Geometrical Optics Method in the Quantum Theory of High Energy Charged Particles Scattering in External Field

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In the geometrical optics method [1, 2], the displacement of a wave front is determined by a motion of family of rays orthogonal to the front. The amplitude of this process is determined via solution of the continuity equation for the rays. In many senses this method is analogical to the semiclassical approximation in quantum electrodynamics for determination of the wave function of a fast particle moving in an external field. In this report we present some results of research basing upon this analogy, that are connected with the study of the scattering process of fast charged particles in the external field [3]. It is shown that the geometrical optics method permits to substantially simplify the calculations by passing from the solution of the wave equation in partial derivatives to the problem of motion of a family of rays. It is particularly important that the simplification of calculations is possible even for processes of interaction of particles with the field of complex configuration, such as the field of crystal lattice. We consider the problem of scattering of fast charged particles in ultrathin crystal in the conditions of the planar channeling. The dependence of the full scattering cross-section on crystal thickness is studied. We predict an analogue of the Ramsauer-Townsend effect of turning into zero of the full scattering cross-section under some parameters of the problem for ultrarelativistic particles. An important role in this problem of the Maslov-Morse index [1, 2] is emphasized.

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2. Arnold V. Mathematical Methods in Classical Mechanics. – NY: Springer-Verlag, 1989.
3. Shul'ga N. F., Shulga S.N. Geometrical optics method in the theory of channeling of high energy particles in crystals. Physics Letters B 2019, 791, 225-229.