Introduction to the special issue on nonlinear optics

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THE 47 papers in this Nonlinear Optics Special Issue of the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS highlight the breadth of research that uses nonlinear optics as a focusing theme. The phenomena investigated range from the subsingle optical cycle duration, to infinitely long, aperiodic chaotic dynamics. This issue that comes at the heels of the last Nonlinear Optics Special Issue in 2002 is one of the largest issues of recent times and it proves again that there is ongoing and ever-expanding interest and active work in this area.

As in the past, the nonlinear optical properties of materials form a major subtopic in this issue, with the expanding interest in photonic bandgap materials strongly represented. Also, novel pulse propagation in nonlinear guided-wave materials continues as a major subtopic. In addition to more traditional nonlinear optics subjects in this particular topical issue of nonlinear optics, we have actively solicited papers in the area of laser dynamics, particularly novel communications with chaotic lasers. The last has attracted a large number of scientists because it not only promotes basic understanding of the various types of synchronization and systems, but it also has a large interdisciplinary flavor in such diverse fields as biology, population dynamics, chemistry, etc. In all of the subtopics, there is a strong emphasis on applications and strong evidence that phenomena that were physical curiosities only a few years ago are being rapidly understood and applied to the complex problems driving today's research.

The call soliciting papers for this Special Issue included, but was not limited to:

1) nonlinear dynamical effects in optical waveguides;
2) nonlinear phenomena in lasers and amplifiers;
3) temporal, spatial, and spatiotemporal dynamics in optical systems;
4) dynamics in harmonic generation and its applications;
5) dynamics in coupled lasers;
6) devices and application of dynamical optical systems;
7) novel applications related to optical communications with chaotic lasers;
8) nonlinear dynamical effects in nonlinear waves and turbulence.

The breath and depth of this issue are indeed remarkable. There are several papers that deal with the characterization of the nonlinearity of materials from semiconductor superlattices to polypeptides. Other papers cover the area of wavelength conversion by four-wave mixing in semiconductor optical amplifiers and Raman generation and amplification in fibers, efficient generation of terahertz radiation, and supercontinuum generation. Several papers are devoted to photonic crystal fibers and discuss soliton induced supercontinuum generation and high repetition femtosecond pulse sources. There are also several papers that deal with dynamics of lasers systems from optical injection, optoelectronic feedback, or optical feedback. The dynamics are investigated in the presence of noise and stochastic effects in vertical-cavity surface-emitting laser systems are also detailed. Several novel applications of chaotic or bistable systems are presented in several papers ranging a laser Doppler velocimeter to lidar systems that are using laser chaos.

There are six invited papers selected to highlight different topics in nonlinear optics. One of the invited papers experimentally addresses the controversial subject of synchronization of two lasers by *common* noise, while another discusses unidirectionally coupled synchronization of optically injected semiconductor lasers. A third invited paper investigates synchronization and coherent beam combination of a broad-area laser array. Another invited paper describes a transverse modulation instability in nematic liquid crystal that shows filamentation and spatial solitons. A fifth paper reports theoretical and experimental studies in fully chaotic microcavity laser diodes with stadium shapes. The final invited paper presents an investigation of nonlinear carrier dynamics in a multiquantum well semiconductor optical amplifier in the context of an ultrafast all-optical gate. We hope that the readers will find this Special Issue on Nonlinear Optics, with an emphasis on dynamical effects in lasers, to be interesting and a source of motivation for both new and existing novel research.

Finally, we would like to take the opportunity to thank the authors of the submitted papers and the reviewers for their time, work, and dedication that made this issue possible. Putting together an issue of this size and scope has been a major undertaking and we particularly appreciate both the patience and timely responses of those who contributed to this issue. We would also thank the Editorial Staff of the IEEE and, in particular, Linda Matarazzo and Janet Reed for their efforts to contact reviewers and provide management and editorial services.

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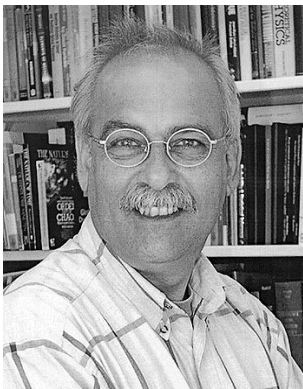
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