books

# Eclipsing binary systems send "coded" messages

**Language of the Stars**

**Z. Kopal**
280 pp., Reidel, Hingham, Mass., 1979.
$63.00 cloth, $28.95 paper

*Reviewed by Edward Guinan*

Over 50% of the stars in the solar neighborhood are members of binary- or multiple-star systems in which gravitationally bound stars undergo mutual orbital motion. A smaller fraction of these star systems (about 0.2%) have their orbital planes nearly coincident with our line of sight, so their eclipses produce decreases in light. Over three thousand eclipsing systems are known so far. These constitute a small sample of the estimated several hundred million eclipsing systems that populate our galaxy.

The theory and analysis of the light variations of eclipsing binary systems provides the central content of Zdenek Kopal's most recent book on the subject. The author, one of the foremost authorities on eclipsing binaries, has published numerous papers and written several books on this subject during the past 50 years. In this book he develops the theory of light changes in eclipsing systems and presents a basically new analytical method of extracting the orbital and stellar parameters from the observed light variations.

The study of the observed light changes of eclipsing systems provides information on the orbital parameters of the systems and about the fractional sizes and relative luminosities of the stars as well as on the properties of the stellar surfaces. More importantly, such astrophysically vital information as stellar masses, diameters, densities and the internal structure of the stellar components can be deduced when additional spectroscopic radial-velocity data are consulted. These quantities are of fundamental importance for the study of stellar structure and stellar evolution.

Kopal describes the problem of interpreting the observed light changes of eclipsing systems and analyzing their physical parameters as a kind of astronomical cryptograph: "The messages these stars sent out on waves of light are encoded by processes responsible for them, while the task of the analyst is to decode the photometric evidence to yield the information which it contains." The book is thus divided into two parts. The first (Chapters I, II and III) is devoted to the mathematical development of the theory of light variations of eclipsing systems—which the author calls the code. In Chapter I the theory for the simplest case of light changes produced by the eclipses of two spherical stars is developed in a rigorous way. The more general and more complex problem of developing a theory appropriate for close binary systems is presented in the next two chapters. In close binary systems, because the star's dimensions are a significant fraction of the orbital separation, the components interact strongly. Gravitationally induced tides are raised, which produces stars that are approximately ellipsoidal in shape, whose facing hemispheres are mutually irradiated and heated. These effects produce light changes over the entire orbit as the stars are viewed at different orbital aspects.

The second part of the book is devoted to the analysis of observed light changes and the extraction of the orbital and stellar parameters, which the author calls the decoding of the message from the stars. These last three chapters deal with extracting the quantities describing the system from an analysis of the observed light variation using Fourier transform techniques.

**A pentimento of a gate seen through a doe.** In this painting, originally a wall panel done by an unknown artist in Virginia in about 1715, the top layer of paint has become somewhat transparent. It is reproduced, courtesy of the Henry Francis du Pont Winterthur Museum, in *Light. Its Interaction with Art and Antiquities* by Thomas B. Brill (Plenum, New York, 1980, $29.50), which discusses the ways light creates effects of texture and color as well as deterioration. Topics are presented from the point of view of materials science for use by conservators, artists, and teachers of physics and chemistry.

Chapter IV is a review of iterative methods of analysis of the light changes in the time domain, which Kopal presented in a previous book on binary stars, *Close Binary Systems*. New material appears in Chapters V, VI and VIII, in which the light changes are analyzed by transposing the problem of analysis from the time to the frequency domain by means of Fourier transforms. In the frequency domain the effects of tidal distortion of the stars and their radiative interactions on light variations are characterized by discrete spectra, while light changes produced by eclipses are marked by continuous spectra of the fundamental frequency range. The Fourier-transform technique of analyzing the light variations of eclipsing binaries will be a valuable addition to methods currently being used. One of the chief attributes of the method is the ease with which it can be adapted for use on small electronic computers. All of the necessary mathematical expressions are provided in the book and in the 21 pages of appendices.

This book gives the reader an excellent resumé of the author's work on the subject and at the same time provides a unified and updated treatment. Although the title of the book suggests that the content of the study is accessible for the nonspecialist, it should be noted, however, that due to the complexity of the material presented and the form in which it is written, the book is hard to approach without a specialized knowledge; for example, the word "language" in the title should be understood as it is used in information theory. The author stresses in the Introduction the value of the procedures he has developed. It is, however, the reviewer's opinion that he has underestimated the merits of the approaches advanced by others and overemphasizes his own contributions to the field, significant though they are.

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*Edward Guinan is an associate professor of Astronomy at Villanova University, Villanova, Pennsylvania.*

## Physics of Semiconductor Laser Devices

**G. H. B. Thompson**
549 pp. Wiley, New York, 1980. $65.00

In another year the semiconductor laser will be 20 years old. Although it is certainly useful, it is far from fully developed. In the form of a diode, we might expect it, as least at first sight, to be relatively simple. Not so. Eight years of work (1962–70) were required before a semiconductor laser could be operated continuously at room temperature. The present book on this subject by G. H. B. Thompson, a well-known contributor to heterostructure laser development, makes it clear that the semiconductor laser is far from simple. While Thompson does justice to diode lasers, he fails to cover comprehensively peripheral topics or other forms of semiconductor lasers.

Thompson's book invites comparison to *Heterostructure Lasers* by H. C. Casey Jr. and M. B. Panish, which provides more information about semiconductor laser history. Both successfully describe carrier recombination and stimulated emission in a semiconductor; both are quite detailed in their descriptions of the waveguide properties of semiconductor lasers; both illustrate various stripe-geometry heterostructure laser configurations and their operating characteristics. Casey and Panish describe crystal and heterostructure growth more extensively and present a much greater list of crystal and material parameters, but Thompson has more complete treatments of the dynamic and noise properties of double heterostructure lasers and the present state of distributed feedback semiconductor lasers. Overall, as would be expected by its later publication date, Thompson's book provides the most current and complete coverage of *diode* heterostructure lasers. At the pace at which research continues in this field, however, neither of these books nor the similar *Semiconductor Lasers and Heterojunction LED's* by H. Kressel and J. K. Butler can be expected to remain current about new developments, such as InP–InGaPAs heterostructure lasers.

Thompson's book, like the book by Casey and Panish, is slanted toward the needs of communication systems. It does not satisfactorily cover other semiconductor laser problems and interests, such as electron-beam pumped lasers, photopumped lasers, laser operation in an external cavity, mode-locked laser operation, visible-spectrum lasers, II–VI semiconductor lasers, carrier scattering, and phonon effects, which *Semiconductor Lasers*, by O. V. Bogdankevich, S. A. Larznek, and P. G. Eliseev does. Although all of the books mentioned in this review are quite good, none of them anticipates the future very well. None indicates, for example, that quantum-well or superlattice active regions can be incorporated into heterostructure lasers to effect fundamental changes and improvements.

It is worth pointing out that the basic silicon device technology that has led to today's integrated circuit was initiated over 26 years ago at Bell Labs, mainly at John Moll's urging; thus today's silicon devices have had a much longer gestation period than most people ap-