Editorial

The advent of nonlinear optics, with the invention of the laser, a powerful source of coherent light, enabled the budding researchers of the 1970s, to enter into a new and exciting domain of optical research, “optical fiber communications”. Despite the critical approbation, the early stage of optical fiber development faced crucial obstacles in the form of dispersion and loss, which posed critical limits to the distance that the optical signal can be transmitted. Then, the remarkable brilliance of Hasegawa and Tappert brought forth the innovative concept of “solitons”, the shape preserving pulses that facilitate the efficient transmission through optical fibers. These optical offspring of John Scott Russel’s fluid solitons then emerged to become the choice of technology for the next generation, ultra long-haul, all-optical terrestrial communications. Solitons gained importance due to their stability against small perturbations and because they could be viewed as the common asymptotic state of diverse kinds of pulses. Although solitons have long been considered the darlings of communication engineers, various versatile aspects of solitons are yet to be explored. This volume constitutes a comprehensive collection of research articles written by leading researchers in nonlinear optics and nonlinear dynamics and presents significant theoretical, numerical and experimental developments over the past 10 years. We hope that this volume will bring enormous insight into soliton evolution, stability and dynamics, in more intriguing classes and subclasses of nonlinear optical media.

The first section provides a review of the solitonic solutions pertaining to nonlinear Schrödinger equations where the authors, Sergey Leble and Bartosz Reichel, present a detailed derivation and numerical solutions of coupled nonlinear Schrödinger equations for pulses of polarized electromagnetic waves in cylindrical fibers and prove stability and convergence in the L_2 space of an explicit finite-difference scheme. In the next article, the N soliton solutions and energy sharing collisions of nonlinear Schrödinger equations with focusing, defocusing and mixed type nonlinearities are discussed by M. Vijayajayanthi, M. Lakshmanan and T. Kanna. Aspiring to the integration of the nonlinear Schrödinger equation in $1+2$ dimensions with non-Kerr law nonlinearity, Anjan Biswas and Daniela Milovic have obtained an exact one-soliton solution in closed form using the solitary wave ansatz for Kerr, power, parabolic as well as the dual-power law nonlinearities. Yaroslav V. Kartashov, Victor A. Vysloukh, and Lluís Torner, have contributed an overview of different types of solitons, including fundamental, multipole, and vortex solitons in reconfigurable lattices optically induced by non-diffracting radially symmetric and azimuthally modulated single Bessel beams, soliton control in networks etc. Self-similar evolution of four kinds of optical similaritons in $(1+1)$ dimensional nonlinear Schrödinger equation, their nature being discovered by Lei Wu and Porsezian using the lens-type transformation. The final part of this section accounts for the problem of characterization of light pulses that propagate in a dispersion-managed optical fiber system in which third order dispersion is acting as a strong perturbation.

In the second section, Akihiro Maruta and Yasuhiro Yoshika discuss the dispersion-managed optical fiber transmission for the propagation of multihump soliton with pulse-to-pulse spacing maintained. Considering versatile systems such as mode-locked lasers, as variants of the classical nonlinear Schrödinger equation, Mark J. Ablowitz and Theodoros P. Horikis have introduced a computational method to find localized waves in the form of solitonic solutions. Towards the end of this section, Carlos Montes, Antonio Picozzi, Celine Durniak, and Majid Taki, discuss the generation of backward symbiotic solitary waves in quadratic media with absorption losses through the nonlinear non-degenerate three-wave interaction. They have also proposed realistic experimental conditions in which backward coherent wave generation from incoherent excitation may be observed and studied.

The third section is concerned with exploration of the Maxwell-Bloch equations governing the pulse propagation in electromagnetically induced two and three level media. A.A. Zabolotskii deals with evolution of the integrable reduced Maxwell-Bloch equations describing interaction of light pulses with the two-level system in dipole approximation beyond the slowly varying envelope application. Miki Wadati extends it further exploring the Maxwell-Bloch equations for a three-level medium. Through the Backlund transformation, they attempt to derive the one-soliton and two-soliton solutions including the so-called simulton solution.

Section IV is concerned with the existence and collision of Ginzburg-Landau solitons. Chun-Kit Lam, Boris A. Malomed, Kwok Wing Chow and P.K.A. Wai deal with a modification of the complex Ginzburg-Landau equation with background linear loss and locally applied gain, a solution for pinned solitons is found in an analytical form. D. Mihalache, D. Mazilu, F. Lederer, H. Leblond, and B.A. Malomed report the results of the first analysis of collisions between stable fundamental and vortical three-dimensional dissipative solitons in a model of a laser cavity. Using the frame work of the continuous-discrete cubic-quintic Ginzburg-Landau model, D. Mihalache, D. Mazilu, and F. Lederer find spatiotemporal dissipative solitons numerically, which are highly confined inside two-dimensional photonic lattices. In the final part of this section, they report systematic results of collisions between discrete spatiotemporal Ginzburg-Landau solitons in waveguide arrays.

Section V deals with higher order nonlinear modes in the form of vortex solitons and soliton clusters propagating in the waveguides created in photonic crystal fibers made of a material with the focusing Kerr nonlinearity. Jose R. Salgueiro and Yuri S. Kivshar study numerically different families of such nonlinear modes with a nontrivial topology, bifurcations and also the soliton stability. Bertrand Kibler, Christophe Finot and John M. Dudley utilize the stochastic numerical simulations to study the statistical properties of supercontinuum spectra generated in photonic crystal fiber with two zero dispersion wavelengths.

The experimental realization of the nonlinear optical properties in fiber media, all-optical signal regeneration using the self-phase modulation in nonlinear fibers is systematically dealt in section VI. Masayuki Matsumoto describes in detail the high-speed on-off keying signal regeneration using a two-stage self phase modulation-based regenerator in bidirectional fiber configuration and on its application to differential phase-shift-keying signal regeneration. Further, Antonio Picozzi, Benoit Barviau, Bertrand Kibler and Sergio Rica analyze the thermalization of incoherent nonlinear optical fields ruled by scalar and vector nonlinear Schrödinger equation. They finally show that the thermodynamic properties of incoherent nonlinear waves may be analyzed by means of the fundamental $T dS$ equation of thermodynamics. At the end of the chapter, C.P. Jisha, V.C. Kuriakose and K. Porsezian have attempted to present a theoretical analysis using variational method to account for the experimental observation of stable propagation of a low power He-Ne laser beam through a bulk photopolymer (Methylene Blue sensitized poly-(Vinyl Alcohol)/Acrylamide (MBPVA/Acrylamide)).

Since this volume has grown out of contributions by eminent scientists in the field, it is believed that it will be of immense use to those who work in both soliton theory and experiments. Also we anticipate that this volume will widen the horizons of young researchers in theoretical physics, applied mathematics and contemporary engineering sciences. It is our duty to acknowledge those who made it possible to realize this volume. We would like to thank Dr. Angela Lahee and Ms. Sabine Lehr of Springer-Verlag, for their support in the preparation of this volume. The editors would also like to thank all the authors for their contributions and

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K. Porsezian

Department of Physics
School of Physical, Chemical and Applied Sciences
Pondicherry University
Puducherry – 605 014
India

V.C. Kuriakose

Department of Physics
Cochin University of Science and Technology, Kochi – 682 022
India