Geophysics

Paul Melchior's comprehensive book **The Earth Tides** (Pergamon, New York, 1966. 472 pp., illus. $17.50) is the first to summarize coherently the voluminous theoretical and experimental contributions to the subject scattered throughout various scientific publications of more than half a century.

The book begins with a brief introduction followed by three major parts, with an appendix on moon tides. Part 1 is devoted to the development of static tide theory. Several useful methods of harmonic analysis and data processing are discussed. A lengthy description of the use of an IBM 1620 is also given. Unfortunately, these methods, including the Lecolazet method which Melchior favors, do not fully utilize the data of a long series, and, as they stand, are generally limited to the analysis of a 30-day series, which is insufficient to permit separation of some principal tidal constituents. Other techniques—least squares, power spectra, filtering, correlations, and so on—for analyzing arbitrary lengths of geophysical time-series data are omitted.

Part 2 summarizes experimental results, including those obtained during the International Geophysical Year, of deflection of the vertical, of variations in the intensity of gravity, of changes of linear strain, and of cubic expansion of the crust. Measurements of the horizontal pendulums, particularly of the Verbaandert-Melchior type, are quite detailed; appropriate anecdotes as well as personal experiences are interspersed. A thoughtful discussion is found in the chapter "Earth tides in relation to physical, geophysical, and geological problems."

Part 3 deals with the fundamental theory of solid earth tides. Molodensky's theory on the dynamic effects of a liquid core on earth tides is presented in what Melchior refers to as "logical deduction rather than detailed mathematical development." Jeffreys and Vicente's theory on the same subject is only very briefly mentioned. The continuity of Part 3 is somewhat disturbed by the inclusion of the chapter "Rheology of the earth" in the midst of earth-tide theory and dynamic effects of a liquid core.

A very useful and complete bibliography from 1800 to 1959 and the supplements from 1959 to 1964 are included at the end of the book. In addition to author and subject indexes for the entire volume, there is also an index to the bibliography. For a first edition, typographical errors are at a minimum.

Despite a few shortcomings, the book as a whole undoubtedly fills the need for an organized summary of the classic field of earth tides. Advanced students and research workers in geophysics will find it a valuable reference.

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Objects and Images

It is unusual to find a book on the microscope in which little or nothing is said about the microscope itself. There are many other books dealing with microscopes and with their use in various technical fields, however, and instead of duplicating these treatments, L. C. Martin, the author of **The Theory of the Microscope** (Elsevier, New York, 1966. 502 pp., illus. $19.50) has undertaken to explain in a very simple and clear fashion how the microscope forms an image, and the relation between the object on the stage and the image that you see in the eyepiece. Abbe, over 90 years ago, recognized that there is a fundamental distinction between the imagery of self-luminous and illuminated objects, and he developed an elementary theory of coherent illumination to explain this. Succeeding workers have greatly elaborated the theory, extending it to include different types of opaque and phase objects. The mathematics here can become formidable unless some simplifying assumptions are made.

The present book contains some perfect examples of a physical model rendered precise by mathematical reasoning. The author does not hesitate to use integrals and Bessel functions where necessary, but he remembers that they are merely tools and that the average reader will learn far more from the extensive explanations than from the mathematics.

For structures at the limit of resolution of the microscope, it is evident that the convenient ray fictions of geometrical optics are no longer applicable. Instead, we are deep in a problem of wave optics. Martin's treatment deals almost entirely with waves, phases, interference, diffraction, and coherence, yet in his hands, with the assistance of numerous unusually clear diagrams, these rather abstruse aspects of microscope imagery become wonderfully clear.

The first three chapters of the book constitute a compact and admirable survey of the basic knowledge of optics which is required for a proper understanding of the microscope. Indeed, they should be required reading for anyone who plans to design or use any image-forming optical system. Chapter 1 covers the fundamental first-order (Gaussian) theory of lenses and mirrors, and photometry. The second chapter moves into the field of vibrations and waves, with Huygens' principle, Young's interference experiment, Fresnel and Fraunhofer diffraction, and the Airy disc. In the third chapter, simple instruments are considered: the microscope and magnifier, eyepieces, entrance and exit pupils, condensers, and image illumination. Chromatic and spherical aberrations are considered in both ray and wave notation. The construction of refracting and reflecting microscope objectives is discussed briefly.

Chapters 4 to 6, representing about one-third of the book, deal with the very important matter of coherent and incoherent illumination in image-forming systems. The incoherent case (a self-luminous object) is generally familiar, and the light distribution in the image of a point, disc, line, grating, and edge have been known for many years. A brief and useful summary of the principal results in this field is given in chapter 4. The subject of partial coherence is introduced in chapter 5, and many of the important phenomena are very simply and clearly treated. In chapter 6 the effects of coherent illumination when objects are viewed under the microscope are covered in detail, including the Abbe theory, grating images, Köhler illumination, dark-ground effects, and the convolution theorem.

Chapter 7 deals with the microscopy of phase objects, presents many excellent explanatory diagrams and worked examples, and concludes with a discussion of phase-contrast microscopy and the many types of interference microscope. In chapter 8 some examples of typical microscopical objects under illumination with various degrees of partial coherence are considered. Appendixes cover the mathematics of Fourier series and integrals, the image