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Orbital Angular Momentum of Channeling Radiation from Relativistic Electrons in Thin Crystals

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The radiation from relativistic electrons moving along a helical trajectory is known to possess the orbital angular momentum (OAM) [1]. An example of the trajectories of such a type is the trajectory of a charged particle in a helical undulator. Twisted photons with energy of 99 eV and OAM ± ħ are observed experimentally in the undulator radiation from 917 MeV electrons [2]. However, the interaction of sub-GeV relativistic particles with a crystalline target allows one to generate radiation in the above-MeV region. The radiation of relativistic particles at axial channeling moving along rosette trajectories also carries the OAM.

Here, using the developed code BCM-2 [3] and the general formula for the probability of radiation of a twisted photon by a classical current derived in [4], we calculate the distribution of photons of channeling radiation over its orbital angular momentum projection and the density of the average number of twisted photons against the photon energy. The calculations are carried out for the initial electron beam energies ranging from 155 to 855 MeV. These are the typical energies of modern accelerators (INFN-LNF and SAGA-LS). It is shown that the radiation from electrons at planar channeling also carry the OAM. The comparison of the results with the ones obtained using the semi-classical approach [5,6] is performed. The proposed scheme for production of radiation carrying the OAM allows one to generate the twisted photons with much higher energies as compared with the scheme based on using the undulator radiation [3,7].

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Primary authors: Dr BOGDANOV, Oleg (LNF&TPU); Dr KAZINSKI, Peter (Tomsk State University); Mr ABDRASHITOV, Sergei (National Research Tomsk Polytechnic University); Dr TUKHFATULLIN, Timur (National Research Tomsk Polytechnic University)

Presenter: Mr ABDRASHITOV, Sergei (National Research Tomsk Polytechnic University)

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