PHYSICS OF NONLINEAR OPTICS

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Photo 1 Angle-dependent spectral structure of continuum generation in heavy water (D_2O) pumped with 602-nm, 0.5-ps laser pulses: (a) noncoUinear emission, (b) collinear emission, and (c) overall emission. (See the explanation for Fig. 7.11 in the text.)

Photo 2 Spectral structure of coherent emission in benzene (C_6H_6) pumped with 602-nm, 0.5-ps laser pulses: (a) noncollinear emission, (b) collinear emission, and (c) overall emission. (See the explanation for Fig. 7.12 in the text.)

Photo 3 Spectral structure of coherent emission in carbon disulfide (CS_2) pumped with 602-nm, 0.5-ps laser pulses: (a) noncollinear emission, (b) collinear emission, and (c) overall emission. (See the explanation for Fig. 7.13 in the text.)

Photo 4 Spatial structures of Stokes spectral components of stimulated Raman scattering and four-wave-frequency-mixing in calcite crystal pumped with 532-nm, 8-ns laser pulses at three different intensity levels. (See the explanation for Fig. 8.7 in the text.)

Photo 5 Spatial structures of anti-Stokes spectral components of stimulated Raman scattering and four-wave-frequency-mixing in calcite crystal pumped with 532-nm, 8-ns laser pulses at three different intensity levels. (See the explanation for Fig. 8.8 in the text.)

Photo 6 Spectra of multi-order anti-Stokes stimulated Raman scattering in high-pressure hydrogen (H_2) sample pumped with 1064-nm, 8-ns laser pulses at three different intensity levels. (See the explanation for Fig. 8.10 in the text.)

Photo 7 Spectra of the forward stimulated Raman scattering (upper trace) and the backward stimulated Rayleigh-Kerr scattering (lower trace) in a 10-cm long CS_2 liquid cell pumped with 532-nm, 10-ns laser pulses of 1-cm^{-1} linewidth at three different intensity levels. (See the explanation for Fig. 8.40 as well as reference [138] in Chapter 8.)

Photo 8 Experimental demonstration of optical phase-conjugation for backward stimulated scattering and emission. Near-field images carried by (a) the 532-nm (or 1064-nm) pump laser beam, (b) the backward stimulated Brillouin scattering from an acetone-filled vial, (c) and (d) the forward and backward two-photon pumped lasing from a dye-solution filled vial, (e) and (f) the forward and backward stimulated Raman scattering from a benzene-filled vial. (See the explanation for Fig. 9.28 in the text.)

Preface

Nonlinear optics is a revolutionary extension of conventional (linear) optics promoted by laser technology. The main subject of nonlinear optics is the study of various effects and phenomena related to the interaction of intense coherent light with matter. A number of books on this topic have been published in the past. Some of them emphasize theoretical descriptions and mathematical formulations, whereas others emphasize technical aspects or experimental results.

This book is written based on the progress and achievements of nonlinear optics over the past forty-years. Within the same time-period, the authors have conducted fundamental research in the field of quantum electronics and published several books on nonlinear optics, laser physics, and laser devices.

This book focuses on both theoretical and experimental descriptions of various nonlinear optical effects and phenomena. Specifically, each chapter or each major section is composed of the following four basic parts: (1) Conceptual discussions and explanations of mechanisms; (2) Rigorous and concise mathematical formulation; (3) Typical experimental behavior and techniques; and (4) Up-to-date research achievements and applications.

In nonlinear optics and related areas, there are a tremendous number of published papers and conference presentations from the past four decades. However, only a very limited number of papers are cited in this book, based on the following three criteria: (i) original papers with the significance of novelty or innovation, (ii) earlier studies establishing basic understanding of the effects or phenomena, (iii) selected examples from a large number of similar studies. Although it is our desire to include all related papers of importance, due to the scope and size of this book, some of them are not cited. We would like to apologize for this.

We are deeply grateful to Prof. Yiping Cui (Southeast University, China), who has written Chapter 6 of this book and suggested the title of the book.

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We are indebted to those authors whose works have been quoted in this book. We are also grateful to many authors and publishers for the permission of reproducing their figures in this book.

Finally, one of us (G. S. H.) wishes to express special thanks to Dr. Paras N. Prasad, the Distinguished Professor and Director of Photonics Research Laboratory, State University of New York at Buffalo, for his valuable support and encouragement in conducting research activities.

The International System of Units (SI) is used throughout this book for all formulations.

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1999

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