um has the form

$$\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}=\frac{1}{V^2}\frac{\partial^2 u}{\partial t^2}\text{"}$$

(p. 7). Of course, for a plane wave, the wave equation does have exactly this form. But it has the same form also for spherical or cylindrical or for all other possible waves in a homogeneous linear medium.

"Wave motion along a normal to the wave surface at any point is called the equation of the ray" (p. 14). A ray is defined in geometrical optics in quite a different manner, but, independently of this, how can one assert that motion is called an equation?

"If the medium is anisotropic or crystalline, then a light ray entering it is broken up in the general case into two plane polarized components which are propagated with different velocities. This phenomenon is called double refraction. The velocities of propagation in each of the two mutually perpendicular planes are inversely proportional to the indices of refraction of the medium in these planes" (p. 22–23). What is the meaning of an index of refraction of a medium in a plane? And what is the meaning of the velocity of propagation in a plane? And what exactly are the two mutually-perpendicular planes about which the only statement made is that they are mutually perpendicular? And, moreover, the beginning of the sentence "If the medium is anisotropic or crystalline..." is inexact. Cubic crystals are optically isotropic.

"Natural light which can be white or monochromatic is a combination of light waves with all possible directions of transverse oscillations randomly replacing each other" (p. 25). If different waves randomly replace each other, then such light cannot be monochromatic.

"In 1845 Faraday for the first time achieved artificial rotation of the plane of polarization by an optically active material by placing it into a longitudinal magnetic field" (p. 39). An optically active material rotates the plane of polarization even without being placed in a magnetic field. Faraday, however, showed that the application of a magnetic field makes an optically inactive material into an active one.

"The position of the vectors E,H,S; E_1,H_1,S_1; E_2,H_2,S_2 corresponds to satisfying the right-hand screw" (p. 34).

"Crystals which produce both the left-handed and right-handed rotation of the plane of polarization differ in form, being mirror images of each other" (p. 37). Probably the author wanted to say "...in their structure".

"The most important specific feature of the Kerr effect is its low inertia. It has been established experimentally that while light traverses a distance of 400 cm, all traces of double refraction disappear" (p. 42). It is not at all clear what the author wanted to say.

"Let a plane monochromatic wave of linearly-polarized light be incident normally on a reflecting surface with an index of refraction $n > 1$" (p. 63). There can be no reflecting surface with an index of refraction. The index of refraction is a characteristic of a medium, and not of an interface.

A list of this kind of statements could be continued. There are very many of them even for a small book of 133 pages.

But, in addition to all this, the presentation has a number of other deficiencies. There is a lack of correspondence between the text and data in tables, between the text and figures, between the text and formulas. The imaginary unit in one place is denoted by i, and in another by j. Both in the text and in the formulas there are misprints and errors.

In summarizing one should say that the book does not resolve any of the tasks posed by the author in the introduction, since it is illiterate in the scientific, methodological and literary aspects.

The responsibility for the publication of the book along with the author has to be shared by the reviewers: candidate of physical-mathematical sciences, a docent of the chair of general physics of the Moscow physico-technical institute G. R. Lokshin, and candidate of technical sciences, docent of the chair of applied optics of the Moscow institute of geodesy, aerial photography and cartography A. M. Zhilkin. By the way, in Belorussia there is an excellent school of physical optics which occupies a leading position in our country. There was no need to send the manuscript of the text for a review to Moscow. The manuscript could have been given a quality review in Minsk or in Gomel'.

Optical bistability: light controls light

S. A. Akhmanov

Usp. Fiz. Nauk **151**, 185–188 (January 1987)

H. Gibbs. *Optical Bistability: Controlling Light with Light.* Academic Press, New York, 1985, pp. 471 (Academic Press Series of Monographs: Quantum Electronics—Principles and Applications).

The book being reviewed is devoted to the rapidly developing in recent years section of nonlinear optics and applied quantum electronics—the selfactions and interactions of light waves in passive nonlinear systems with feedback. As in nonlinear systems with lumped constants (for example, in a nonlinear oscillator whose eigenfrequency depends on the amplitude of the oscillations; an oscillator described by Duffing's equation) in a distributed optical nonlinear medium feedback leads to the appearance of multistability, instability and chaos. However in optics phenomena due to feedback are much more multifaceted: here feedback is realized for fields and not for one-dimensional functions of the time. Therefore new nonlinear effects arise—transverse optical bistability due to space modulation of the beam, polarization bistability and multistability, polarization chaos.

In optics the variants of feedback are also multifaceted—together with the simplest variant, where feedback arises as the result of reflection from the mirrors of a Fabry-Perot resonator, systems with distributed feedback (counterpropagating waves continuously interact in many cross-sections of a nonlinear medium) are acquiring ever greater importance. Optical electronic hybrid systems have turned out to be convenient model systems; these are systems where feedback is achieved by electrical control of the parameters of an optical medium.

Investigation of optical bistability, multistability, chaos or "optical turbulence" of such systems has become one of the most interesting divisions of modern nonlinear optics. At the same time the rapid progress in the technology of nonlinear materials (and first of all in the production of multilayered semiconductor structures—superlattices with quantum wells) led to the fact that optical bistable devices have acquired also an undoubted practical significance. On the basis of semiconducting nonlinear resonators the fast-acting ($\sim 10^{-12}$ s) optical triggers have been created with an energy of the switching signals $\sim 10^{-12}$ J. The latter, together with successes in the development of fiber lightguides and the realization of stable nonlinear regimes of propagation within them of picosecond and femtosecond laser pulses (formation of optical solitons), can without doubt be regarded as a big step on the path of creating a new class of computers—superfast-acting optical computers.

In the book being reviewed written by a professor of the University of Arizona (USA), H. Gibbs, a detailed and clear presentation of the present state of physical and applied aspects of optical bistabilities is given. Much original material is presented in the book; a large role was played here by the fact that in the course of the last decade the papers of H. Gibbs and his colleagues have continuously stood at the forefront of investigations in the physics of optical bistability and its applications for processing of information.

In the introduction the author terms his book as a research book—this, perhaps not so widely used as yet term, very accurately reflects its dynamic style, the character of presentation of theoretical and experimental data. The author begins with a general introduction, in which considerable attention is devoted to the latest achievements in the development of optical logical elements. A brief outline of the history of work on optical bistability is given. The experiments on optical hysteresis and bistability in a gas laser with a nonlinear-absorbing cell first carried out in the USSR by Lisitsyn and Chebotaev in 1968 are noted.

The principal emphasis is on the optical bistability in passive systems. This was first observed by McColl, Gibbs, Churchill and Venkatesan in 1974 in a Fabry-Perot resonator filled with sodium vapour. Since then over a thousand articles have been published in this field; a carefully selected list of them (with complete titles) forms the bibliographic base of the book under review[1]).

Now in order to give a more concrete idea about the book of H. Gibbs (and at the same time about the range of physical and applied problems unified by the common title "Optical bistability") we give below its chapter headings with brief comments.

2. Steady state models of optical bistability

A consistent and quite exhaustive presentation of the theoretical bases. The author begins with a detailed examination of the nonlinear response of a ring optical resonator, filled by two-level atoms. Particular attention is paid to the cases of absorptive (nonlinear absorption—the imaginary part of the nonlinear susceptibility is operating) and dispersive (due to the real part of the nonlinear susceptibility, and to the nonlinear increment to the phase velocity) bistability. Different methods of description are discussed in detail; along with the complete theory based on the simultaneous solution of Maxwell's equations and Bloch equations simple models are presented, graphical methods of calculating regimes of a nonlinear resonator are described, etc. A special section is devoted to the "transverse" bistability in bounded beams.

3. Experiments on observing optical bistability

The chapter contains a practically exhaustive list of data on optical bistability in optical resonators with different nonlinear media—atomic vapors, liquid crystals, semiconductors. In particularly great detail are discussed results of papers utilizing thin optical resonators, in which strong exciton nonlinearities of semiconducting superlattices of gallium arsenide are utilized. In such resonators optical bistability at room temperature can be observed at a power level of $\sim 10^{-2}$ W. It must be said that the range of nonlinear optical systems in which bistability is observed is rapidly being broadened.

Data are quoted on bistability, arising in systems of wavefront reversal, on interface boundaries, in optical waveguides. Of fundamental interest is optical bistability due to the strong local nonlinear response of an individual atom or molecule when the required feedback arises in each elementary oscillator of the field—"mirrorless" or "intrinsic" bistability.

In terms of the physics of the action of powerful radiation on matter one is dealing obviously with laser-induced phase transitions not associated with a change in temperature. A strong local nonlinear response qualitatively alters also the wave picture of propagation of light in a nonlinear medium.

The possibilities of experimental observation of these interesting phenomena have recently been attracting the attention of many research groups.

4. Bistability in hybrid systems

A hybrid system is an optical electronic arrangement consisting of an optical resonator with an electro-optics crystal placed within it and of an electrical feedback circuit. With an appropriate choice of parameters bistability arises in such a system. On the basis of nonlinear transparencies hybrid systems with a two-dimensional feedback have been produced.

Starting in 1977 numerous experiments have been carried out on observing bistability, multistability and optical turbulence in hybrid systems. Although the rates of switching attained here are usually not very great, hybrid systems are very convenient for studying this new class of nonlinear optical phenomena.

5. Optical switching; controlling light with light

It is specifically with these phenomena that the applied importance of optical bistability is associated. The main emphasis in chapter 5 is on an analysis of different designs for controlling the characteristics of a nonlinear optical resonator by an external optical signal. A theory of non-steady-state phenomena in a nonlinear resonator is presented, different designs of optical triggers, transistors, etc., are described.

6. Instabilities; non-steady state phenomena in the case of an unmodulated input signal

Instabilities, stochastic behavior of dynamical systems that are being intensively studied at present in different subfields of physics, are vividly and characteristically manifested in nonlinear optics.

Chapter 6 is, essentially, one of the first monographic reviews on this subject in world literature. A beautiful example of optical instability are the so-called regenerative pulsations of the intensity of laser radiation passing through a Fabry-Perot resonator filled with a medium with competing mechanisms of optical nonlinearity. Considerable theoretical and experimental material has been accumulated that demonstrates the regularities of the transition to chaos in nonlinear optical resonators and hybrid systems.

7. Towards the creation of practical devices

In this chapter, the results of investigations of optical bistability are considered from the point of view of developing elements of optical processors, with *parallel processing of information*. It is noted that from the point of view of fast action, optical logical elements are now already beyond competition; switching times of $\sim 10^{-12}$ s have been attained, and limiting values are $\sim 10^{-14}$ s. Rapid progress is seen in lowering the energy expended on switching. Quite a comprehensive compilation is given of data on cubic nonlinear susceptibilities of semiconducting materials which characterizes the possiblities available here.

The advances in the development of effective nonlinear materials, of various systems of controlling "light with light" make it possible to have a new attitude towards the prospects of optical computers. In evaluating these advances one should have in mind that we are dealing not only with a new elementary base, but also with a new architecture of computers; for optics parallel information processing is entirely natural.

In what has been said is contained one of the main reasons for the rapidly growing interest in optical bistability and its applications.

Undoubtedly the book under review will be met with great interest by specialists and by persons beginning work in this promising field of nonlinear optics.

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1) The list of references is systematized according to authors and years. Nowadays one encounters ever less frequently this method of citing references; it is regarded to be uneconomic. And yet, how much more vivid and descriptive is such a picture of the development of science compared with the dry indications of the numbers of the "blind" (without citation of titles) references!

Crystal structures of silicates

S.E. Sigarev

Usp. Fiz. Nauk **151**, 188–189 (January 1987)

Landolt-Börnstein. *Numerical Data and Functional Relationships in Science and Technology*. New Series, Group III: Crystal and Solid State Physics, V.7: Crystal Structure Data of Inorganic Compounds. Part d: Key Elements Si, Ge, Sn, Pb; B, Al, Ga, In, Tl, Be. d1: Key Elements Si, Ge, Sn, Pb. d1β: Key Element Si (Substance Numbers d1169...d2377). Springer-Verlag, Berlin; Heidelberg; New York; Tokyo; 1985, pp. 506.

The handbook being reviewed is the second part of the issue III/7d1 in the series devoted to crystal structures of inorganic compounds. The first volume of the issue III/7d1-1α, containing data on anhydrous complex oxides of silicon appeared at the beginning of 1985. In the present edition—1β—information is collected on silicates containing H_2O and (or) other simple or complex anions.

The materials listed in the handbook (1209 units) are listed according to the position in the periodic system of the elements of the cations of which they are composed.

The system of listing information in volume 7d1β is the same as in volume 7d1α, i.e., the reader is presented with the chemical formula of the material (the name of the mineral if it exists in nature); structural data which include the space group, the parameters of the elementary cell and the number of formula units within it; the structure type; the density; the method of obtaining information on the atomic structure of the material (x-ray diffraction, neutron diffraction, electron