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Analytical approaches to description of nonlinear processes in inhomogeneous optical waveguides

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Despite a wide outspread of applied programming packages, the development of analytical methods for description of the nonlinear regime of the short modulated pulse propagation in a graded-index dielectric waveguide with longitudinal inhomogeneity remains an urgent problem. These are the analytical approaches that enable to study the very structure of the propagation process, each its component separately and their interaction, as well as to clarify the effects of various physical factors into the travelling pulse parameters. The pulse under scrutiny appears to be a sinusoid of an optical frequency with an envelope covering from several units through several tens of oscillations (sub-picosecond pulses), with the phase modulation, e.g. chirp, being also allowed. Considered as a propagation medium, is a graded-index waveguide - a planar or cylindrical dielectric with the refractive-index profile providing the wave field localization within the waveguide cross-section. The refractive index is supposed to depend on the longitudinal coordinate, and a slight bending of the waveguide axis is also allowed. The asymptotic technique proceeds from the generalized nonlinear wave equation, uses a unique small parameter, and allows in a natural way to extract a linear component of the process. This linear task defines the mode structure of the pulse, i.e. the propagation constant and the field distribution within the graded-index waveguide cross-section. A more realistic *sech*-refractive-index profile (instead of quadratic) is involved into analysis, nevertheless explicit formulae are derived in this case. The nonlinear pulse dynamics is characterized by a generalized nonlinear Schroedinger equation, its coefficients depend on material and waveguide dispersion and are functions on the longitudinal coordinate. This is substantial in taking into account the longitudinal inhomogeneity in describing the nonlinear pulse dynamics.

Biography

Mikhail A Bisyarin has received his Doctor of Science (Phys. & Math.) degree in 2010 and continues his studies at St. Petersburg State University. He is a Head Researcher at the Department of Radiophysics and carries out research on analytical methods in the theory of non-linear oscillations and waves. He has published about 50 papers in reputed journals and has co-authored (with I. A. Molotkov and S. A. Vakulenko) the monograph entitled *"Nonlinear Localized Wave Processes"* (in Russian).

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