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Effects of correlation in transition radiation of super-short electron bunches

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Nowadays there is a tendency to use short bunches rather than long ones. The shorter electron bunch is, the shorter the pulse of generated radiation can be. Extremely short pulses of electromagnetic radiation are to be widely used in nanotechnology, medicine, biology. In this report we investigate effects of correlations between electrons in transition radiation as far as these effects remain outside the scope of research.
We consider the intensity of transition radiation from a super-short bunch of electrons as a sum of three parts: incoherent, coherent and correlation. We derive the conditions when the correlations can affect upon the coherent radiation. Correlation function of particle density distribution is obtained with help of Debye–Hückel theory. Contribution of correlations to the form-factor is investigated. The condition linking Debye radius in electron bunches and length of the bunch is obtained. The obtained results can be of use in the projects SINBAD and FLUTE (which are currently under construction) with bunches having extremely small length (~1-10 fs). The contribution of correlations to the form-factor and intensity of TR are estimated numerically for the existing and future facilities; we argue that the effect of correlations can be detected with existing technics.

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