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Book reviews

Laser Physics

Proceeding, Hamilton, New Zeland 1983

Edited by J. D. Harvey and D. F. Walls

Lecture Notes in Physics, Vol. 182

Springer-Verlag, Berlin, Heidelberg, New York, Tokyo 1983

The book contains a collection of lecture notes presented at the Third New Zealand Symposium on Laser Physics which was held at the University of Waikato, Hamilton, New Zealand from 17-th to 23-rd January, 1983. A relatively small group of physicists (about 60 persons in 1983) participate usually in these symposia, which makes excellent conditions for discussions on various problems of laser physics. Although the scope of the third symposium was rather wide and heterogeneous, there were, however, some problems dominating distinctly. These are such as optical bistability and chaotic behaviour of optical systems. The book contains 16 lecture notes on the following topics.:

— *Optical bistability in semiconductors* (S. D. Smith and B. S. Wherrett),

— *Optical bistability with two-level atoms* (H. J. Kimble, D. E. Grant, A. T. Rosenberger and P. D. Drummond),

— *Optical bistability and non absorption resonance in atomic sodium* (W. R. MacGillivray),

— *Polarization switching and optical bistability with resonantly driven $J = 1/2$ to $J = 1/2$ atoms in a ring cavity* (W. J. Sandle, and M. W. Hamilton),

— *Chaos in nonlinear optical systems* (H. J. Carmichael),

— *Spontaneous pulsation in lasers* (L. W. Casperson),

— *Experimental evidence for self-pulsing and chaos in CW-excited lasers* (N. B. Abraham, T. Chyba, M. Coleman, R. S. Gioggia, N. J. Halas, J. M. Hoffer, S. N. Liu, M. Maeda and J. C. Wesson),

— *Second harmonic generation in a resonant cavity* (P. Mandel and T. Erneux),

— *On the generation of tunable ultrashort light pulses* (A. Seilmeier and W. Kaiser),

— *Raman spectroscopy with ultrashort coherent excitation. Narrowing of spectral lines beyond the dephasing linewidth* (W. Zinth, W. Kaiser),

— *An autocorrelator for the measurement of CW ultrashort optical pulses having frequency variations* (Y. Cho, T. Kurobori and Y. Matsuo),

— *Multiphoton ionization of atoms* (G. Leuchs),

— *Pump dynamical effects in superfluorescent quantum initiation and pulse evolution* (C. Bowden),

— *Coherent population trapping and the effect of laser phase fluctuations* (B. J. Dalton and P. L. Knight),

— *An introduction to the physics of laser fusion* (B. Luther-Davies),

— *Distribution functions in quantum optics* (R. F. O'Connell),

— *Quantum non demolition measurements* (D. F. Walls and G. J. Milburn).

As it can be seen, the subject matter of this conference was diversified. The authors of the respective notes presented the problems being the matter of their own research, that is why an overall criticall review of such a book is difficult. What can be done is only to evaluate the individual presentations, which are not the same either. Some of them, as this on optical bistability in semiconductors, are short, while the others being in majority, are comprehensive analyses with many experimental results.

An interesting problem was raised by D. F. WALLS and G. J. MILBURN, while searching for gravitational radiation the quantum uncertainty occurring in the measurements should be seriously taken into account. The detectors are in this case 10 ton bars and it may seem surprising that even for such values of mass these quantum fluctuations should be taken into account. This is due to a fact that the gravity waves are very weak and measurements of displacements of orders of 10^{-19} m may appear to be necessary. Here is an example given by the authors. Let the detector be a free mass. A measurement of its position with an accuracy $\Delta x_i = 10^{-19}$ cm will perturb the momentum by an amount given by Heisenberg's uncertainty relation $\Delta p \geqslant \hbar/2\Delta x_i$. The expected period of the gravity waves equals about 10^{-3} s, therefore the next measurement of gravity waves should be made during the time interval of 10^{-3} s. During this time the mass will move from its initial position by an amount of $\Delta x = \frac{\Delta p}{m}\tau \geqslant \frac{\hbar\tau}{2m\Delta x_1}$. For $m = 10$ tons we have $\Delta x \geqslant 5\times 10^{-9}$ cm which exceeds the displacement. For this reason, it is better to measure the momentum first, even though it disturbs the position measurement, because the latter is not directly coupled with the momentum. This type of measurements is usually called a non-demolition measurement (NDM).

A compact review of multiphoton ionization process was presented by G. LEUCHS who gave interesting examples of the photoelectron angular distribution, Y. CHO et al. worked out an autocorrelator which measured not only ultrashort pulse times, but also phase relations between mutually delayed light beams. L. W. CASPERSON, a well-known expert in chaos and electromagnetic noise, presented important problems of spontaneous pulsation in lasers. The paper by H. J. KIMBLE et al. about optical bistability with two-level atoms is of a very high value. It contains a comprehensive analysis and experimental examples.

The book *Laser physics* presents a valuable position. It was published soon, a few months after the symposium, which speaks well for the Springer-Verlag. The book may be recommended to a wide circle of physicists who are concerned with both lasers and quantum optics.

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Optoelectronic materials and devices

Proceeding of the Third International School, Cetniewo, 1981

Edited by MARIAN A. HERMAN

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PWN – Polish Scientific Publishers, Warszawa 1983

Around the world scientists and engineers are engaged in a race to build new fiber-optic systems to transmit voluminous information at unprecedented bit rates and over longer distances than those achievable with existing communications system. Their attention is focussed on: (i) new materials and technologies for optical fibers, (ii) new technologies for integrated optoelectronic devices, and (iii) the search for better lasers. Especially, a new type of light source (i.e., single-frequency semiconductor laser) for the last generation of fiber-optic systems is actually in a centre of the research and development activity.

The first generation of fiber-communication systems (the one being in a wide use today) is a digital system using multimode fibers and either light-emitting diodes (LED-s) or laser diodes (LD-s). Such a system operates at the wavelength of 0.8–0.9 micrometers and has two fundamental limits referring to the distance a signal can be sent and to its signal-carrying capability. The second-generation system also uses multimode fibers and LED-s or LD-s and is still limited by modal dispersion. Such a system, however, works at the wavelength of 1.3 micrometers eliminating chromatic dispersion to be source of pulse broadening. The third generation also operates at 1.3 with the same sources as above, but it uses single-mode fibers eliminating that pulse broadening effect of both modal and chromatic dispersion. The now-emerging fourth generation of fiber-optic systems is the one with single-frequency laser. It will use the LD made of modern quaternary semiconductor (e.g., GaAsInP) emitting signals at 1.55 micrometers to be sent by means of single-mode fibers. That eliminates the effects of modal dispersion; the spectral purity of single-frequency LD overcomes the chromatic dispersion at that wavelength, as well. At the bit rate of 2 Gbits per second information might be sent well over 100 km.

From the viewpoint of the latest world record of information and error rates, the book reviewed is not actual. One should note, however, a long publishing procedure (well over a year) and the due date of presentations (September 1981). Therefore, the main merit of the proceedings is to set up the state of the art of the optoelectronic systems of the late 70-ties and very early 80-ties. The arrangement of the book includes technological problems and general properties of materials widely used in optoelectronic (Chap. 1), technological methods for fabrications of optoelectronic structures (Chap, 2), some physical phenomena in optoelectronic materials and devices (Chap. 3), theory and applications of some optoelectronic devices (Chap. 4), and, finally, forewords to panel discussions (Appendix). This arrangement could be somewhat better. In particular, physical (fundamental) phenomena in materials and devices (Chap. 3) seem to be the most important part and could also comprise some contributions from Chapters 1, 2 and 4. This chapter (now could be numbered 1) might be followed by Chap. 2 covering modern procedures of preparations of materials and devices and, furthermore, be followed by Chap. 3 including future prospects of optoelectronic devices. Nevertheless, the book covers a broad field of interest and deals with some topics in present-day optoelectronics. The review of GaAsInP properties and optoelectronic applications (contribution no. 4), technology of optoelectronic structures (entire Chap. 2), and development of some devices (contributions no. 17–21) are of a great importance, especially.

The number of problems discussed in the book is certainly limited by the number of the authors and by the reasonable volume of their contributions. Also, the contents reflects the authors' positions on the problems for the presentation. Nevertheless, the publication is fully justified and the book is strongly recommended to the scientists and engineers acting in optoelectronics.

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Transmission Electron Microscopy

Physics of Image Formation and Microanalysis

LUDWIG REIMER

Springer Series in Optical Sciences, Vol. 36

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[pp.i–xii+521, with 264 Figures]

The book is a valuable issue describing physical aspects of formation and interpretation of images obtained with transmission electron microscopy. Problems connected with an interaction between electrons and a specimen in an electron microscope have been also included.

This is the second, revised and completed version of the first part of a book by the same author entitled *Elektronenmikroskopische Untersuchungs- und Präparationsmethoden* which includes most of achievements made in the transmission electron microscopy during the last ten years. The book consists of ten chapters dealing with essential problems connected with the contemporary transmission electron microscopy.

In the *Introduction*, different types of electron microscopes and occuring therein electron-specimen interactions have been reviewed and compared. These have been discusses in terms of high-resolution, analytical and high-voltage microscopy.

In Chapters 2 and 3, problems of electron optics, particularly connected with acceleration and deflection of electron beam, lens construction applied in electron microscopes and with types of lens aberrations, have been presented and discussed. Basing on the theory of wave optics of electrons their scattering in specimens has been discussed.

In Chapter 4, the construction and design features of more important elements of electron microscopes have been described taking account of the latest development trends in this field. A special attention has been paid to an analysis of factors influencing the transmission electron microscope resolution.

Electron-specimen interactions have been discussed in Chapter 5, including elastic and inelastic scattering of electrons, multiple-scattering and Auger-electron emission.

In the chapter entitled *Scattering and phase contrast for amorphous specimens*, the physical grounds for formation of scattering contrast, phase contrast and imaging of single atoms in amorphous specimens have been described. Contrast transfer function and imaging with electron holography and Lorentz electron microscopy have been also analysed.

Kinematic and dynamic theory of electron diffraction has been presented in Chapter 7. It contains the fundamentals of crystallography, the kinematic and dynamic theory of electron diffraction and the dynamic theory of absorption. A theory of intensity distribution in diffraction patterns has been described with the factors influencing their course taken into account.

In Chapter 8, the diffraction contrast for ideal crystals, crystal-structure imaging with the high-resolution microscopy applied and the analysis of diffraction contrast of lattice defects in crystals have been discussed. The analysis of diffraction effects due to the presence of small-dimension particles is also a valuable novelty.

Chapter 9 is devoted to the analytical electron microscopy. Microanalysis theory with the spectroscopic method and with aid of X-rays in transmission electron microscopes have been discussed therein. Much attention has been also devoted to an electron-diffraction application in order to explain the problems connected with the analysis of crystalline structure of the investigated specimens. The possibilities of interpretation of diffraction patterns containing high-order Laue zone patterns have been presented.

In Chapter 10, the kinds of specimen damages due to electron interactions have been described. Specimen heating, radiation damage of organic and inorganic specimens as well as origins and methods of contamination prevention in an electron microscope have been discussed therein.

The book is written very synthetically, it contains only the most important information from this field which is classified in sections according to the problem importance. Data contained in this book are the effect of the author's recapitulation of the state of the knowledge and his works in this field including a wide literature review. According to the introductory remarks the author has written this book using intentionally some formal simplifications in order to make the described problems be comprehensible for people not concerned professionally with the theory and construction of electron microscopes. It seems that the realization of the author's intentions may be considered as being successful.

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