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Orbital Angular Momentum of Radiation at Axial Channeling

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The angular momentum of electromagnetic radiation has been widely studied in recent years. The first theoretical and experimental research have been made by use of laser radiation. Radiation in the x-ray range carrying the angular momentum was recently obtained by using a helical undulator at BESSY II storage ring. Some authors proposed the methods for generation radiation with angular momentum in the free electron lasers based on helical undulators. The twisted beam of high-energy photons can provide new methods in the solid-state physics and enable the design of novel imaging systems of microscopic scale.
In this talk, we propose a method for generation of such radiation in the x-ray and gamma-range energies by means of relativistic particles at axial channeling in a crystal. Electrons in the axial channeling are known to trace a rosette-like trajectory in the transverse direction. We use a simplified model of the averaged crystal axes potential in order to solve analytically the equations of motion. The obtained solution is used for calculation of the angular momentum of radiation in order to explore the basic characteristics of the angular momentum of emitted radiation. We show that the presence of angular momentum in radiation could manifest itself via a left-right asymmetry of the radiation and the asymmetry magnitude can be well detectable. Despite the fact that part of the channeling electrons are revolving around the axis of the crystal in the opposite directions, radiation of the electron beam can carry significant orbital momentum under certain initial conditions. The prerequisite to the formation of radiation with maximum value of orbital angular momentum are explored.

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