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INCREASING EFFICIENCY OF USING ARTIFICIAL BOUNDARY CONDITIONS FOR 1D NONLINEAR SCHRÖDINGER EQUATION DESCRIBING LASER PULSE IN PHOTONIC CRYSTAL

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As it well known, the artificial boundary conditions is widely used for computer modelling of various problems (see, for example [1,2]). To increase efficiency of artificial boundary conditions we propose a new method, which consists in the introduction of a number of additional functions related with the equation under consideration(in our case 1D nonlinear Schrödinger equation). These functions describe the propagation of reflected waves from the photonic crystal layers and used for decreasing their influence on solution in photonic crystal. Using proposed method also leads to essential computer simulation time decreasing.

We consider 1D nonlinear Schrödinger equation, describing a femtosecond laser pulse interaction with optical periodic structure (photonic crystal) in following form

$$\varepsilon(z)\frac{\partial A}{\partial t} + \imath D\frac{\partial^2 A}{\partial z^2} + \imath\beta(\varepsilon(z) + \gamma(z)|A|^2)A = 0, t > 0, 0 < z < L_z, \tag{1}$$

with initial condition

$$A|_{t=0} = e^{-(z-L_c)^2 + \imath 2\pi\chi(z-L_c)} \tag{2}$$

which corresponds to wave propagating in a positive direction of z-axis if a parameter χ is positive and with artificial boundary conditions proposed in [3].

Above, a function $A = A(z,t)$ is a complex amplitude slowly varying in time; t is a time; z denotes a spatial coordinate along which a laser pulse propagates; L_t, L_z are maximal values of time and space coordinate, L_c is a coordinate of the laser beam center at initial time. D, β, χ are real coefficients, which satisfy the conditions $D = \frac{1}{4\pi\chi}, \beta = \pi\chi$.

We have also shown the effect of energy localization in a one-dimensional photonic crystal and the formation of solitons in some layers in case of non-instantaneous medium response.

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REFERENCES

[1] X. Antoine, C. Besse and V. Mouysset. Numerical schemes for the simulation of the twodimensional Schrödinger equation using non-reflecting boundary conditions. *Math Comput*, (73):1779–1799, 2004.

[2] Z. Xuand and H. Han. Absorbing boundary conditions for nonlinear Schrödinger equations. *Phys Rev*, (74):037704, 2006.

[3] E.B. Tereshin, V.A. Trofimov and M.V.Fedotov. Conservative finite difference scheme for the problem of propagation of a femtosecond pulse in a nonlinear photonic crystal with nonreflecting boundary conditions. *Comp Math and Math Physics*, **46** (1):154–164, 2006.