Optica Applicata, Vol. XIII, No. 3, 1983

Book reviews

Introduction to the theory of laser-atom interactions

MARVIN H. MITTLEMAN

Plenum Press, New York and London 1982
[pp. i–xi + 198]

The book by MITTLEMAN entitled *Introduction to the theory of laser-atom interactions* is a very valuable publication which is worthy of careful notice by all who intend to work or are working already in the fields of laser physics, quantum electronics and photochemistry and physical chemistry. The basic purpose of this book – the pointing out that the laser field is capable to change (frequently in a dramatic way) the face of many classical processes of the atomic physics, especially the scattering processes, has been achieved by the author in the way of elegant and convincing considerations.

The first four Chapters of the book are essentially a concise introduction which, with some small exceptions, is devoted to the traditional problem of an isolated atom in a resonance electromagnetic field, and in particular to the problem of nonperturbative determination of states and energies of the atom in a laser field of various intensity and frequency, as well as to the problem of spontaneous emission and resonance fluorescence spectrum in the model of two-level atom. This part of the book fulfills two useful tasks. Firstly, it makes the book completely self-sufficient in the sense that the reader is not forced to use any other complementing publication during the reading. The Chapters 1–4 provide moreover a very good introduction to the further study of much more difficult, three-body problems in which, beside a photon and an atom, a third factor must be encountered, e.g., an external field, free electron or an additional atom (of the same or other sort).

In the Chapters 5, 6, 8 and 9 the author discusses carefully and profoundly how the laser field deflects the atom beam, how it modifies the electron scattering on a potential or an atom, and also how it influences the scattering of the atom on an atom, the charge transfer in this process, the reaction rate and the van der Walls potential.

The Chapter 7 and the Appendix at the end of the book have been devoted to various aspects of two- and many-photon ionisations both of resonance and nonresonance types. The richness of the topics discussed and the attractive way of their presentation may guarantee a high popularity of this book.

The book is essentially thought of as a theoretical lecture but whenever it is possible the predictions of the theory are confronted with the experimental data (unfortunately very few so far). The lecture is of a very high scientific level and all the problems considered are precisely formulated and consequently solved, the detailed calculations being obviously omitted. An inquiring reader, however, may always find them in the original papers, to which he is frequently referred by the author. That is why the essence of both the phenomena discussed and the mathematical formalism used to their description is always easily perceptible and the book does not seem to be overloaded with the formulae though they are really numerous. A less advanced reader are offered a good opportunity to get acquainted with some calculational techniques presented to a full extent and being fairly commonly used in the field of these laser-atom interactions the author deals with.

The high estimation of this book is by no means lowered by the fact that several errors may be found in it. In particular, in the formula (1.2.4) instead of $a_{K\lambda}$ in the second component of the sum it should be $a^{+}_{K\lambda}$, while in the formula (2.13) the square root is denoted bye $\sqrt{\ }$ and 1/2 power simultaneously of which only one is necessary, finally, on the page 97 the name Fedorov is written incorrectly.

Ryszard Parzyński
Institute of Physics
Adam Mickiewicz University
Poznań, Poland

Fiber-optic rotation sensors and related technologies

Editors: S. Ezekiel and H. J. Arditty

Springer Series in Optical Sciences Vol. 32

Springer-Verlag, Berlin, Heidelberg, New York 1982
[pp. i–x+440, with 331 Figs.]

During many decades mechanical gyroscopes were used as rotation sensors. The discovery of lasers offers real possibilities of employing the well known Sagnac effect for the same purposes. On the basis of this effect a ring laser gyroscope has been elaborated and introduced to some navigation systems in the course of last two decades. It seems, however, that the future of rotations sensors belongs to much more perfect multiturn fiber optic interferometers based on the same principle. The Sagnac effect principle, especially in its classical formulation, is simple, but the same cannot be said about its practical realization. Many complex problems of theoretical physics, integrated fiber optics, polarization optic and a number of other problems of laboratory techniques and glass fiber production technology are here involved. Some of them were considered at the SPIE Conference in San Diego, California, as early as in 1978. First conference devoted totally to fiber-optic rotation sensors was organized in MIT, Cambridge, Mass., USA in 1981. Among the participants there were numerous scientists and industry workers from the most advanced countries in the world. The book revieved is just the proceedings of this conference, its form, however, does not resemble a typical set of papers, which is usually the case. The Editors S. Ezekiel and H. J. Arditty have elaborated a kind of monograph of the topic containing the following Chapters:

1. Tutorial review
2. Theoretical considerations
3. Building blocks
4. Fiber optic rotation sensor system
5. Limiting factors
6. Advanced concepts
7. Related fiber-optic sensors
8. Market considerations

Such a monotopic elaboration offers a good chance to all the scientists, engineers and students, who would like to widen their interest and get acquainted with actual state-of-affairs

in the field of fiber-optic rotation sensors but who had no opportunity to participate in this MIT Conference. The problems discussed in the book are still alive. Further papers from this field are among others to be presented at the DGaO Conference (Deutsche Gesellschaft für angewandte Optik e.V.) in Darmstad (West Germany) in 1983 and at the SPIE's Technical Symposium EAST 83, Arlington, Virginia, USA.

Florian Ratajczyk
Institute of Physics,
Technical University of Wrocław
Wrocław, Poland

Inverse problems of lidar sensing of the atmosphere

SV. E. ZUEV, I. E. NAATS

Springer Series in Optical Sciences, Vol. 29

pringer-Verlag, Berlin, Heidelberg, New York 1983
[pp. i–xi+260, with 71 Figures]

A characteristic feature of this book, written by two outstanding specialists in the field of atmospheric optics, in general, and of remote sensing by lidar methods, in particular, is that it reports mainly the achievements of one scientific centre, i.e., the well-known Institute of Atmospheric Optics, SB USSR Academy of Sciences, Tomsk, USSR. In this way the reader is offered a special opportunity of getting acquainted in a complex and exhaustive way with the philosophy and methodolody of lidar sensing developed at this Institute.

In accordance with its title the book deals with many fundamental aspects of the methodology of solving the inverse problems involved in remote control of the atmosphere by using the lidar technique: exploiting the back scattering effects by atmospheric aerosols and molecules as a source of information about the latter.

The authors start with explaining the relations between the required information about the size distribution of the aerosols and the optical characteristics of the atmosphere to relate next the latter to the scattering data available by detection. Thus the direct problem (which constitutes a natural basis for solving the inverse problem of interest) has been formulated for one-dimensional (spherical particles) case to be next generalized to the case of nonspherical aerosol particles. The said relations being described in the form of integral transforms the inverse problem may be formulated in terms of the corresponding integral equation to be solved. The wide variety of the methods of solving these integral equations for these numerous cases of lidar sensing, such as: polydispersed systems of spherical particles, polydispersed systems of convex randomly oriented particles, polydispersed systems of ellipsoidal particles and others, constitute the subject matter of the large part of this book.

A special attention has been paid to the various methods of multi-frequency lidar sensing applied to both aerosol microstructure and index of refraction determination. The methods reviewed in the book include the iteration method, those of logarithmic derivative and of combined discrepancy and others. The next two sections are devoted to the determination of the aerosol microstructure in the boundary layer and in the low stratospheric aerosol, respectively.

An extensive study of inverting the polarization data is offered in the large Chapter four, where the special distribution of the scattered light becomes the main source of information about the aerosol composition. The general method consists in inverting the scattering phase matrix for polydispersed systems of particles (which is sensitive to the shape of the scattering particle), the matrix elements being possible by means of the laser polarization nephelometer or bistatic lidars. The methods of solving the inverse problems are reviewed largely for the case of spherical particles. The nonspherical case, remaining, in general, unsolved, may be attacked by analyzing the influence of the particle nonsphericity on the results obtained by exploiting the spherical approximations (Mie theory), and parametric modification of the respective integral equation, to encounter the information about the type of nonsphericity. Such an analysis (in addition to many others connected with the problem) followed by the study of bistatic lidar sensing possibilities may be found in the book reviewed.

The last Chapter is devoted to remote determination of the atmospheric parameters, such as humidity, temperature, vector and wind velocities, turbulence and the like, by using the lidar techniques, exploiting the light scattering by aerosols.

Although the whole material presented in this book is richly illustrated by algorithms and numerical results, the emphasis is put on the in-depth theoretical analysis of the aerosol microstructure determination. Therefore the book may be recommended first of all to the scientific workers working in the field of atmospheric optics. It may prove to be especially advantageous to the young researchers wanting to be quickly introduced, in a systematic and ordered way, into the whole complexity of the lidar sensing of the atmosphere. On the other hand, the relatively high prerequisits seem, however, to restrict significantly the circle of possible nonprofessional readers.

Ireneusz Wilk
Institute of Physics
Technical University of Wrocław,
Wrocław, Poland