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V.E. ZAKHAROV
S. WABNITZ

OPTICAL SOLITONS: THEORETICAL CHALLENGES AND INDUSTRIAL PERSPECTIVES

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Editors

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FOREWORD

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After about a quarter of a century since the first theoretical predictions of optical solitons, the industrial application of the optical soliton concept is near to reality in the booming field of modern telecommunications, where the demand for high-speed data transmission and routing is of ever-growing. This book contains a set of lectures that were presented at a Les Houches school on optical solitons in September 1998. The school was successful in gathering among the lecturers most of the well-recognized world leaders in the field of optical solitons.

A variety of different aspects of research into optical solitons was exposed in the lectures, ranging from the mathematical fundations of integrability theory to the rapidly evolving technological advances of fiber soliton-based telecommunication systems. The overall impression that the participants and the students received from the school is that this field of research is an excellent example of the rapid transfer that occurs nowadays from basic science to the technological implementations of the first principles. The subjects that were covered by the lectures can be broadly grouped into four main categories: optical soliton theory, fiber soliton telecommunications, optical soliton generation methods, and all-optical information processing via spatial solitons.

The main issues that need to be solved for the practical deployment of solitons in real-world transmissions were outlined, such as timing jitters induced by noise and by pulse interactions and collisions. Nowadays, the research on soliton telecommunications is basically focused on the solution provided by dispersion management or compensation. In this regime, optical pulse propagation in the presence of fiber nonlinearity turns out to be extremely stable: a full theoretical understanding of the dynamics of these nonlinear pulses is still to be developed.

Soliton-shaping effects play a key role in the generation of ultrashort optical pulses; a variety of effects and devices were described, ranging from stretched pulse lasers and fiber ring memories, to Bragg couplers and Raman or Brillouin soliton lasers.

Another manifestation of optical solitons is given by spatial solitons; in this case, nonlinear self-focusing may balance the diffractive speading of a pulse in a dielectric. All-optical signal processing could be based on spatial soliton effects, whereby light may induce reconfigurable waveguides in the form of arrays of bright or dark spatial solitons. For the stability of these pulses in a bulk medium, a saturable nonlinearity is required; as a possible physical mechanism for such nonlinear response, the photorefractive effect has recently received considerable attention. This effect has the merit of providing low soliton powers, at the expense of long response times; moreover, soliton formation with incoherent (white) light was recently predicted.

In summary, this book contains a unique panoramic review of recent theory and experiments in a rapidly evolving domain of applied physics, and should provide an interesting reference both for postgraduate students starting their research in the field and for researchers actively involved in nonlinear optics and optical communications.

The school was carried out within the framework of the "Training and mobility of researchers" summer school programme of the European Commission. Additional institutions that gave their generous support to the event were Alcatel, CNET-France Télécom, the CNRS, the GDR-POAN, the Frency Ministry of Foreign Affairs, and the European Commission Cooperation Project on Science and Technology (COST) 241.

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