Nonlinear fiber optics

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Govind P. Agrawal. *Nonlinear Fiber Optics*, Academic Press, Boston; San Diego; New York; Berkeley; London; Sydney; Tokyo; Toronto, 1989.-pp. 342.

The monograph being reviewed is published in the series *Quantum electronics-principles and applications*-one of the most popular in this field edited by P. F. Liao and P. L. Kelly. The monograph provides a current summary of the development of nonlinear fiber optics during the last fifteen years. The initial interest in this subject was of an entirely nonacademic nature: it was stimulated by such purely technical questions as the prevention of distortion of information in systems of fiber optical communications. However already at the beginning of the 1980's it became clear that fiber light guides are in many respects "ideal" media for the study and practical application of "temporal" nonlinear effects. The low threshold for observing stimulated scattering (in a number of cases it does not exceed tens of milliwatts) and of selfaction is due not so much to large values of the susceptibility cubic with respect to field, but to a unique possibility of realizing kilometer lengths of nonlinear interaction of waves and a high degree of concentration of energy in the core the light guide that has a diameter of several microns. These circumstances impose specific features also on the very nature of nonlinear interactions: they manifest themselves together with dispersion effects.

The most vivid manifestation of the joint action of nonlinearity and dispersion is the formation of optical solitons. By now the theory of propagation, interaction and amplification of optical solitons has been worked out in detail and has been supported by carefully carried out experiments. The subject of the newest investigations are subtle effects observed in the femtosecond range of duration. Another, no less timely sphere of activity is the utilization of fiber light guides for rapid phase modulation of ultrashort light pulses. Subsequent phasing of components of the spectrum broadened by a factor of severalfold in a dispersive delay line leads to a considerable (in a number of cases more than three orders of magnitude) compression of the pulses. Thus femtosecond light pulses can be confidently obtained uner the envelope of which there are contained only a few periods of optical oscillations. Vivid and practically important results have been obtained in the study of different forms of auto- and cross-modulation instabilities, nonlinear polarization phenomena, transient Raman scattering. They have led to the production of new classes of lasers, amplifiers and frequency transformers.

Govind P. Agrawal has undertaken the difficult task of summarizing all these results scattered in numerous publications into a single book. We present brief information on the contents of the monograph. The two introductory chapters precede the principal presentation. The first of these deals with the structure, dispersion and nonlinear characteristics of modern fiber light guides. Then the main approaches to the mathematical description of the formation of mode structures and the dynamics of transformation of the temporal envelope of a pulse are briefly presented. After an analysis of linear dispersion effects the author goes on to an examination of phase self-modulation–the simplest and the well studied nonlinear effect which leads to the lowering of the current frequency at the front of the pulse and to its increase at the trailing edge. The fifth chapter is devoted to the theoretical and applied aspects of the physics of optical solitons. The sixth chapter examines a set of problems associated with the compression of light pulses. The seventh chapter is in many respects based on original investigations of the author. Here he deals with the interaction of waves through nonlinear addition to the index of refraction–phase cross-modulation. Questions of nonlinear birefringence, and polarization instabilities are discussed in detail. In the next two chapters the specific features of stimulated scattering are analyzed, results of experiments with Raman and Brillouin fiber lasers and amplifiers are brought together. The book concludes with a discussion of parametric interactions of waves in light guides.

The monograph is not free from deficiencies and omissions. It practically does not touch upon the important problems of selfaction and interaction of stochastic wave fields. Clearly insufficient attention has been paid to effective methods of analysis of solutions of nonlinear equations of the Schrödinger type based on the apparatus of generalized spectral transformations (the method of the inverse scattering problem).

Nevertheless the book under review gives a good and a sufficiently complete idea of the subject, methods and applications of nonlinear fiber optics. Because of the accessibility and clarity of presentation it can be recommended not only to specialists in the field of laser physics and fiber optics, but also to students of upper years, and also to graduate students of the appropriate specialties. The Mir publishing house plans to publish a Russian translation of this book.