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X-Ray Dynamical Diffraction Rocking Curves in Case of Third Order Nonlinear Renninger Effect

Authors : Minas Balyan

Abstract : In the third-order nonlinear Takagi's equations for monochromatic waves and in the third-order nonlinear time-dependent dynamical diffraction equations for X-ray pulses for forbidden reflections the Fourier-coefficients of the linear and the third order nonlinear susceptibilities are zero. The dynamical diffraction in the nonlinear case is related to the presence in the nonlinear equations the terms proportional to the zero order and the second order nonzero Fourier coefficients of the third order nonlinear susceptibility. Thus in the third order nonlinear Bragg diffraction case a nonlinear analogue of the well known Renninger effect takes place. In this work, the 'third order nonlinear Renninger effect' is considered theoretically and numerically. If the reflection exactly is forbidden the diffracted wave's amplitude is zero both in Laue and Bragg cases since the boundary conditions and dynamical diffraction equations are compatible with zero solution. But in real crystals due to some percent of dislocations and other localized defects, the atoms are displaced with respect to their equilibrium positions. Thus in real crystals susceptibilities of forbidden reflection are by some order small than for usual not forbidden reflections but are not exactly equal to zero. The numerical calculations for susceptibilities two order less than for not forbidden reflection show that in Bragg geometry case the nonlinear reflection curve's behavior is the same as for not forbidden reflection, but for forbidden reflection the rocking curves' width, center and boundaries are two order sensitive on the input intensity value. This gives an opportunity to investigate third order nonlinear X-ray dynamical diffraction for not intense beams – 0.001 in the units of critical intensity.

Keywords : third order nonlinearity, Bragg diffraction, nonlinear Renninger effect, rocking curves
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