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*Most of the texts available on lasers deal with laser engineering and laser applications, only a few of them treating theoretical aspects of the laser at an advanced level.*

*Introduction to Laser Physics provides an introduction to the essential physics of quantum electronics and*

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*lasers. Fundamental topics in modern optics, the applicability of various theoretical approaches, and the physical meaning of laser-related phenomena are carefully described. Experimental results and properties of practical lasers are interwoven, thereby allowing an explicit demonstration of the rate equation approach and the semiclassical treatment. The basic concepts of nonlinear optical devices and laser*

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*spectroscopy are introduced. The second edition includes additional information on optical resonators, minor improvements of the text and several new problems, completed with solutions.*

*In recent years there has been renewed interest in the scientific and industrial communities in tunable solid state vibronic lasers. Much of this has been spurred by the user desirous of obtaining compact primary laser sources*

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*(independent of nonlinear optical frequency shifts) throughout the visible and near infra-red spectral regions. To further motivate and stimulate research and development in this area, workshops sponsored by the Laser Division of the US Army Night Vision Electro-Optics Laboratory (NVEOL) at Fort Belvoir, Virginia were held during 1-3 April 1981 and 16-17 June 1983 at Keystone and NVEOL, respectively. The consensus of opinion*

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*of the participants at these workshops was that any successful program leading to the identification and development of vibronic tunable laser materials in the visible and IR must include coordinated activity between crystal growers, theoretical and experimental investigators into the fundamental processes of vibronic lasing, and laser device engineers. Continued interaction between government, industry, and academia was encouraged*

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*in order to establish a unified approach to these areas and, when necessary, redefine and redirect programmatic activity. The organization of this 1st Annual Conference on Tunable Solid State Lasers held at the La Jolla Institute 13-15 June 1984, was based around the latest results in tunable vibronic materials and laser development, but structured in a manner consistent with the recommendations of the NVEOL*

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*workshops.*

*A new volume in the field's bestselling options reference--an entirely new opus focusing on x-ray, nonlinear, and vision optics. Provides the same mix of tutorial writing with in-depth reference material that distinguished Volumes I & II.*

*In this book series on Optical Sciences, holography has been the subject of three previous volumes. In particular, Vol. 16, written by one of*

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*us (W. S. ) and Dr. M. Dubas, treated holographic interferometry of opaque bodies from the standpoint of deformation analysis. However, the fundamental principles of holography are developed there only briefly in preparation for a discussion of interference fringe modifications. This new volume in the series is intended to consider in detail many topics which were previously omitted, such as the deformation or distortion of holo*



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*graphic images, the theory of volume holograms, composite or multiplex holography, holographic interferometry of transparent media, time dependent effects, holographic contouring, and applications of fringe modifications to the deformation of opaque bodies. In addition, these and other subjects will be treated with the same unifying concept developed in Vol. 16, but with an additional emphasis on those features that have their origins in*

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*classical optics, especially the small-wavelength approach, the coupled-wave theory, and the Seidel aberrations. Since the field of holography and its various applications is growing rapidly, it is impossible to be comprehensive in a single book. Every effort has been made to avoid unnecessary duplication of Vol. 16. For example, displacement and fringe localization problems are only briefly discussed, while some modification*

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*techniques (e. g. , sandwich holography) are not included. When needed, however, the reader is directly referred to complementary publications. This book has been prompted by our desire to share with others our appreciation of the harmony and beauty in a particular sphere of modern optics known as "optical phase conjugation". Practical applications of the phase conjugated wave are likely to be far-reaching. Optical phase conjugation*

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*(OPC) combines in itself aesthetic and pragmatic attractiveness, a synthesis that has made OPC a subject of general attention. The figure presents the approximate rate of publications (number of articles per year) on OPC in the world literature for recent years, the lower curve denoting the work carried out in the USSR. The efforts of a large unofficial international collective have yielded an impressive result. 150 100 50 1975 1980 At present, the*

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*physical processes underlying various OPC methods are quite understandable, and it is the physics of OPC to which our book is devoted. Practical and scientific applications of phase-conjugated waves, which are of no less interest, have been touched upon in short, as major achievements in this sphere are a matter of the future. Today there are two main methods of OPC: i) by backward stimulated light scattering, ii) by four-wave mixing.*

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Naturally, much attention is given to these methods in our book which, after the introductory Chap. 1, can be divided into two almost independent parts - Chaps. 2 - 5, and Chaps. 6 - 8.

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X-ray microscopy fills a gap between optical and electron microscopy. Using soft x-rays, a resolution higher than with visible light can be obtained. In comparison to electron microscopy, thick, wet, unstained specimens can be examined. This is especially advantageous for biological applications. The intense synchrotron radiation of electron storage



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rings and the development of optical elements for soft x-rays render x-ray microscopy feasible for basic research. Wider applications will be possible in the future with the development of laboratory x-ray sources and microscopes. In 1979 a conference on x-ray microscopy was organized by the New York Academy of Sciences and in 1981 a symposium on high resolution soft x-ray optics was held at Brookhaven. The present volume contains the contributions to the symposium "X-Ray Microscopy", organized by the

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Akademie der Wissenschaften in Göttingen in September 1983. In their capacity as conference chairmen, the editors would like to thank the Akademie der Wissenschaften, especially Prof. H.G. Wagner, Secretary of the Academy, and Mr. J. Pfahlert for organizing the symposium. We are indebted to the Stiftung Volkswagenwerk for financial support. The symposium was held at the Max-Planck-Institut für Stromungsforschung. We are grateful for their hospitality and assistance during the symposium. Thanks

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are due to all authors and to the Springer Verlag for their combined efforts. We thank Dipl.-Phys. P. Guttman, Dr. B. Niemann and Mrs. A. Marienhagen for their assistance during the final preparation of the manuscripts.

Photon correlation is a kind of spectroscopy designed to identify optical frequency shifts and line-broadening effects in the range of many MHz down to a few Hz. The optical intensity is measured in terms of single photon detection events which result in current pulses at the

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output of photomultiplier tubes. This signal is processed in real time in a special-purpose parallel processor known as a correlator. The resulting photon correlation function, a function in the time domain, contains the desired spectral information, which may be extracted by a suitable algorithm. Due to the non-intrusive nature and the sound theoretical basis of photon correlation, the phenomena under study are not disturbed, and the parameters in question can be precisely evaluated. For these reasons photon

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correlation has become a valuable and in many instances indispensable technique in two distinct fields. One of these is velocimetry in fluid flow. This includes hydro- and aerodynamic processes in liquids, gases, or flames where the velocity field may be stationary, time periodic, or turbulent, and may range from micrometers per second for motion inside biological cells to one kilometer per second for supersonic flow. The other major field is stochastic particle propagation due to Brownian motion.

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The CO<sub>2</sub>-laser technology may be considered the most advanced in the laser field. Research has been stimulated strongly because of its high potential for many scientific and industrial applications. This book is primarily devoted to the main, more established developments of the CO<sub>2</sub>-laser. Advances in continuous systems, pulsed systems, mode-locked pulses, and the amplification of short pulses are dealt with in detail. This is done by giving an extensive treatment of relevant molecular physics, gas kinetics,

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excitation and relaxation processes, and laser physics pertinent to CO<sub>2</sub>. It also provides a thorough theoretical background of specific technologies used in various devices. Many numerical values of physical constants and accurate spectroscopic data of CO<sub>2</sub> isotopes are included.

Our intent in producing this book was to provide a text that would be comprehensive enough for an introductory course in integrated optics, yet concise enough in its mathematical derivations to be easily readable by a practicing engineer who

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desires an overview of the field. The response to the first edition has indeed been gratifying; unusually strong demand has caused it to be sold out during the initial year of publication, thus providing us with an early opportunity to produce this updated and improved second edition. This development is fortunate, because integrated optics is a very rapidly progressing field, with significant new research being regularly reported. Hence, a new chapter (Chap. 17) has been added to review recent progress



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and to provide numerous additional references to the relevant technical literature. Also, thirty-five new problems for practice have been included to supplement those at the ends of chapters in the first edition. Chapters I through 16 are essentially unchanged, except for brief updating revisions and corrections of typographical errors. Because of the time limitations imposed by the need to provide an uninterrupted supply of this book to those using it as a course text, it has been possible to include new

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references and to briefly describe recent developments only in Chapter 17. However, we hope to provide details of this continuing progress in a future edition. One of the most remarkable things about seeing is how effortless this complex task appears to be. This book provides a comprehensive overview of research on the myriad complexities of this task. Coverage includes such classic topics as color, spatial, and binocular vision, areas that have seen a recent explosion of new information such as motion vision, image

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formation and sampling, and areas where new tools have allowed a better investigation into processes (e.g. neural representation of shape, visual attention). Seeing is a needed reference for researchers specializing in visual perception and is suitable for advance courses on vision.

[Interim Report, 1976](#)

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The optoacoustic method has by now an almost one-century-long history of application in spectroscopy, but it was only with the advent of the laser that it became a convenient and

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effective method among the vast family of spectroscopy techniques. The great variety of these techniques is capable of tackling most diversified tasks, such as the achievement of a high sensitivity and a high spectral or temporal resolution. The optoacoustic method is one of the simplest and most versatile ways to attain a high sensitivity for both gaseous and condensed media. It is precisely for this reason that the method has found wide use, and that we have decided to publish a monograph reviewing the information on this method available in the literature and gathered by us at the Institute of Spectroscopy during the past few years. We hope that such a systematic exposition of the material scattered throughout numerous scientific journals will be of use to many potential readers. The reader will undoubtedly notice the

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absence in our monograph of references to some recent works, but unfortunately, this is inevitable when the translation and publication of a book in a foreign language takes several years. Nevertheless, we tried our best to cover the entire field from the material available to us, but unfortunately, some recent publications might be missing due to the time lag for the translation and publication in a language foreign to us.

The most comprehensive and up-to-date optics resource available Prepared under the auspices of the Optical Society of America, the five carefully architected and cross-referenced volumes of the Handbook of Optics, Third Edition, contain everything a student, scientist, or engineer requires to actively work in the field. From the design of complex optical

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systems to world-class research and development methods, this definitive publication provides unparalleled access to the fundamentals of the discipline and its greatest minds.

Individual chapters are written by the world's most renowned experts who explain, illustrate, and solve the entire field of optics. Each volume contains a complete chapter listing for the entire Handbook, extensive chapter glossaries, and a wealth of references. This pioneering work offers unprecedented coverage of optics data, techniques, and applications. Volume V covers atmospheric optics, modulators, fiber optics, and x-ray and neutron optics.

In this newest edition of Optics and Lasers, I have added a substantial number of problems and moved most of the older ones to the end of the book. There are now about one

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hundred problems, which, I hope, will make the book more useful in the classroom. As before, some of the problems derive an especially important or useful result; these I have left integrated within the body of the book. In such cases, I state the result and, often, give it an equation number and a citation in the index. Teachers who adopt the book may obtain solutions to the problems by asking me for them on letterhead stationery. In addition, I have rewritten over a dozen paragraphs to improve their clarity or precision and, further, corrected minor errors of punctuation and taken care of other such small details. The field of optics has been changing greatly for almost two dozen years. Partly because of the applied or engineering nature of much of modern optics, there has been a need for a practical text that surveys



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the entire field. Such a book should not be a classical-optics text, but, rather, it should be strong on principles, applications and instrumentation, on lasers, holography and coherent light, and on optical-fiber waveguides. On the other hand, it should concern itself relatively little with such admittedly interesting phenomena as the formation of the rainbow or the precise determination of the speed of light. Basic and Clinical Applications of Vision Sciences contains the edited papers presented at the Enoch Vision Science Symposium, April 27-30 1996, which was organized in honor of the pioneer in vision science, Dr Jay M Enoch. Dr Enoch served for twelve years as Dean, School of Optometry, University of California, Berkeley. The book is organized along the lines of Dr. Enoch's contributions to vision science,

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but is not limited to these topics. Of special note, the reader will find papers on important new developments in photoreceptor, ophthalmic and visual optics, retinal imaging, ophthalmic physiology and pathophysiology, visual psychophysics and visual techniques. The papers are grouped into the following sections: photoreceptor optics; ophthalmic and visual optics; binocular vision, developmental vision, eye movements and physiology; ophthalmic dysfunction; visual psychophysics and clinical applications; history of vision science. £/LIST£

The aim of this book is to outline the physics of image formation, electron specimen interactions, imaging modes, the interpretation of micrographs and the use of quantitative modes "in scanning electron microscopy (SEM). It forms a

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counterpart to Transmission Electron Microscopy (Vol. 36 of this Springer Series in Optical Sciences) . The book evolved from lectures delivered at the University of Münster and from a German text entitled Raster-Elektronenmikroskopie (Springer-Verlag), published in collaboration with my colleague Gerhard Pfefferkorn. In the introductory chapter, the principles of the SEM and of electron specimen interactions are described, the most important imaging modes and their associated contrast are summarized, and general aspects of elemental analysis by x-ray and Auger electron emission are discussed. The electron gun and electron optics are discussed in Chap. 2 in order to show how an electron probe of small diameter can be formed, how the electron beam can be blanked at high frequencies for time-resolving

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experiments and what problems have to be taken into account when focusing.

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[Perimetry Update 1996/1997](#)

[Proceedings of the Second International Symposium,](#)

[Tucson, Arizona, October 23-25, 1982](#)

[Proceedings of the International Symposium, Göttingen, Fed.](#)

[Rep. of Germany, September 14-16, 1983](#)

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## Seeing

### Laser-Induced Dynamic Gratings

There have been two major review articles on the iodine laser in the last 11 seven years, liThe Photochemical Iodine Laser by K. Hohla and K. Kompa (Handbook of Chemical Lasers, edited by R. Gross and J. Bott, Wi 1 ey, New York, 1976) and a SANDIA report (No. 78-1071, 1978) entitled liThe Atomic Iodine Laserll. Since then, a large body of new material has been published, and practical experience has been gained with large iodine laser systems in Garchi ng (ASTERIX II I) and in the USSR. These 1 asers have now become very reliable

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tools, especially in fusion-oriented plasma experiments, which represent their main field of application. They can deliver powers in excess of many terawatts per beam and are thus also suited for use in other areas such as X-ray lasers, incoherent X-ray sources, compression of matter and its behaviour at very high densities. The physics of the iodine laser is now rather well understood, and its technology has reached a standard adequate for the construction of large scale systems in the multi-hundred kJ range. In view of this new situation, we thought it useful to document the present state of the

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art in a book. Its contents and the literature cited therein have been chosen to cover those areas which are of main concern in the design and operation of pulsed high-power iodine lasers.

The aim of this book is to outline the physics of image formation, electron specimen interactions and image interpretation in transmission electron microscopy. The book evolved from lectures delivered at the University of Munster and is a revised version of the first part of my earlier book *Elektronenmikroskopische Untersuchungs- und Präparationsmethoden*, omitting the part

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which describes specimen-preparation methods. In the introductory chapter, the different types of electron microscope are compared, the various electron-specimen interactions and their applications are summarized and the most important aspects of high-resolution, analytical and high-voltage electron microscopy are discussed. The optics of electron lenses is discussed in Chapter 2 in order to bring out electron-lens properties that are important for an understanding of the function of an electron microscope. In Chapter 3, the wave optics of electrons and the phase shifts by electrostatic and



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magnetic fields are introduced; Fresnel electron diffraction is treated using Huygens' principle. The recognition that the Fraunhofer-diffraction pattern is the Fourier transform of the wave amplitude behind a specimen is important because the influence of the imaging process on the contrast transfer of spatial frequencies can be described by introducing phase shifts and envelopes in the Fourier plane. In Chapter 4, the elements of an electron-optical column are described: the electron gun, the condenser and the imaging system. A thorough understanding of electron-specimen

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interactions is essential to explain image contrast.

In June 1984 a conference on visible and IR tunable solid-state lasers was held in La Jolla, California. The proceedings were published as the first volume of this series, Tunable Solid State Lasers \*. The emphasis of this meeting focused on discerning unified themes in the generic areas of: - Laser host/dopant identification and growth procedures, - Theoretical analysis to elucidate fundamental tunable laser principles, - Experimental investigations on laser spectroscopy to which theoretical

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analyses and models can be anchored, and - Auxiliary technology developments in efficient laser pumping sources (diodes, flashlamps). Subsequent to the La Jolla conference, two topical meetings were held, co-sponsored by the Lasers and Electro-Optics Society of the Institute of Electrical and Electronics Engineers, and the Optical Society of America (OSA). The contents of Tunable Solid-State Lasers II comprise the proceedings of the second of these two, held at Rippling River Resort, Zigzag, Oregon, June 4-6, 1986. In addition to the four areas of attention in the La Jolla meeting, papers

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on color-center and new rare-earth lasers, and on nonlinear frequency shifting were also given. In a fashion similar to the previous meetings, the informal atmosphere of the conference and meeting site was conducive to constructive interaction among the attendees. A total of 54 papers were scheduled for presentation, 20 of which were invited and 34 contributed.

This volume of Documenta Ophthalmologica Proceedings Series collects the scientific papers presented at the 2nd International Symposium on Retinal Pigment Epithelium and the 4th Meeting of the European Macula Group

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held in Genoa, May 29–June 1, 1996. The Symposium on Retinal Pigment Epithelium was promoted by the University Eye Clinic of Genoa as the natural continuation of the first Symposium held with great success in Genoa in 1988. The previous Meetings of the European Macula Group were held in Coimbra (1988), Crete (1989) and Athens (1994). I was greatly pleased and honoured to host the fourth congress of this distinguished Society and I am grateful to Gabriel Coscas, Jose Cunha-Vaz and George Theodossiadis, founders of the Society, for selecting Genoa on this occasion. The two meetings integrated well in

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an unicuum and brought together an exceptional number of outstanding retinal specialists coming from all over the world. All the aspects of the current research concerning retinal pigment epithelial and macular diseases were covered. Several interesting presentations regarded new techniques of retinal and choroidal imaging. A full session was dedicated to the latest advances in culture and transplantation of retinal pigment epithelial cells. Age-related macular degeneration was a major subject for discussion, including new approaches to treatment. This topic was high lighted by a

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mini-symposium on drusen, including a series of superb lectures on classification, clinicopathological studies, indocyanine green imaging, and laser treatment for prevention of choroidal neovascularization. As there recently has been increased interest in the applications of optical techniques in biomedical research and clinical diagnostics, it seemed to be appropriate to organize a comprehensive international conference on optics in medicine and biology. Such a broad international meeting had not been held before. An international conference on Optics in Biomedical Sciences was organized and took

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place in Graz, Austria, September 7th through 11th, 1981, sponsored by the International Commission for Optics (ICO) in co operation with the European Optical Committee, the Austrian Association on Biomedical Engineering, and the German Society for Applied Optics. It seemed timely to establish a forum for communication among specialists on an international level. This book, presenting the papers given at this conference, demonstrates the state of the art of this increasingly expanding field of applications of optics. Furthermore, the interested reader will find an extended list



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of references in the various contributions. This book helps to overcome the difficulty, inherent in all interdisciplinary research fields, of gathering widely scattered literature. The contributions to this book are focussed on the following topics:

Biomedical applications of - unconventional imaging in microscopy, - image processing, - interferometry and holography, - speckle-techniques and spectroscopy, - optometry, and - Moire methods. In addition, the brilliant and humorous closing remarks of Nils Abramson from the Royal Institute of Technology, Stockholm, have been included.

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The Workshop on Tunable Solid State Lasers for Remote Sensing was held at Stanford University in October 1984 to assess the state of the art in tunable solid state lasers for remote sensing from satellite platforms. The value of conducting global remote sensing measurements of

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atmospheric chemistry, climate, and weather in the 1990s is now established. What is not yet defined, however, is the status of the developing tunable laser technology that must meet both the scientific requirements and the space platform constraints. This workshop was convened by the Office of Aeronautics and Space Technology (OAST) of the National Aeronautics and Space Administration (NASA) to assess the status and progress in tunable solid state laser sources for remote sensing. The workshop was organized to facilitate information exchange across a number of technologies from remote sensing requirements to crystal growth of the materials important for the development of the tunable laser sources. The emphasis was on the recent developments in tunable solid state laser sources necessary

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to meet the future transmitter requirements for global remote sensing. A goal of the workshop was to form recommendations to NASA on the current and future prospects for solid state laser technology that will allow remote sensing measurements from air, shuttle, and free-flying satellite platforms. The emphasis was on solid state laser sources because they offer the best potential for meeting the demanding requirements of compact size, good efficiency, and long operational lifetimes required for future space station and free-flying platform operation. Designed for anyone interested in low vision and vision rehabilitation, this volume reflects recent advances in practice, research, technology and design from international perspectives. The articles were selected from

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more than 750 presentations at the international conference Vision '99. Topics cover the life span and include low vision diagnosis and management, education and rehabilitation, mobility and environmental concerns, access issues of design, technology, the workplace, international models of rehabilitation/habilitation, psychosocial issues, family involvement and age-related vision loss as well as professional preparation of the vision-related workforce. Global and local public awareness strategies are included along with such special topics as multiple impairments, HIV/AIDS-related vision loss and planning and service-delivery issues.

Opening Remarks of the President, 2nd ISVO, Professor G.M. Breinin, M.D. The study of visual processes is surely

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unique as a clinical specialty, in incorporating the disciplines of physics, chemistry, physiology, and psychology.

Diagnosing and correcting disorders of the visual system in these last two decades of the 20th century has brought all of us into close proximity with computer sciences, laser technology, the marvels of electronic microcircuitry, and the impressive developments in optical materials. During the course of this meeting we shall be hearing about how these different technologies can interact with one another, and we shall discover that such interaction may produce new diagnostic tools and new optical devices. We shall also learn that the optical qualities of the eye change during life, producing subtle and complex alterations in vision. On behalf of the members and organizing committee of the

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American Committee on Optics and Visual Physiology and our co-sponsoring organization, the Optical Society of America, I welcome you to this second symposium on visual optics. The first symposium took place in Japan in 1978 and, like the present one, was a satellite meeting of the International Congress of Ophthalmology. The third symposium in this series will take place in Italy in 1986 as part of the next session of the International Congress of Ophthalmology.

The invention of the laser 25 years ago resulted in powerful light sources which led to the observation of unexpected and striking phenomena. New fields of science such as holography and nonlinear optics developed constituting the basis of this volume. The classical principle



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of linear superposition of light waves does not hold anymore. Two laser beams crossing in a suitable material may produce a set of new beams with different directions and frequencies. The interaction of light waves can be understood by considering the optical grating structures which develop in the overlap region. The optical properties of matter become spatially modulated in the interference region of two light waves. Permanent holographic gratings have been produced in this way by photographic processes for many years. In contrast, dynamic or transient gratings disappear after the inducing light source, usually a laser, has been switched off. The grating amplitude is controlled by the light intensity. Dynamic gratings have been induced in a large number of solids, liquids, and gases, and are

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detected by diffraction, 'forced light scattering' of a third probing beam, or by self-diffraction of the light waves inducing the grating. The combined interference and diffraction effect corresponds to four-wave mixing (FWM) in the language of nonlinear optics. The process is called degenerate if the frequencies of the three incident waves and the scattered wave are equal. Degenerate four-wave mixing (DFWM) is a simple method to achieve phase conjugation, i.e. to generate a wave which propagates time reversed with respect to an incident wave.

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