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Quantum and classical effects in scattering of fast electrons by the atomic planes of ultrathin crystal

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At motion of accelerated charged particle through crystal the phenomenon of plane channeling is possible, at which the particle performs oscillatory motion in the channel formed by crystal planes. In ultrathin crystals such regime fails to be established, and a problem appears on the properties of motion and scattering of particles in this case. For MeV electrons such a transitional motion regime takes place in the crystals less that 0.1 micron thick. Since last years, there exist accelerator experiments with such crystals [1,2].

In the present work we present the results of study of the scattering process of relativistic electrons in this case. The classical and quantum theories of such process are developed. The quantum study is based upon so-called spectral method [3-5] of finding of the electron wave function in the crystal. It is shown that for MeV electrons the quantum effects are substantial, that manifest themselves as sharp maxima in the angular distributions of scattered particles, being characterized by the crystal inverse grating vectors. As the particle energy increases up to GeV range the possibility of multiple rainbow scattering within the transitional range of crystal thicknesses appears, that reveals itself in quantum so far as in classical consideration. With the energy increase the quantum effects in scattering smoothly turn into the classical ones. The influence of the beam divergence that strongly affects the scattering picture, particularly the quantum one, is studied. The possibility of experimental observation of the considered effects is studied [6].

References

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