Advances in Information Optics and Photonics

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Editors
Library of Congress Cataloging-in-Publication Data

Advances in information optics and photonics / Ari T. Friberg and René Dändliker.
   p. cm. -- (Press monograph ; PM183)
   Includes bibliographical references and index.
   TK5103.59.A35 2008
   621.3827--dc22
   2008022953

Published by

SPIE
P.O. Box 10
Bellingham, Washington  98227-0010 USA
Phone: +1 360 676 3290
Fax: +1 360 647 1445
Email: spie@spie.org
Web: http://spie.org

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Printed in the United States of America.
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• Computing: A Joint Venture for Light and Electricity? P. Chavel

The second book in the series appeared under the title “Current Trends in Optics” in the Lasers and Optical Engineering series of Academic Press Limited, London, 1994 (ISBN 0-12-20720-4). The Editor is ICO Past President, Prof. J.C. Dainty of Imperial College, London. It includes the following chapters:

• Atomic Optics, S.M. Tan and D.F. Walls
• Single Atoms in Cavities and Traps, H. Walther
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Preface

This volume is the sixth in a series of books that the International Commission for Optics (ICO) edits for publication at the time of its triennial congresses. The earlier volumes have covered a broad scope of interests in optics at the time and have dealt with fundamental subjects, while the later editions have increasingly addressed advances in applied optics and photonics. The books previously published in the series are


The complete history of the ICO Book series, including the Tables of Contents of the previous volumes, can be found on p. xix of this book.

Besides highlighting the main developments of international optics and photonics, the aim of this book series is to promote the general awareness of the ICO and raise funds for its global activities, in particular the travelling lecturer program, which is aimed at enhancing optics in developing nations. Therefore all royalties will go to the ICO for that purpose.

In today’s ‘age of light,’ optical information science and technology play a central role. The ICO has a long tradition in the subjects of information optics, dating back to the ICO topical meetings in Kyoto, Japan 1994 (Frontiers in Information Optics) and Tianjin, China 1998 (Optics for Information Infrastructure). The ICO has also been a permanent sponsor of the Optical Computing/Optics in Computing conferences, a series of meetings spanning well over a decade. In 2006, the ICO organized two key events on information optics: the ICO topical
• Meet a Squeezed State and Interfere in Phase Space, D. Krhmer, E. Mayr, K. Vogel and W.P. Schleich
• Can Light Be Localized? A. Lagendijk
• Time-resolved Laser-induced Breakdown Spectrometry, G. Lupkovics, B. Nemet and L. Kozma
• Fractal Optics, J. Uozumi and T. Asakura
• On the Spatial Parametric Characterization of General Light Beams, R. Martinez-Herrero and P.M. Mejias
• To See the Unseen: Vision in Scattering Media, E.P. Zege and I.L. Katsev
• Backscattering Through Turbulence, A.S. Gurvich and A.N. Bogaturov
• Why is the Fresnel Transform So Little Known? F. Gori
• Fourier Curios, A.W. Lohmann
• The Future of Optical Correlators, D. Casasent
• Spectral Hole Burning and Optical Information Processing, K.K. Rebane
• Holographic Storage Revisited, G.T. Sincerbox
• Colour Information in Optical Pattern Recognition, M.J. Yzuel and J. Campos
• The Optics of Confocal Microscopy, C.J.R. Sheppard
• Diffraction Unlimited Optics, A. Lewis
• Super-resolution in Microscopy, V.P. Tychinsky and C.H.F. Velzel
• Fringe Analysis: Anything New? M. Kujawinska
• Diagnosing the Aberrations of the Hubble Space Telescope, J.R. Fienup
• Laser Beacon Adaptive Optics: Boom or Bust? R.Q. Fugate

The third book in the series appeared in August 1996 under the title *Trends in Optics—Research, Developments and Applications*. ISBN 0-12-186030-2. Like its two predecessors, it was published by Academic Press. The Editor is ICO Past President, Prof. Anna Consortini of Universita degli Studi di Firenze, Italy. The Museo ed Istituto della Scienza in Florence deserves thanks for its permission to use the photography of one of its Galileo Galilei lenses as cover illustration. The book includes the following chapters:

• A Short History of the Optics Group of the Willow Run Laboratories, E.N. Leith
• Bio-speckles, Y. Aizu and T. Asakura
meeting on Optoinformatics / Information Photonics in St. Petersburg, Russia (Chairs A. V. Pavlov, M. L. Calvo, and J. Jahns) and the ICO/ICTP Winter College on Optics in Trieste, Italy, with title “Quantum and Classical Aspects of Information Optics” (Directors P. Tombesi, M. L. Calvo, and P. Knight). Additionally, the recent ICO Prizes – most notably those in 2003 (B. J. Eggleton), 2004 (A. V. Krishnamoorthy), 2005 (I. Bloch), and 2006 (H. Sotobayashi) – have dealt with various basic and applied aspects of optical information. Hence it was quite natural to take advantage of these developments and focus the current volume of the ICO Book series on Advances in Information Optics and Photonics.

The present volume VI differs from the previous ones in at least three respects: it concentrates on a specific, though extremely important, topic within the broad field of optics and photonics, it does not contain the words ‘International Trends’ explicitly in the title, and it is published as a paperback. We hope that with these changes the book will find its way as a standard reading and reference material on the topic. The volume consists of 32 invited contributions from scientists or research groups working throughout the world on optical information science, technology, and applications. Many of the authors have actively participated in the ICO conferences and other activities and all of them are internationally recognized leaders in their respective subjects.

Many new concepts in classical and quantum-entangled light, coherent interaction with matter, novel materials and processes have led to remarkable breakthroughs in information science and technology. While it is difficult, and sometimes even dangerous, to group the contributions under separate headings, we have divided the chapters of this book into 7 sections:

1. Beam Optics
2. Laser Photonics and Components
3. Electromagnetic Coherence
4. Imaging, Microscopy, Holography, and Materials
5. Photonic Processing
6. Quantum Information and Matter
7. Communications and Networks

The sections contain chapters that address optical information sciences broadly in the linear, nonlinear, classical, and quantum regimes and describe the foundations, state-of-the-art devices and technologies, as well as the diverse applications of information optics and photonics. It is hoped that the reader will find chapters that are directly relevant to his/her own
work or otherwise will create interest in this fascinating, rapidly advancing, and highly potential subject.

We would like to express our sincere appreciation to all of the authors who have devoted their time, effort, and expertise to write the superb and timely contributions for this volume. We would also like to thank the staff of SPIE Press, and especially Merry Schnell, Gwen Weerts, and Eric Pepper, for their professional work to produce this high-quality publication for the benefit of the global optics and photonics community.

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• Olmec Mirrors: An Example of Archaeological American Mirrors, J.J. Lunazzi
• Galileo Galilei: Research and Development of the Telescope, G. Molesini and V. Greco
ICO International Trends in Optics
Series History

The first book in the series appeared in 1991 under the title “International Trends in Optics” in the Lasers and Optical Engineering series of Academic Press. The Editor was 1987–1990 ICO President, Prof. J.W. Goodman of Stanford University, USA. It includes the following chapters:

- Integrated Optics, OEICs, or PICs? H. Kogelnik
- Quantum Optoelectronics for Optical Processing, D.A.B. Miller
- Optics in Telecommunications: Beyond Transmission, P.W.E. Smith
- Microoptics, Kenichi Iga
- Holographic Optical Elements for Use with Semiconductor Lasers, H.P. Herzig and R. Dändliker
- Fibre-Optic Signal Processing, B. Culshaw, I. Andonovic
- Optical Memories, Yoshito Tsunoda
- How Can Photorefractives Be Used? H. Rajbenbach and J.-P. Huignard
- Adaptice Interferometry: A New Area of Applications of Photorefractive Crystals, S.I. Stepanov
- Water Wave Optics, J. J. Stamnes
- About the Philosophies of Diffraction, A.W. Lohmann
- The Essential Journals of Optics, J.N. Howard
- Optics in China: Ancient and Modern Accomplishments, Z.-M. Zhang
- Unusual Optics: Optical Interconnects as Learned from the Eyes of Nocturnal Insects, Crayfish, Shellfish, and Similar Creatures, P. Greguss
- The Opposition Effect in Volume and Surface Scattering, J.C. Dainty
The fourth book in the series appeared in August 1999 under the title *International Trends in Optics and Photonics*. It was edited by Prof. T. Asakura and published by Springer-Verlag as Volume 74 of the Springer Series in Optical Sciences. The book includes the following chapters:

- Optical Twist, *A.T. Friberg*
- Principles and Fundamentals of Near Field Optics, *M. Nieto-Vesperinas*
- Atoms and Cavities: the Birth of a Schroedinger Cat of the Radiation Field, *J.-M. Raimond and S. Haroche*
- Quantum Tomography of Wigner Functions from Incomplete Data, *V. Buzek, JG. Drobny and H. Wiedemann*
- Some New Aspects on the Resolution in Gaussian Pupil Optics, *S.S. Lee, M.H. Lee and Y.R. Song*
- Holographic Optics for Beamsplitting and Image Multiplication, *A.L. Mikaelian, A.N. Palagushkin and S.A. Prokopenko*
- Image Restoration, Enhancement and Target Location with Local Adaptive Linear Filters, *L. Yaroslavsky*
• All-Optical Regeneration for Global-Distance Fiber-Optic Communications, E. Desurvire and O. Leclerc
• Non Quantum Cryptography for Secure Optical Communications, J.P. Goedgebuer
• Pulsed Laser Deposition: An Overview, I.N. Mihailescu and E. Gyorgy
• Absolute Scale of Quadratic Nonlinear-Optical Susceptibilities, I. Shoji, T. Kondo and R. Ito
• Femtosecond Fourier Optics: Shaping and Processing of Ultrashort, Optical Pulses, A.M. Weiner
• Aperture Modulated Diffusers (AMDS), H.P. Herzig and P. Kipfer
• Optical Properties of Quasi-Periodic Structures: Linear and Nonlinear Analysis, M. Bertolotti and C. Sibilia
• Diffractive Optical Elements in Materials Inspection, R. Silvennoinen, K.-E. Peiponen and T. Asakura
• Multiple-Wavelength Interferometry for Absolute Distance Measurement, R. Dandliker and Y. Salvade
• Speckle Metrology—Some Newer Techniques and Applications, R.S. Sirohi
• Limits of Optical Range Sensors and How to Exploit Them, G. Hauser, P. Ettl, M. Schenk, G. Bohn and I. Laszlo
• Imaging Spectroscopy for the Non-Invasive Investigations of Paintings, A. Casini, F. Lotti and M. Picollo
• Optical Coherence Tomography in Medicine, A.F. Fercher and C.K. Hitzenberger
• The Spectral Optimization of Human Vision: Some Paradoxes, Errors and Resolutions, B.H. Soffer and D.K. Lynch
• Optical Methods for Reproducing Sounds from Old Photograph Records, J. Uozumi and T. Asakura

The fifth book in the series appeared in August 2002 under the title International Trends in Applied Optics. It was edited by Past President of ICO, Arthur H. Guenther and published by SPIE. The book includes the following chapters:

• Ultrashort-Pulse Laser-Matter Interaction and Fast Instabilities, M. N. Libenson
• Ultrafast Mode-locked Lasers for the Measurement of Laser Frequencies and as Optical Clockworks, R. Holzwarth, T. Udem, and T. W. Hänsch
• Ablation of Metals with Femtosecond Laser Pulses, S. I. Anisimov
• Laser Microprocessing and Applications in Microelectronics and Electronics, Y. Feng Lu
• There are No Fundamental Limits to Optical Lithography, S. R. J. Brueck
• Laser-produced Rapid Prototyping in Manufacturing, Y. P. Kathuria
• Computer Numerically Controlled Optics Fabrication, H. Pollicove and D. Golini
• Interference Coatings for the Ultraviolet Spectral Region, N. Kaiser
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• Advances in Thin Films, K. Lewis
• Recent Progress in System and Component Technologies for Fiber Optic Communication, N. Shibata
• Short-Distance Optical Interconnections with VCSELs, H. Thienpont and V. Baukens
• Spontaneous Emission Manipulation, M. O. Scully, S. Zhu, and M. S. Zubairy
• Progress in Fiber Optics and Optical Telecommunication, A. K. Ghatak and B. P. Pal
• Nano- and Atom Photonics, M. Ohtsu
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• Optical Pattern Recognition of Partially Occluded Images, K. Chalasińska-Macukow
• Optical Sensing by Fiber and Integrated Optics Devices, G. C. Righini
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• Polarimetric Imaging, P. Réfrégier, F. Goudail, and P. Chavel
• Atmospheric Compensation, R. Q. Fugate
- Coherent Imaging Metrology in Life Sciences and Clinical Diagnostics, G. von Bally
- Optical Data Storage, H. Coufal and G. W. Burr
- Archaeological Optics, J. M. Enoch
- Thirty Years of Laser Applications in Conservation, R. Salimbeni, Roberto Pini, and S. Siano