On a textbook on physical optics

B.M. Bolotovskiĭ and Yu. A. Kravtsov

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N.M. Spornik. *Physical Optics* (In Russian). Reference text for a specialized course for third-year students. Grodno State University, Grodno, 1983, pp. 133.

In the introduction, the author indicates the principal tasks which the course on physical optics under review sets before itself. These tasks are formulated in the following manner (we quote them in the author's formulation).

"... 1. To increase the depth of understanding by the students of the concepts of the principal optical phenomena of interference, polarization, diffraction of light, etc., and their relationship to the solution of research and applied problems; 2. Orientation of students towards the practical realization of the knowledge obtained in the research and production circles; 3. Mastery of the new knowledge and methods in the given field, becoming familiar with the lines of development of scientific investigations and the acquisition of habits in the design of experiments in scientific research" (p. 5).

The course consists of 8 sections: 1. Wave processes and their general properties. 2. Polarization of light. 3. Interference of light. 4. Coherence of light. 5. Diffraction of light. 6. Elements of the general theory of interferometers. 7. Optical methods for the diagnostics of phase media. 8. Optical instruments for the diagnostics of phase media (the term "phase media" has been adopted in the textbook for media which alter only the phase of the wave passing through them).

Already from this brief enumeration it can be seen that the reference text under review largely repeats in a condensed form the chapter "Optics" from a general course in physics. Indeed the content of the first six of the eight sections included in the specialized course in fact differ but little from the corresponding sections of a university course in general physics. The last two sections contain information on optical designs and specific instruments usually included in laboratory manuals. Thus, the choice of material hardly corresponds to the modern level of physical optics. And certainly this choice of material does not correspond to the aims of the lecture course stated above.

The first section is devoted to the general properties of wave processes. The author begins by stating that "all wave processes, independently of their nature, follow the same regularities and are described with the aid of the same concepts" (p. 7). On this basis nothing at all is said in the first section about those distinctive properties which electromagnetic waves have in comparison with, let us say, sound waves or with waves running along a string, or with surface waves. Moreover, the author describes the basic properties of electromagnetic waves by calling upon mechanical analogies. Thus, the concept of a wave is explained using the example of vibrations of a string, the expression for the energy of the wave is also derived from a mechanical model. Having embarked on this path the author, essentially, turns away from deriving quantitative relationships in physical optics. The basis for deriving any quantitative relationships are Maxwell's equations, but they are not stated nor even mentioned. Therefore the content of the course reduces not to a derivation but to a description of the basic laws of physical optics, with the basis of the description being mechanical analogies. The presentation of section 2 dealing with polarization of light has the same character. The polarization of light is also defined on the basis of a mechanical model. The section devoted to the polarization of light begins as follows:

"Before we go on to a discussion of the polarization of light we shall consider one more feature of oscillatory motion of a particle, i.e., its motion simultaneously in two mutually orthogonal directions" (p. 20). And further, "Polarized light can be imagined as disturbances in which the particles perform transverse oscillations along definite trajectories in a plane perpendicular to the propagation of light" (p. 26). About what particular particles the statement is made the book offers no explanation, and without that the quoted sentences do not explain anything. And, moreover, the polarization of an electromagnetic wave is a property of the electromagnetic field and not of mechanical particles. No particles need be present, but a light wave nevertheless can have a quite definite polarization. We must also add that if a charged particle is placed in the field of a plane linearly polarized wave, the trajectory of the particle will not lie in the plane perpendicular to the direction of the propagation of the wave. As is well known, the laws of electromagnetism cannot be deduced from mechanics. Mechanical analogies are only analogies and nothing more. They do not explain anything in electrodynamics and, certainly, do not replace Maxwell's equations.

In presenting the material of the following sections the author utilizes essentially the same methods as in presenting the first two sections discussed above. Quantitative relationships, as a rule, are either quoted without derivation, or the derivation is not a consistent one, and moreover the material essentially is contained within the framework of the program of a general course in physics.

The referenced text has many formulations, expressions and assertions which are difficult to describe as other than illiterate. Here are some examples:

"...Mirages or shadows appearing on a screen from light that has passed through heated air (anisotropic medium) are a consequence of the refraction of light rays in the inhomogeneity"...(p. 5).

But heated air is not an anisotropic medium.

"Propagation of waves is described by a wave equation which for a plane wave propagating in a homogeneous medi-

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um has the form

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

(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

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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 medi-