Optica Applicata, Vol. XII, No. 3-4, 1982

Book reviews

High-Peak-Power Nd: Glass Laser Systems

by DAVID C. BROWN

Springer Series in Optical Sciences, Vol. 25

Springer-Verlag, Berlin, Heidelberg, New York 1981
[pp. i – ix +276 with Figures]

Looking for new inexpensive energy sources is a timeliness question for humanity. But the most radical problem is looking for the methods of performing a controlled thermonuclear reaction.

The works in this range have lasted for as long as nearly 30 years and dealt with producing and sustaining the high temperature deuteron-tritium plasma, in which a fusion occurs at sufficiently high output. Soon after the laser invention and a possibility of generating giant pulses of very high peak powers, enabling us to obtain a huge concentration of power for a volume unit, a new idea of producing the plasma originated.

N.G. Basov and J.N. Dawson theoretically revealed that such laser pulses may be used for heating a deuteron-tritium disc or sphere to temperatures required by the thermonuclear reaction. The experimental works which were started lead as early as in 1968 to the emission of neutrons from the plasma produced by laser. The experiments testifying the aptness of the assumed hypotheses have stimulated further investigations. So during the 70-ties we have witnessed the development of research base of lasers, which could be applied to produce the high temperature plasma. Among them the Nd:glass laser systems generating the pulses of the peak powers of the trawatts range have occupied a front place.

In the successive years the construction of multiheaded and multibeamed solid state laser systems has been developed, such as Argus, Shiva, GDL, OMEGA, and Delfin. In these systems the neodymium dopped glass was applied as the active material of laser amplifiers. Also the works on pulse lasers of high power on other active media, such as CO_2, iodine, excimer lasers, etc., have been advanced.

Today, the euphoria of the first investigation period has already passed. The investigations turned out to be extremely expensive and a perspective of a practical realization of a laser thermonuclear power station is rather far-away. Thus only the wealthiest countries able to raise the weight of investigation both in financial and technological relation remained on the field. These are practically two countries:

the United States of America and the Soviet Union.

From the retrospective point of view it should be stated that laser technics, especially the solid-state lasers owe much to this particular line application. Theoretical, experiment and, above all, technalogical works have been advanced. Though a full characteristic of investigations which have been initiated in lasers or considerably intensified by the works in the range of high temperature plasma, exceeds the scheme of this elaboration, it seems to be necessary to mention some of them: interaction of laser pulses radiation with active media (amplifying ones), nonlinear interaction, shaping of the time and spacial radiation characteristics, technical design problems of large systems and their protection against the reflected radiation and, first of all, the works in the range of laser glass technology, transmission materials and dielectric layers of high thresholds of damages due to radiation. The level achieved in this area results undoubtedly from high concentration of finances and means for the investigations on laser microfusion.

Such reflections emerge in the course of reading and presenting to our readers the new book by D.C. BROWN: High-Peak-Power Nd:Glass Laser Systems published by Springer Series in Optical Sciences. The title of the book does not leave room for any doubt; in reality it refers to the laser systems applied to the plasma heating. A question arises whether it was necessary to devote a monograph to a so exclusive and narrow subject to which a very rich and extensive non-monographic literature has been devoted. An answer to this question is not self-evident. Undoubtedly the number of specialists interested and working in this field is not too great and a documentation of these works is very extensive. None the less account should be taken that this literature consists mainly of laboratory and governments reports or conference proceedings. So these materials are not easily available and especially for Polish readers may be difficult to obtain. Moreover, the increasing applicability of laser enlarges more and more the circle of people interested in the design of large Nd:glass laser system. This concerns to a high degree the probing of atmosphere by the pulses of high power and investigations of interaction (mainly nonlinear one) of radiation with the matter.

A doubt which could arise from the question, put above, is settled by the author, what can be easily seen even when the reader is only superficially accquainted with the book reviewed. D.C. BROWN presents in it physical principles, theory and results of experimental investigations on fundamental phenomena occurring in high power laser systems. These fundamental phenomena include nonlinear effects, damage of materials due to radiation and amplification of laser radiation pulses and of a spontaneous emission as well as parasitic oscillations. The author discusses, moreover, optical and physical characteristics of various laser glasses and gives a rich comparative material and a full set of numerical data necessary for design of arbitrary laser system in which the neodymium dopped glass is used as the active material.

The book dealing with so many problems has a general and universal character. It exceeds the narrow frames imposed by the already mentioned specific application of laser system and should be considered as a monograph treating with the physical laser principles. For these reasons it will undoubtedly be in demand and read in libraries.

Let us present in more details the contents of the book, which is formulated by the author in eight Chapters:

1. Glass Laser Physics
2. Optical and Physical Properties of Laser Glasses
3. Optical Pump Sources for Nd:Glass Lasers
4. Amplified Spontaneous Emission and Parasitic Oscillations
5. Amplifiers for High-Peak-Power Nd:Glass Laser Systems
6. Damage Effects in High-Peak Power Nd:Glass Laser Systems
7. Nonlinear Effects in High-Peak-Power Nd:Glass Laser Systems
8. The Design of High-Peak-Power Nd:Glass Laser System

The first Chapter is devoted to the glass laser physics. The energy level of the neodymium ion is discussed taking into consideration the transitions of absorption (of pump) and fluorescence (of laser).

Much space is given to discussion of the influence of environment on the ion acting on the principal glass parameters, such as the induced-emission cross-section, the ratio of the 1.06 μm to 0.88 μm fluorescence intensity (branching ratio) and also the total time of population decay of the metastable level. While analysing the change of population the author has taken into consideration radiative processes, multiphonon nonradiative processes and the energy transfer to other ions. Moreover, an elementary theory of amplification of the short (three-level approximation) and long pulse (four-level approximation) was compared with the terminal life time. For these systems the saturation energy and total amplification was defined. Finally, the most important parameter of laser glasses employed in the high-power systems, namely the total refraction index of the material and its dependence on the intensity of the propagating light wave, was defined and discussed. Its intensity-dependent part (nonlinear index) is responsible for the well-known selffocussing effect limiting the peak-powers of generated laser pulses. The nonlinear refraction indices for linear and circular polarization of amplified radiation have been defined and determined.

It is rather important that the last one be smaller. The numerical data given in the text present not only a rich comparative material but also are useful in engineering practice.

In the second Chapter the author defines and discusses the main optical and physical parameters (thermal, mechanical, and so on) of the principal laser glasses available on the market. The remaining part of the chapter is devoted to the figure of merit formalism. The author defines the general figures of merit of rod, disc and active-mirror amplifiers. The fundamental figures of merit of laser glasses in the corresponding sets of amplifiers are in detail discussed, taking account only of the active cross-section, i.e., amplification coefficient, and nonlinear effects. From the latter viewpoint other optical elements: lens, window, Faraday rotators and Pockels cells were also analysed. Likewise, other characteristics neglected in figures of merit and important in some cases, were specified.

The third Chapter is devoted to simulating sources of the glass laser system, i.e., to the Xe flashlamps and their pulse forming network. Here, the analysis of optimum adjustment of supplying system to the flashlamp and the assesment of the life time on the Xe flashlamps (quantity of flashes) should be noticed.

The fourth and fifth Chapters concern the optimization of construction of the Nd:glass laser amplifiers. The luminescence amplification and parasitic oscillations which may appear in rods, discs and active-mirror amplifiers reduce considerably the amplification coefficients in material and as far as possible should be limited and eliminated. These problems discussed in the fourth Chapter are analysed more thoroughly in the fifth one, where the theory, construction principles, results of investigations and the characteristics of fundamental types of amplifiers are given.

The sixth and seventh Chapters deal with problems which limit the level of energy and peak-powers generated in the glass laser systems. These limitations result mainly from radiation-damaged optical materials (Chapter 6). The author explains the mechanisms of bulk and surface damages of materials transmitting the high-power laser pulses. He also discusses the reasons for the damages of thin layers. He quotes numerical data about the strength of laser glasses and other materials commonly used in laser techniques.

The seventh Chapter deals with the central designing problem of the amplifiers of high-power laser pulses, namely with nonlinear effects. The existence of nonlinear refraction index is a reason for self-focussing. This is the main phenomenon limiting the peak-power of generated pulses. These problems are widely discussed. The author presents a general theory of sefl-focussing including the theory of small scale self-focussing and the whole beam self-focussing as well as their consequences resulting for the laser systems. The construction of terawatts laser systems requires an exact filtering of distribution of the transverse laser beam from the ripples. Therefore sets of spacial filters occupy an important place in these systems. This also finds its repercussion in the presented work.

The author dedicates the last Chapter 8 to the problems of building the high-peak-power Nd:glass laser systems. Properly said these are remarks concerning the design of these systems. This is understandable considering the importance of this problem.

The author assigns much place for discussion of the major issues relevant to the design of high-power laser systems and to the costs of systems production. The building costs of these systems are so high that they should be optimized like other parameters of the system; thus they enter in the laser design process.

Starting from these data the author discusses the design methodics for the Nd:glass high-power laser systems, including: first-order design, design exploration and full system simulation.

By presenting the above information about the book by D.C. BROWN and especially by indicating that his work really concerns the principles of laser physics I hope to encourage our readers to get acquainted with it. The book does not belong to easy ones. The reader who wants to take advantage of it should be prepared and have some prerequisite knowledge about the subject. The lack of denotation index and also repetition of denotations are additional shortcomings making the reading more difficult.

I think this book is mainly directed to the engineers specialists in the domain of lasers in general, and in solid-state lasers, in particular. Of course, the specialists working in the domain of laser microfusion would obligatorily read it. The author refers to numerous literature positions. According to my opinion a full understanding of the book requires that the reader be acquainted with some of them.

This effort may be worth while, because of the great range of knowledge contained in the book. This is the modern knowledge, referring to the newest investigations. Therefore, I can also recommend this book to the students of Physics Departments at Universities and to the students of Technical Universities.

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Optical Fiber Systems and Their Components

A.B. SHARMA, S.J. HALME, M.M. BUTUSOV

Optical Sciences, Vol. 24

Springer-Verlag, Berlin, New York, Heidelberg 1981
[pp. i – viii + 246, with 125 Figs.]

The book reviewed being written by three authors: A.B. SHARMA, S.J. HALME, and M.M. BUTUSOV was edited in the year 1981 by Springer-Verlag as the volume 24 of series edited by T. Tamir. The book contains the following Chapters:

1. Introduction
2. Generation, Modulation and Detection
3. Light Propagation in Waveguides
4. Components of Waveguide Systems
5. Fiber Measurements
6. Fiber Optical Systems and Their Applications.

Besides the book offers 38 problems to be solved and rich literature references.

As the authors write in the face the aim of the book is to provide an introductory material to the engineers and physicists intending to work in this field. Thus, it is a typical high level university textbook of didactic quality verified practically at the Helsinki Technical University.

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Color Measurement
Theme and Variations

D.L. MACADAM

Springer Series in Optical Sciences, Vol. 27

Springer-Verlag, Berlin, Heidelberg, New York 1981
[pp. i–xiii + 228, with 92 Figs. and 4 Colorplates]

The measurements of physics phenomena even of those evoked by simple physical stimuli like laudness, lightness and color are difficult, while the available mathematical-physical models are still far from being perfect. The difficulties are enlarged also by the adaptation and the influence of the surrounding during the perception time. Obviously, all these troubles refer to the measurement of colors. They were defined initially by their counterparts in the nature, like madder, indigo, henna, and so on. The next step was to create the color-order systems of which the Newton cycle, Ostwald double cone, any cylindrical arrangement of Munsell gained the greatest fame. In the course of further development of science and technology these systems become too primitive. The elaboration of the CIE system of color measurement accepted in 1931 and based on the results of investigations in psycho-physiology of seeing was a significant success. This system was to some extent a mathematical simulator of the human perception apparatus. A synthesis of this system has been described by the staff of the Color Measurement Laboratory of the Massachusetts Institute of Technology in the "Handbook of Colorimetry", editet by Prof. ARTUR C. HARDY (published by Technology Press in 1936). One of the co-authors of this handbook was D.L. MACADAM who is the author of the book being here reviewed. More than 45-year experience of the author and also his continuous professional and publicistic activity in the field of colorimetry, testified by many publications is a very good recommendation of his qualifications and of the high level of his work.

In the first few chapters of his Color Measurement the author introduces the reader into the principles of CIE-colorimetry of 1931 completing them by periferial information about the light sources and elements of spectroscopy. However, he ignores the elements of color seeing physiology which seems to be naturally connected with the topic and reduces maximally the mathematical apparatus preferring the descriptive method. Such an approach to the topic suggests that the book is not intended for the experts in colorimetry but rather for the physicists and engineers wanting to be introduced to the field of colorimetry or to refresh their knowledge in this field and make it up to date. . A good opportunity to realize the latter aim is offered by the second part of the book which is devoted – as it was formulated by the author in the title – to Theme and Variations of the main subject which obviously is the measurement of colors. In particular, the methods of determination of tristimulus values are reported among which the selected-ordinate method and the Gaussian quadrature aptic terminals, interceptor constants, foveal photoreceptors and pigment epithelial cells. Finally, a comparative study of the morphology of rods and cones is offered. The discussion here is by no means limited to pure structural description. Also, some information about the used experimental techniques may be found as well as an idea of functioning of particular details of retinal photoreceptor is given. This chapter may be of considerable assistence to those readers who have no background in anatomy and physiology of the eye.

The whole Chapter 3 (written by J.M. ENOCH and H.E. BEDELL) is devoted to a deep and multilateral discussion of the Stiles-Crawford (S-C) effect in its basic formulation and many additional versions, e.g.: S-C effect of the first and second kinds, extra foveal S-C effect, photopic S-C effect, transcent S-C effect, and the like for many vertebrates. The discussion starts with the principles of S-C function measurements and the description of the measurement setup developed in the author's lab and is followed by broad analysis of experimental data obtained in a great variety of experiments performed. This chapter is closed by concluding remarks about the significance of the S-C effect.

In the following Chapter 4 (J.M. ENOCH) the retinal receptor orientation is treated at length in the form of a systematic discussion devoted to directional sensitivity problems mentioned occasionally in the previous chapters. The histological, psychophysical and X-ray methods of the retinal receptor orientation study are reported, the emphasis being put on the possibilities offered by psychophysical techniques. These techniques are used to examine both the normal eyes of many vertebrate species including man as well as to detect the changes in retinal receptor orientation from the normal anterior pointing position occurring due to different kinds of pathology (the anterior pointing locus being a point near the centre of the exit pupil of the eye). Also some recovery mechanisms of disturbed anterior pointing orientation are experimentally studied, in particular, the recovering role of the light.

The next Chapter 5 (J.M. ENOCH and F.L. TOBEY, Jr) starts a broad discussion of light guiding ability of retinal cones and rods. A review of techniques and observations is given to show the contemporary possibilities of observation on retinae and single receptors. The very important problem of sample preparation technique which would not introduce any essential changes in the structures examined is discussed carefully including both the in situ and in vitro preparations employable to many species, especially to those practically available at relatively low costs. Next, the qualitative techniques are reviewed for the waveguide behaviour, wavelength and directional sensitivity of transmission and image transfer observations. They are followed by a discussion of waveguide behaviour as a source of morphological information in such animals as goldfish, frog and some mammalian. The qualitative observations are carried out mainly by using the well known MTF concept. The retinal MTF was measured experimentally by several authors. The apparatus is described and the results of MTF measurements obtained for albino rat retina, squirrel monkey fovea and both human fovea and parafovea are reported and compared. Next, an important and very difficult problem of quantitative study of single receptor behaviour is widely studied. The study includes: the isolation techniques, V-parameter determination for low order modes in single receptors, important techniques of both refractive index determination in the retinal waveguide and its surrounding as well as the waveguide diameter estimation. This chapter offers also the basic knowledge enabling to better understand the validity of the theoretical considerations concerning the waveguiding properties of the retinal photoreceptor presented next in the Chapter 6.

The Chapter 6 (B.R. HOROWITZ) starts with the specification of a simplified three-segment tapered model of the retinal photoreceptor as a waveguide, i.e., to be of circular cross-section, smooth and gradual ellipsoidal taper, homogeneous and isotropic individual segments, linear media, the refractive index of which is independent of wavelength. Additionally, the medium surrounding the photoreceptors is assumed to be homogeneous and non-absorbing. The structural assumptions are then followed by the supposition defining the electromagnetic validity of the model, that the first-order effects may be calculated in the presence of the above assumption and that the in situ properties of a retinal photoreceptor may be obtained from the calculations performed for a single photoreceptor model by considering additionally such effects like: optical excitation, optical coupling between the neighbouring receptor and the role of the light scattered within the retina. Then the modes of the dielectric waveguides are discussed relatively extensively. The discussion concerns, in particular, such problems as: basic behaviour of exact mode solutions (comprising bound modes, unbound modes, modal expansion of field, mode orthogonality, power considerations), approximate bound-mode solution for small differences in refractive index (comprising the following topics: approximate bound modes, some mode properties, mode combinations, power carried by bound modes and mode coupling), and absorbing filters for both single-bound and multiple-bound modes. One of the final problems discussed in this chapter is the optical excitation of modes for some specific illumination sources. The chapter ends with the remarks specifying the applicability of the accepted model of the photoreceptor, especially, so far as the photoreceptor directivity is concerned.

The more theoretical part of the book is continued in the next three Chapters 7, 8 and 9, which deal respectively with optical interactions in an array of retinal receptors, visual receptor as a light collector and microphotometry of such optical phenomena like: birefringence, dichroism, and anomalous dispersion.

In the first of them (Chapter 7, by W. WIJNGAARD) the optical interaction between the retinal receptors is analysed. This interaction is understood as an influence on the absorption exerted in one receptor by the presence of the other receptors. The discussion starts with the explanation of the aperture effect, to consider next the two somewhat extreme cases of guided light behaviour, i.e., in a pair of dielectric rods and in an infinite regular array of dielectric rods. In the first one the reader's attention is drawn to such effects like mode field for a pair of dielectric rods, beating phenomenon and possible interaction effects for double cones. In the second one the situation is considered when the light beams fall on a rod being an element of a regular array of rods. Here the formerly achieved results are essentially exploited to shorten the discussion. At the end of the chapter two Appendices are added, the one dealing with symbols and definitions and the other concerning the transfer of power between the $HE_{1,1}$ modes of the rods of a linear array.

In the short Chapter 8 (R. WINSTON) the principles of ideal collection are formulated. Then the light collecting properties of certain models of visual receptors are discussed and followed by some interesting examples.

The contribution of microspectrophotography to better understanding of the seeing processes is the subject matter of the Chapter 9 (F.I. HAROSI). The main discussion is here preceded by some elementary consideration concerning the interaction of light with the matter, comprising among other the following topics: absorption of light, refraction and reflection, polarization and its forms, linear birefringence, linear dichroism, optical activity, and optical dispersion. Next, the main topic is developed, i.e., the applicability of different variants of the microspectrophotometric tecnniques to retinal photoreceptor examination. For example, one of the brilliant results provided with the single visual cell microspectrophotometry was the demonstration that the goldfish, known to perceive colours independently of brightness and to require three colours to match a given spectral line, has three types of spectroscopically distinguishable visual pigments segregated into separate cells. This result was next proved to be true also for man. In the sequel some attention is payed to such phenomena as diffusion, birefringence, dichroism and shape variation in absorption spectra, all occurring in visual pigment. The chapter ends with specifying further topics of research.

Tapeta lucide of vertebrates is the subject of consideration in the Chapter 10 (J.A.C. NICOL). The structure of tapeta is described for different species and the chemical composition, reflection mechanisms, transmission through photoreceptors, retinal absorption and visual sensitivity are considered and completed with discussion of ecological aspects.

The last Chapter 10 (G.D. BERNARD) is devoted to some comparative study of vertebrate and invertebrate photoreceptors the emphasis being naturally put on the specificity of the invertebrate eyes. In this respect both the anatomy and optics is discussed the considerations being concentrated on photochemical and physiological aspects of invertebrate visual organs.

The above summarizing remarks seem to be necessary to illustrate the richness and extention of topics considered in this book. Thus, the reader is offered an extensive and extremely interesting knowledge. In the most cases it is very up-to-date and presented in a very attractive way. On the other hand, the reader is not requested to have a too high-level background in the fields discussed. Instead, a general knowledge of anatomy and physiology of the eye and, what may be a little more difficult, some elemental knowledge in geometric optics, optical diffraction and optical waveguides would be highly recommended. Therefore, the book may provide a valuable intelectual adventure to a wide circle readers of different background and involvement, wanting to know more about their most important source of information about the world surrounding, which is their sight.

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Optische Nachrichtentechnik

Eine Einführung

GERHARD GRAU

Springer-Verlag, Berlin, Heidelberg, New York 1981
[pp. i–xi + 353, with 144 Figs.]

One of the most successful fields of science and technology developed in the last decades is the generally understood communication. New hopes and expectation have arisen in this field connected with the development of fibre optics and planar optics waveguides. It is still too early to judge to what extent these hopes are justified since the subject is now under careful and extensive study in many research centres all over the world. On the one hand, the up-to-date prototype realization seem to be very encouraging but on the other one, very serious technological and economic problems remain still unsolved. The book reviewed may serve as a guide to the specific optical communication problems solved (at least partly) so far.

The author starts the considerations in Chapter 1 with a short introductory presentation of the basic concepts and phenomena in plane waveguides to carry them quickly over to fibre waveguides. This chapter presenting also some methodological fundamentals may be particularly useful for those readers who begin to be involved in optical waveguide communication problems.

The proper lecture on the optical communication starts in Chapter 2, which offers a systematic study of the fibre lightguides, including careful description of the behaviour of light guided in fibre lightguides in two fundamental versions of the latter: monomode fibres and multimode fibres. For these two cases the dispersion relations are given and discussed taking account of such important concepts as the chromatic dispersion, mode, intermode and intramode dispersion, profile dispersion and, finally, the dispersion measurement methods. Considerable attention is paid to the waveguide transfer function and especially to the losses and attenuation occurring in the lightguides. This chapter is ended with a brief review of such problems like fibre production, measurement of refractive index profile, coherence, nonlinear effect and some summarizing remarks concerning the waveguide characteristics.

The next two chapters provide the basic information about the light sources and photodetectors used in fibre optics communication systems. So far as the sources are concerned the discussion is concentrated mainly on light-emitting diodes and laser diodes of various types and includes their construction and principles of operation, the emission properties as well as the light modulation possibilities and systems. The presentation of photodetectors is started with principle of operation and a review of suitable materials. Then the PIN-diodes, i.e., their construction types (conventional, multireflection and heterostructure with homo-pn-transition) and properties are considered. Then the photocurrent dynamics is analysed for delta pulse and other irradiations. Relatively more place is devoted to the avalanche photodiodes. Here, beside the construction forms the stationary behaviour is carefully discussed to end with some rise-time data. Finally, the dynamic behaviour of APD is considered.

The important problem of the noise in fibre optics communication is the subject of separate Chapter 5. It starts with a short review of noise sources to study extensively the laser noise so far as laser light intensity fluctuation and its consequences to photocurrent fluctuation in the detecting systems are concerned. Account is also taken of two important kinds of noise appearing specifically in optical fibre waveguides, i.e., mode partition noise and mode noise. The latter is especially carefully considered for fibres of stepped and parabol profiles. A short treatment of the noise in both photodetectors and four-terminal networks including its instationary version, followed by discussion of the detector threshold problem ends this chapter.

The last three chapters devoted respectively to receivers, coupling elements and optical communication systems are of more engineering character. The first of them is mostly devoted to the calculation of both analog and digital receivers. In particular, the transfer of both the signal and noise and the requested input power is analysed. The analysis of coupling elements, being first formulated in general terms and defining the fundamentals of coupling, becomes soon specified to two basic cases: generator-fibre coupling and fibre-fibre coupling. In the last case the three kinds of coupling are examined: plunge connections, splice connections and optical branching (all of them constituting the basic coupling problems in optical communication systems).

A brief review of optical communication systems is the subject of the last chapter of the book. The fundamentals of the general system theory are first formulated and next used to perform a comparative study (with conventional communication systems). The discussion is ended with a very brief mention of some special cases of such systems.

I have read this book with a pleasure. There are, at least, three reasons for this feeling to be mentioned: proper selection and organization of the material, a tendency to use only relatively simple mathematical formalism and the language which tends to avoid the "natural" complexity of written German. The latter feature of the book is very important for the non-German readers (which is also my case). The book, dealing with basic physical phenomena occurring in the waveguides is also technically-oriented.

This widens considerably the circle of potential readers. In particular, the book may be recommended to the physicists specializing in optics, optic fibre communication engineers as well as to the people not involved professionally in these fields but wanting to widen their technical horizon (provided they have sufficient background in physics and mathematics on general university level).

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Electromagnetic Theory of Gratings

Editor: R. Petit, with contributors

Topics in Current Physics, Vol. 22

Springer-Verlag, Berlin, Heidelberg, New York 1980
[pp. i – xiv + 284, with 182 Figs.]

Optics owes much to gratings, yet, according to the authors of the book reviewed, gratings are greatly indebted to electromagnetics. This, of course, implies a conventional distinction between these two branches of physics. If, however, the latter is designated as vector wave optics then the title of the book would simply suggest that properties of gratings fepend on polarization.

Historically, gratings were designed as a tool to study the wave nature of light, but nowadays reflection from and transmission through periodic structures provide relevant information for various kinds of wave phenomena. Present applications comprise a very wide area "including airport business" (p.213) and exceed the domain of electromagnetic radiation.

Confining attention to optics, it is impressive indeed to find gratings in so many devices. Thus, obviously, the understanding of both their properties and role performed in transformation of light is crucial for inventive thinking in optics and optical engineering.

A significant step in making the theory and applications of gratings more accessible is due to a competent theam of French and Australian authors of the book discussed here.

Assuming with these experts that an adequate general framework for further grating studies is set up by Maxwell's equations the role of the computer in a practical im mentation of such a program cannot be overemphasized. Somewhat philosophically one cannot help thinking that one of the reasons lies in the fact that the information to be extracted from whatever is processed in so clearly defined and that it reduces to efficiencies.

Naturally, numerical methods employed in the analysis of gratings are far from routine. Moreover, the use of computer is not limited to solving an integral equation or a system of differential equations in terms of which a grating boundary value problem has been formulated. As evidenced by Chapter 5 devoted to "The homogeneous problem" an ingenious use of the computer is involved in an approach that might be described as hybrid, where numerical calculations are closely woven into deep analytical thinking. However, one is still under the impression that nature has something else to reveal about grating and that the computer will be crucial in this respect (similarly as for some nonlinear problems).

Insofar as the basic electromagnetics of grating theory is concerned, it could be summarized as follows:

1. For all mono-periodic structures with incidence normal to their generatrices the analysis reduces to two independent scalar problems for two relevant second order (wave-like) partial differential equations (scalarizable problems).

2. For arbitrary incidence this reduction occurs only for perfectly conducting monogratings.

3. In other cases (oblique incidence and bigratings) we deal with essentially vectorial problems. For perfectly conducting bi-gratings the analysis can be reduced to two independent Helmholtz equations coupled by boundary conditions. In general, however, we have to deal with the full set of Maxwell's equations or one vectorial wave equation.

These facts discussed in the book, in view of its title, deserve a more explicite presentation and a stronger emphasis. In this context one wonders what is meant by "usual cases of polarization" (p. 39).

Once a grating problem has been formulated as a scalar or vectorial boundary problem, it is its solution that constitutes the real task. This solution - approximate or exact - can be sought analytically, numerically or in some mixed way. The authors often refer to their numerical approach as "rigorous". It should be noted, however, that the question whether their numerical solutions converge to the exact ones remains open. No proofs on this account are given, though the accuracy of the solutions is investigated by various numerical checks.

It seems that, despite the title of the book which puts stress on electromagnetic vectorial aspects of the grating theory, the authors in fact are much more interested in contrasting their numerical approach with approximate analytical solutions.

As is well known, most of the early useful results were obtained from approximate solutions based, for example, on Kirchhoff's theory; nowadays this trend is represented, for instance, by the use of various kinds of approximate boundary conditions.

In connection with electromagnetics aspects of the gratings theory it is unfortunate that the authors have not defined precisely what they mean by scalar theory of gratings. A guess is made that within this theory light is described by one scalar function satisfying a Helmholtz equation, and that boundary conditions and solutions are appropriate.

In this context the reviewers feel rather strongly that the book would be far better balanced, if in what is called "A tutorial introduction" a review of earlier results of gratings theory, current research trends and even some controversial questions were briefly presented. Of course, we are aware of the existing review papers but a concise discussion of these matters seems to constitute a very desirable background of the book. It could also be used to compare more comprehensively some of the authors' results with the earlier approximate solutions. Such a review could also better unify some theoretical results scattered throughout the book; for example, it seems that the theorems from page 176 should be given in such an enlarged introduction.

The reader should also be aware that the content of the book is decisively determined by the authors' personal interests. Thus the book deals mainly with planar mono- and doubly-periodic dielectric, metal or mixed structures. Such types of gratings, as Bragg reflection, bleached holographic, slanted or concave gratings are not discussed. Similarly, a number of modern analytical and numerical methods are not mentioned otherwise than in the list of references.

As another example let us point out that results and applications presented in Chapter 6 are restricted to metal gratings only. Hence, the reader interested in integrated optics would be rather dissatisfied. The reviewers are inclined to disagree with the opinion that "dielectric gratings have been effectively neglected (...) because until very recently, no electromagnetic study of them was required " (p. 223), especially in view of many references contained in the book which indicate something quite contrary.

A point about which the reviewers have some doubts and rather mixed feelings is the use of distribution theory in presenting basic electromagnetics and rudiments of gratings theory. Of course, an approach is quite understandable for fellow countrymen of Laurent Schwartz. Nevertheless, the reviewers are not in favour of modernizing electromagnetics as a side effect of grating theory.

Generally speaking, the distribution calculus proves useful in the analysis of the periodic stratified structures, but, at least at this level, it gives nothing more than can be obtained from the classical integral form of Maxwell equations. Moreover, some considerations (pp. 20, 21) by their redundancy, contribute also to our objections.

A shortcoming of the book stems also from the fact that no account was taken of the Soviet contributions to gratings theory. The authors ascribe this to the language barrier but it seems to us that at least some Russian books of basic importance for gratings could be listed. In particular we have in mind:

- V.P. SHESTOPALOV, Method of Riemann-Hilbert Problem in Theory of Diffraction and Propagation of Electromagnetic Waves, Kharkov Univ. Press, Kharkov 1971.
- E.I. NEFEYODOV E.I., A.N. SIVOV, Electrodynamics of Periodic Structures, Nauka, Moskva 1977.
- V.P. SHESTOPALOV, L.N. LITVINENKO, S.A. MASLOV, V.G. SOLOGUB, Diffraction of Waves by Gratings, Kharkov Univ. Press, Kharkov 1973.

If our suggestion, concerning an enlarged tutorial introduction, finds Dr. PETIT'S approvement, we shall call his attention to the recently published papers:

- M.G. MOHARAM, T.K. GAYLORD, Coupled Wave Analysis of Reflection Gratings, Appl. Opt. 20 (1981), 240-244.

- R.A. HURD, E.V. JULL, Theory of a Reflection Grating with Narrow Grooves, Radio Sci. 16 (1981), 271-277.

To end our review on a less subjective note we give a brief description of the book's content.

The book is divided into 7 chapters. The editor's efforts are obvious from their complementary character. In A Tutorial Introduction the editor presents the basic concepts of electromagnetic theory and describes fundamental methods of grating theory, i.e., the Rayleigh expansion, the integral, differential and modal expansion methods.

An Appendix gives a brief account of the theory of distributions.

In the second Chapter entitled Some Mathematical Aspects of Grating Theory M. CADILHAC discussed basic properties of the solutions of the Helmholtz equation, uniqueness and reciprocity theorems, improved point-matching technique.

The third Chapter Integral Methods describes the methods of reducing the problem of diffraction by a single or multiprofile grating to a Fredholm equation of first or second kind or to a system of such equations and to their numerical solutions.

In the fourth Chapter Differential Methods G. VINCENT treats the same problems with the help of two differential methods. The first reduces Maxwell's equations to a set of ordinary differential equations, in the second a conformal mapping technique is employed to simplify the geometry of the problem. Both theory and practical aspects of its applications are discussed in these two chapters:

A very interestig Chapter entitled The Homogeneous Problem is devoted to analysis of such phenomena, as Wood anomalies, total absorption and excitation of leaky waves. In contrast to other chapters the author stresses qualitative physical aspects of the problem considered. Some applications, e.g., to grating couplers are also discussed.

The six Chapter is devoted to The Experimental Verification and Application of the Theory. Numerous efficiency curves and other quantitative data are presented and used to compare theoretical results with experiments. Various types of gratings, e.g., ruled, sinusoidal, lamellar are discussed for a broad spectrum ranging from microwave to X-ray domains.

The last Chapter Theory of Crossed Grating by R.C. MCPHEDRAN, G.H. DERRICK and L.C. BOTTEN considers the doubly periodic diffraction structures. The modal expansion, multiple-scattering and conformal mapping approaches are used and the application in construction of selective filters for solar energy absorption is analysed.

Thus, summarizing our conclusions and despite our criticism, the people dealing with grating problems has received a useful and informative book, especially concerning powerful numerical approach which will certainly contribute to the solution of various advanced grating problems. However, there still remains a great need for a fundamental, comprehensive monography on grating theory.

A number of misprints has been spotted: p. 3 - formula below (12), p. 7 - footnote, p. 42 - 4th line from the top; p. 55 - line above (2.8), p. 86 - 6th line from the top,

p. 87 - 2nd line from the top, p. 127 - 2nd line from the bottom, p. 131 - 2nd line and 8th line from the bottom, p. 213 - 3rd line from the top, p. 261 - footnote.

The reviewers being not native English speakers are not in the position to give an opinion about the language of the book, the following terms, however, seem to be questionable:

p. 7 - nondependent of, should rather be independent of,

p. 10 - damped, should rather be decaying,

p. 124. - by a dipole the author means a simple resonant two-terminal network,

A grammatical dilema of the English language is solved by using the term "a Green function" (p. 21).

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Laser Spectroscopy

Basic Concepts and Instrumentation

W. DEMTRÖDER

Springer Series in Chemical Physics, Vol.5

Springer-Verlag, Berlin, Heidelberg, New York 1981
[pp. i – xii + 694, with 413 Figs.]

The invention of laser gave an impetus to a rapid development of the classical optical spectroscopy, mainly the Raman scattering spectroscopy, and laso stimulated new kinds of spectroscopies. Here, nonlinear spectroscopy, multiphonon spectroscopy, time-resolved spectroscopy may be mentioned; all they being termed generally laser spectroscopy. The extension of the method, especially the improvement of its spectral resolution, has enabled the investigations of numerous problems concerning the structure of gases, liquides and solids.

WOLFGANG DEMTRÖDER in his Laser Spectroscopy has decided to present largely the method itself and to limit its applications to the atomic, ionic and molecular problem in gaseous state.

The book consists of three parts. The first one, including three chapters, introduces the fundamentals of the theory and instrumentation of general optical spectroscopy with a special emphasis on the aspects important for gases and for laser techniques. When defining the basic notions of absorption and emission of light (Chapter 2), like oscillator strength, transition probability, intensity and polarization of spectral line, coherence and so on, the author presents the corresponding mathematical formulae, the graphical description and the techniques allowing the determination of quantities in question.

The natural linewidth of spectral lines and different mechanisms of their broadening: Doppler, collision, time-of-light, homogeneous and inhomogeneous, and saturation broadening, are described in detail in Chapter 3. Starting from the classical equation of damped oscillator and its Fourier transformation, the Lorentz, Gauss, Voigt and other analytical formulae for line profile are derived. In this chapter the time scale of phenomena turns out to be very important in interaction of molecules with the radiation field, and correlation function, e.g., between the oscillation before and after collision, is often used.

In Chapter 4 the available classical and modern instruments for measurement of wavelength and intensity of spectral lines are discussed. After characterizing prism spectrographs and grating spectrometers by their speed, spectral transmittance, spectral resolving power and free spectral range, the various kinds of interferometres as essential devices for narrowing, monitoring and stabilizing the laser linewidth and wavelength, are described in terms of the above given characteristics. A special attention is devoted to the detectors of light. Apart from the calorimeters, bolometers, Golay cells, different photocells, photocathodes, photomultipliers and photon counting detectors, videly used in spectroscopy, the new detection instruments "which could escape from military research into the open market" are presented. They are: single-stage image intensifier, cascade image intensifier, photodiodes and very interesting optical multichannel analyser, called vidicon detector. At the end of this chapter the equipments allowing measurements of fast transient events, like the boxcar integrator, the transient recorder and the fast transient digitizer with subnanosecond resolution are outlined.

The second part of the book consists also of three chapters. They deal with various lasers as spectroscopic light sources. Chapter 5 gives the basic principles of laser with special emphasis on the modes behaviour: their competition due to the gain saturation, spatial hole burning and the conditions for the maximum output power of a laser. Chapter 6 characterizes fixed-frequency lasers, tunable lasers and multimode lasers. Here the special attention is given to the conditions of wavelength and intensity stabilization and of the tuning of wavelength. Chapter 7 considers different tunable lasers, and not only lasers, as infrared, visible and ultraviolet radiation sources. They are: semiconductor diode laser, spin-flip Raman lasers, Zeeman tuned gas laser, color center laser, dye lasers, excimer laser, and numerous coherent radiation sources based on nonlinear electrooptic susceptibility of materials. The latter include devices utilizing nonlinear optical mixing techniques, like second and third harmonic generation, sum or difference frequency generation, and also optical parametric oscillators and tunable Raman lasers. Beside the main ideas of these methods the schematic presentation of experimental arrangement and the tables containing the different realizing designs are often given.

Chapter 8 treats of the absorption and fluorescence spectroscopy of gases with resolution limited by Doppler broadening of spectral line, including: excitation spectroscopy, photoacoustic spectroscopy, intracavity absorption, optogalvanic spectroscopy, ionization spectroscopy, laser magnetic resonance spectroscopy, Stark spectroscopy, laser induced fluorescence (LIF), stepwise excitation, spectroscopy of Rydberg states, optical-radio-frequency double resonance, optical microwave doube resonance (OMDR), microwave-infrared double resonance, optical-optical double resonance, multiphoton spectroscopy and multiphoton-ionization spectroscopy.

In Chapter 9 the main ideas of the linear Raman spectroscopy and several nonlinear Raman techniques: stimulated Raman scattering (SRS), coherent anti-Stokes Raman spectroscopy (CARS) and hyper-Raman spectroscopy, are given.

Chapter 10 presents the news branches of spectroscopy, in which the knowledge on the atomic and molecular structure may reach a higher level. In this chapter the techniques which overcome the Doppler width resolution limit are deals with, mamely: the spectroscopy in collimated molecular beams, saturation spectroscopy, polarization spectroscopy, saturated interference spectroscopy, heterodyne spectroscopy, Doppler-free multiphonon spectroscopy and level-crossing spectroscopy.

In the next Chapter 11 the main problem is also high resolution but considered in the time scale. The fundamentals of generation of short laser pulse and lifetime measurements are given as well as the basic principles of the picosecond spectroscopy, quantum beat spectroscopy, photon echoes, optical nutation and free induction decay, and pulse Fourier Transform Spectroscopy.

Chapters 12 and 13 deal with slightly different subjects. Besides spectroscopy, information about atomic and molecular structures and interaction potentials is provided by the investigation of scattering or collision processes in gases. The introduction of laser has also contributed to the development of this field of knowledge. The techniques of laser spectroscopy presented in the previous and next chapters are discussed in Chapter 12 in relevance to molecular collisions.

The possibility of reaching the ultimate resolution limit with the aid of recently developed techniques, such as optical Ramsay fringes and trapping and cooling of atoms and the conditions to be satisfied are outlined in Chapter 13.

In the last Chapter 14 the author briefly considers the applications of laser spectroscopy to isotope separation, monitoring of the atmospheric composition and to the investigation of other problems in biology and medicine.

The author addresses his book to physicists and chemists who are interested in more detailed study of laser spectroscopy. It seems that also other scientists and students who have some knowledge in the classical spectroscopy may profit by reading this book owing to its didactic values, like clear presentation of the main ideas and the corresponding mathematical formulations, gradually increasing difficulty of the presented problems, numerous figures well illustrating the phenomena discussed, numerical examples ending the several paragraphs and numerous references to the definitions given in earlier Chapters and to the complementary bibliography (824 references).

In spite of the large size and fairly large introductory part this book is written very concisely. This is especially clear when taking account of the fact that to each of the described spectroscopies one book of a comparable size (as it is often a fact) might be devoted.

The short time of publication caused inevitable editorial errors. One has noticed the following:

p. 58, Sec. 2.9.6. Density Matrix (before Sec. 2.9.5) is the second Sec. 2.9.6, not evidences in Contents,

p. 137, bottom line 5 - instead of "... defined by (4.28)" it should be (4.29),

p. 178, bottom line 2 - instead of "... $\Delta n = 0.04$" it should be $\Delta n = 0.16$, and consequently other value of $\delta\nu$,

p. 342, caption to the Fig. 7.17 - instead of "gracing" should be "grazing".

p. 346, in Fig. 7.21 the succession of L_1, M_1 is other than that in the text,

p. 433, in Fig. 8.36c negative and positive signals λ_{1m} and λ_{2a} are labelled contrary to the text.

p. 505, in Fig. 10.34 is opposite labelling of polarizers P_1 and P_2 than in the text.

Summing up, the Laser Spectroscopy by W. DEMTROEDER is a very valuable textbook, which actually realizes the intention of the author "to close the gap between the advanced research papers and the representation of fundamental principles and experimental techniques".

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Laser Spectroscopy of Solids

Editors: W.M. YEN, P.M. SELZER, with contributors

Topics in Applied Physics, Vol. 49

Springer-Verlag, Berlin, New York, Heidelberg 1981
[pp. i – x + 310, with 117 Figs.]

The monograph Laser Spectroscopy of Solids edited by W.M. YEN and P.M. SELZER fills a gap in the specialistic scientific literature concerning the application of the laser spectroscopy to investigation on some classes of properties of the inorganic and organic dielectric crystals.

The book is organized as follows: Chapter 1 (by C.J. IMBUSCH and R. KOPELMAN) surveys in general terms the field of spectroscopy of insulators and establishes the basic features. The Chapters 2 (by T. HOLSTEIN, S.K. LYO, R. ORBACH) and 3 (by D.L. HUBER), respectively deal with the microscopic and macroscopic aspects of the theory of dynamics of optically excited states with emphasis on ion-ion interactions which are responsible for optical energy transfer and diffusion in condensed phases. Chapter 4 by P.M. SELZER presents detailed experimental techniques which are used in laser spectroscopy in solids. Finally, the last three chapters (Chapter 5, by W.M. YEN, P.M. SELZER, Chapter 6 by M.J. WEBER, and Chapter 7 by A.H. FRANCIS and R. KOPELMAN) present surveys of the empirical and organic solids, respectively.

Other areas in the study of optical properties of condensed matter, where lasers have played crucial roles and where considerable advances have been made such as semiconductors and the various types of scattering experiments, are not in the principal focus of this volume and, hence, will not be reviewed here.

These limitations in the scope of interest of the monograph's editor allows to expect the appearance of the next separate volumes in Topics in Applied Physics series which will be concerned with application of laser spectroscopy to e.g. semiconductors, etc.

A precise, clear and didactic presentation of the basic problems of optical spectro scopy of solids given by all contributors to this volume, makes the reviewer agree completely with Profs. W.M. YEN and P.M. SELZER - the authors of the preface - that the views presented in this monograph will be very useful both to the neophytes and the veterans in this field of knowledge.

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Optical Information Processing

Fundamentals

Editor · S.H. LEE

Topics in Applied Physics, Vol. 48

Springer-Verlag, Berlin, New York, Heidelberg 1981
[pp. i–xi + 308, with 197 Figs.]

The book reviewed is the 48th volume of the Springer Series: Topics in Applied Physics and, being devoted to the methods of optical information processing in both coherent and incoherent optical systems, it deals with the problems discussed earlier in 23th volume of the same Springer Series. The book, written by many-authors, comprises the following

Chapters:

1. Basic Principles
2. Coherent Optical Processing
3. Incoherent Optical Processing
4. Interface Devices and Memory Materials
5. Hybrid Processors
6. Linear Space-Variant Optica Data Processing
7. Nonlinear Optica Processing

In the introduction to the book the editor presents in a concise form the basic problems in optical field transformations and optical imaging including the transforming properties of thin lenses. These problems are considered for coherent, incoherent and partially coherent light. Thus, the Chapter 1 should be treated as an introduction to the problems of optical information processing. In two further Chapters (2 and 7) S.M. LEE discussed the spatial filtering and coherent processors as well as the problems in nonlinear optical processing. The author analyzes the grating filters, complex spatial filters and computer-generated spatial filters, as well as their applicabilities. The concept of spatial filtering function based on coherent optical feedback, introduced by the author by analogy with electronic feedback filtering function, deserves a special attention. In the last chapter S.H. LEE concentrates his attention on nonlinear optical processing showing how to exploit such nonlinear operations in optics like: logarithm, exponentiation, intensity level slicing, thresholding, analog-to-digital conversion, logics and bistability. The systems and devices necessary for realization of the nonlinear operations in optical processing are also discussed.

Noncoherent optical systems are characterized mainly by redundancy and immunity to noise, that is why they are being more and more extensively used in the optical information processing. In the Chapter 3 W.T. RHODES and A.A. SAWCHUK discuss the system and methods of noncoherent optical processing. Based on earlier reports from this field, mainly by G.L. Rogers, the authors consider three main groups of systems: i) diffraction systems, ii) systems based on geometric optics laws, and iii) shadow casting.

In Chapter 4 C.R. KNIGHT deals with the interface devices (comparing the usefulness of their recent implementations), and considers various applications of the optical storage materials with their performance characteristics. The spatial light modulators and their operating parameters are discussed together with the optical processing applications demand recyclable materials to be used as interface devices. D.P. CASASENT discusses (in Chapter 5) the hybrid processors and their applications which also determine the specifications and performance requirements of the optical/digital interfaces. The hybrid systems are, however, at various research stages, and can be classified among three basic groups: 1) diffraction pattern sampling, 2)optical processors, and 3) hybrid correlators. Obviously, the basic idea of specific operations is to use the parallel processing features of an optical system and the programability offered by a digital system.

In Chapter 6 J.W. GOODMAN presents the linear space-variant operations with their optical implementations. A discrete version of the superposition integral relating the input and output of a space-variant system is discussed, therefore the optical applications are based on the results of this discrete approach. The space-variant linear operations utilize the following optical methods: 1) ray optics, 2) holographic multiplexing of filters, 3) performing of one-dimensional linear space-variant operations, 4) coordinate processing, and 5) matrix formulation of the filtering problem (matrix multiplication implementations). The basic properties of space-variant linear operations and a variety of means by which they can be performed optically are considered.

There are errors noticed in the book. In the page 47 line 5 from the bottom it should be $\delta(\xi, \eta - b)e^{-j\Phi}$ instead of $\delta(\xi, \eta - b)^{-j\Phi}$. In the page 63 line 13 from the bottom it should be: "The lens L_1", instead of "The lens L". In accordance with the notations in the text the position of convolution and correlation in Fig. 2.7b should be marked by the parameter or the reference 2.3 should be added where the defintion of α is given.

Summing up, it should be stated that the book reviewed, being devoted to the methods of optical information processing, offers an excellent introduction to the important and difficult problems of contemporary optics. A thoroughful discussion and interpretation of the results makes this book a basic one in this field. It should be found in any library of physicists, engineers or graduate students working not only in holography and optical information processing but also in many related fields.

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Lasers and Applications

Editors: W.O.N. GUIMARAERS, C.-T. LIN, A. MOORADIAN

Springer Series in Optical Sciences, Vol. 26

Springer-Verlag, Berlin, Heidelberg, New York 1981
[pp. i–ix + 335, with 200 Figs.]

The book contains a selection of contributed papers given at the Symposium in honour of Sergio Porto organized in June 1980 in Rio de Janeiro in Brasil. Prof. Sergio Porto was one of the distinguished Brasilian physicists working in the field of quantum electronics. He died suddendly in 1979 during the Laser Conference in Novosybirsk in Soviet Union.

The occasional character of the symposium resulted in a high variety of the admitted papers so far as their contents and forms are concerned. Except for relatively few original scientific reports the most papers presented are of reviewing character. The papers have been grouped into six parts according to their contents, i.e., Part I –

Raman Spectroscopy, Part II - Laser Spectroscopy, Part III - Laser Photochemistry, Part IV - New Laser Devices and Applications, Part V - Laser Biology and Medicine, and Part VI - Picosecond Bistability.

So far as the content is concerned the Part I containing 11 papers is the most uniform. Apart from some extensive reviewing papers, like those by R. LOUDON, Surface Brillouing Scattering, and by P.A. FLEURY and K.B. LYONS, High-Resolution Studies of Phase Transition in Solids, there are several contributed papers of different importance, from very valuable papers, like that by R.K. CHUNG et al. Enhanced Raman Spectroscopy of Molecules Adsorbed on Ag, Cu and Au Surfaces, to statistical review reported by R.S. KRISHNAN and R.K. SHANKER, A Statistical Analysis of Trends in Research on Laser Raman Spectroscopy.

The Part II is composed of only 5 contributed papers which is a rather small number for such an important field in quantum physics. The paper by V.P. CHEBOTAYEV, Superhigh-Resolution Spectroscopy should be especially distinguished. In addition to a review of fundamental physical phenomena responsible for widening the spectral lines of atoms and molecules it contains a discussion of basic ways of producing narrow optical resonance, i.e., the method of saturated absorption, two-photon resonances in standing-wave field, and resonances in separated optical fields. The last method is especially promissing as it is expected to enable to realize the resonances with a relative width $< 10^{-13}$. Unfortunately, this important paper being written very concisely rather signals than presents and explains the problem. Another interesting work by C.K.N. PATEL, E.T. NELSON and A.C. TAM Opto-Acoustic Spectroscopy of Condensed Matter given in the second paper concerns the applicability of the opto-acoustic laser effects in spectroscopy. These effects connected with the transformation of integral excitation energy into kinetic energy appearing in the process of collisional relaxation heve been recently the subject of intensive examinations in the range of microwave and for infrared excitation.

The Part III reports shortly about 5 experimental works not introducing any new theoretical concepts.

Similarly, the Part IV contains 7 contributed papers differing considerably in topics. Therefore, it would be difficult to find out from this information about the trends in development of news laser devices and their applications. The work by R. SRIVASTAVA, Fiber Optics in Brasil, seems to be a programme rather than the information about the results of the research.

The value of Part V is that the six papers included offer a possibility of getting introduced to the applications of laser technique in the medicine, a subject rather little known to the majority of physicists. It turns out that the laser techniques are exploited even in gynecology (J.A. PINOTTI et al. Preliminary Evaluation of the Use of the CO_2 Laser in Gynecology), and stomatology (L. ABBATTISTA et al. Application of Vertical Brackets in Orthodontic Treatments: A Laser Speckle Study).

The last Part VI brings only three papers from the very special field of optival bistability. This is one of many nonlinear optical phenomena. It is expected that this effect will be of significant importance in semiconductor techniques (S.D. SMITH Optical Bistability in Semiconductors), i.e., in design of opto-electronic switching devices.

Summing up, it seems that the edition of the materials of the Sergio Porto Symposium in the form of a book, was unnecessary. The book would be much more useful if the material to be published was more carefully selected to eliminate the contributed works in favour of more extensive reviewing papers. It is a pity that so many distinguished authors have not been asked to contribute more extensively to the book by widening their texts presented at the Symposium.

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Modular Optical Design

ORESTES N. STAVROUDIS

Springer Series in Optical Sciences, Vol. 28

Springer-Verlag, Berlin, Heidelberg, New York 1982
[pp. i – xii +198, with 54 Figs.]

In his book on Modular Optical Design O.N. STAVROUDIS presents a new approach to the initial stages of optical design. The text is divided into nine chapters. The theory of optical design modulas depends entirely on paraxial optics and Seidel aberrations. Therefore, the author summarized these subjects in the first Chapter. The second Chapter is devoted entirely to Delano $\bar{y}$-y diagram. The two-surface system is studied exhaustively in Chapter three. In particular, the properties of two-surface optical system were derived and third order image, pupil, field and primary chromatic aberrations calculated.

One of the most challenging problems of optical imaging systems is the compensation of many different aberrations. In Chapter four the next step in the development of the module was made by including into considerations an optical system consisting of two spherical refracting or reflecting surfaces. The formulae derived in the previous chapter were used by the author to calculate a relationship between refractive indices, curvatures, thicknesses and focal distances for which third-order spherical aberrations become identically equal to zero, as well as a relationship between the height and slope of the chief ray that results in complete vanishing of third-order astigmatism. Critical values are very carefully discussed in a separate chapter. The author looks for such values of independent parameters that result in zero, or poles for parameters associated with the module. In such a way regions in which the module is well behaved were estimated. The desired solutions of cubic and quadratic polynomial equations are presented in detail and followed by fascinating historical development. Chapter six is devoted to canonical equations. Canonical optical parameters, canonical ray tracing and canonical aberration coefficients are described in this formalism which enables to couple modules or to assemble starting of coupled modules in which certain third-order aberrations are, a priori, set equal to zero.

In the seventh Chapter these results are extended to the domain of the fifth-order aberrations and seven-order spherical aberrations. There the lens designer will find very useful tables containing the notation comparison. Some numerical examples are contained in Chapter eight.

The last Chapter, entitled Conclusion is the shortest one. It completes the book with the usual speculation about future developments. The book is, of course, a highly theoretical with a great deal of calculations. In many pages there are more lines of equations than words. This is somewhat troublesome feature of this book. Unfortunately, there are also some needless typographical errors. These are:

Page	Is	Should read
12	1.1.12-16	1.2.12-16
12	1.2.6	1.2.16
33	1.2.7	1.2.8
35	3.1.2,3	3.1.1,3
38	Q (formula 3.3.1)	q
45	3.2.12	3.3.11
58	t' (Fig. 4.1)	$\bar{t}'$
58	y-y (Fig. 4.2)	$y-\bar{y}$
68	3.3.15	4.3.15
69	4.2.1	5.2.1
86	4.1.4	4.1.2

There is no formula 4.14 in the book.

All these errors will be obvious to most readers. A few duplications of designations were introduced for readers' convenience.

The book would be hard going for the beginners in the field. However, it should be a welcome addition to any lens designer's library and even more welcomed to the optical engineer for helping him better understanding the lens designer's analysis.

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