

PREFACE

After the invention of lasers, nonlinear optics has emerged as the most sought after subject in all the frontiers of science by both theoreticians and experimentalists. Indeed, nonlinear optics is one of the vital cores of recent scientific advancements and it continues to be so for future research work. Nonlinear optics has stirred many phenomena like fabrication of new nonlinear materials, harmonic generations, optical solitons, parametric amplification, stimulated Raman scattering, self-induced transparency, modulational instability, etc., which find a myriad of applications ranging from high data transmission in optical communication, switching, amplifiers, pulse reshaping, pulse compression, tunable lasers to encoded message transmission. Notable among these exciting phenomena is the concept of optical solitons, pioneered by Hasegawa of Japan. It revolutionized the scope of telecommunication world, mainly optical fiber communication (OFC), like never before and solitons are nowadays perceived to be the carriers of communication signals in near future. In recent years optical soliton fiber communication has attracted much interest in the academic and industrial worlds. In fact, the continuous pursuit of both methodological and technological innovation has led to the realization that conventional linear models of real systems suffer from severe limitations. Today the potential of soliton engineering is recognized worldwide with research groups actively working on this topic in every part of the globe. Perhaps, solitons are the most elegant and complex structures produced by nature in the realm of nonlinearity, which in fact attract theoreticians. On the other hand, for experimentalists, the main appeal is the prospect of applications of solitons in telecommunication, pulse compression, logic gates, optical switching and so on.

This special issue on “Optical Solitons: Theory and Experiments” is intended for beginners, research workers and experts in general who specialize in nonlinear dynamics/nonlinear optics as well as telecommunications. It is meant for readers from academic environment who are interested in the latest developments in optical soliton applications and those from technological environment who are interested in a first but in-depth look at the improvements that soliton based OFC can bring to existing systems. Articles cover a wide range of topics such as temporal and spatial solitons, nonlinear optical materials, nonlinear Schrödinger (NLS) systems, dark solitons and so on. Wadati briefly emphasizes a general introduction of solitons and their universality and ubiquity. Arumugam deals with the historical developments of optical fiber communication. Arivuoli discusses essentially the materials used in nonlinear optics. Lakshmanan and Kanna discuss an interesting new concept in the area of optical solitons, namely shape changing collisions of optical solitons and their connection to logic gate operations. Considering the coupled nonlinear Schrödinger (CNLS) equations, they review critically recent developments like partially coherent stationary solitons and so on in this area. Anderson, Lisak and Berntson present a variational approach to nonlinear Schrödinger equations in nonlinear optics and Rayleigh–Ritz optimization method is used to find the approximate solutions of different nonlinear evolution equations in optics. Chow and Lai present exact, periodic wavetrains for systems of coupled NLS equations obtained through Hirota method and theta function identities and confirm their results through computer algebra and also discuss the physical implications of their results. Maimistov considers completely integrable models of nonlinear optics by considering different optical effects and analyse his results in detail. By considering lossless as well as lossy couplers, Ajit Kumar discusses the concept of up-switching and down-switching between bistable solitons in doubly inhomogeneously

doped fiber systems. Vinoj and Kuriakose, using the Hirota bilinear scheme, present nonlinear compression of bright and dark solitary waves in inhomogeneous NLS equations. Crasovan *et al* review the concept of spinning solitons in both conservative and dissipative cubic-quintic nonlinear media. Malomed *et al* discuss the existence of fully stable spinning solitons in fibers with Kerr nonlinearity and in bulk media featuring a combination of the cubic self-defocusing and quadratic nonlinearities. Considering a system of CNLS equations for the fundamental and helical modes, results of collisions between solitons carried by two modes are discussed from the analytical and experimental point of view. Hasegawa, who is the father of optical solitons, presents an overview of soliton based communication researches on present day ultra-high speed communications and discusses the recent theoretical and experimental results in this area. Sukhorukov and Kivshar discuss the basic concepts of the theory of spatial solitons including soliton stability in non-Kerr media, collision of solitary waves in nonintegrable media. Wise reviews the recent experimental developments in the study of optical spatiotemporal solitons. Finally, Barill e and Rivoire analyze the experimental study of the light wave propagation in a planar waveguide filled with a liquid that confirms the model of the bidimensional spatial soliton and the spectral changes due to stimulated Rayleigh and Raman scattering are discussed.

To reach a diversified audience, a pool of internationally renowned scientists have graciously agreed to contribute articles treating the aspects of soliton engineering that they have mastered. The editors wish to thank them warmly for devoting their time to the preparation of their article. From the above articles, it is clear that we have covered different areas of optical solitons and their applications. We have enjoyed in compiling the volume together with the articles from the experts, and hope that the reader will feel the importance of optical solitons and other related optical devices in our future communication systems. We are very thankful to the Editors of *Pramana* for giving permission to edit this special issue and also to all the referees for their kind help and cooperation.

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(Guest Editors)