

The finite difference methods of computation of X-rays propagation through a system of many lenses

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Abstract

The propagation of X-ray waves through an optical system consisting of many X-ray refractive lenses and X-ray focusing is considered. For solving the problem of electromagnetic wave propagation, a finite-difference method for the paraxial wave equation is suggested and applied. The error of simulation is estimated mathematically and investigated. It is found out that very detailed difference mesh is necessary for reliable and accurate computation of propagation of X-ray waves through a system of many lenses. The reasons of necessity of very detailed difference mesh is that after the wave passes through a system of many lenses the electric field becomes a quickly oscillating function of coordinates perpendicular to the optical axis and very detailed difference mesh is necessary to digitize such a wave field. To avoid this difficulty, we introduce the equation for a complex phase function instead of the equation for an electric field. Equation for complex phase is nonlinear equation, in contrast to the paraxial wave equation. It is shown that equation for a phase function allows to considerably reduce the detail of difference mesh without loss in reliability and precision of simulations of X-rays propagation through the system of many lenses and the X-rays focusing. The simulation error of the suggested method is estimated and the examples of computation result are presented.

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