the superposition of oscillations and longitudinal drift provided by \( \mathbf{v} \times \mathbf{B} \) force. The latter one is responsible for the Doppler shift of the scattered radiation. Thorough QED analysis of the scattered spectrum is fairly complicated task due to complexity of integrals involved [2]. However, the semiclassical reasoning can be turned into mathematically strict construction. The key point here is use of the language of “ray surfaces” and catastrophe theory. It both reproduces the up-to-date results, and provides a new insight into the problem. New point of view provides new optimization methods for tailoring the scattered spectra.

The talk is devoted to theoretical study of the spectral distribution of the radiation scattered in Nonlinear Compton process for slowly varying pulses. We consider arbitrary chirp, time-dependent ellipticity and arbitrary temporal intensity profile. Long list of free parameters declared above makes the expressions governing the structure of the spectrum extremely complicated. However, the qualitative conclusions on the scattered spectrum for general angle can be made without performing full-scale calculations in a straightforward manner. The underlying idea is to study of the behavior of special type of two-dimensional surfaces under projection map with the mathematical apparatus inherited directly from catastrophe theory and diffraction theory.

References