BOOK REVIEW

ECLIPSING VARIABLE STARS

V.P. Tsesevich, editor. Translated from the Russian by R. Hardin. (Halsted Press, John Wiley & Sons, New York, and Israel Program for Scientific Translations, Jerusalem, 1973) 310 pages, $28.50.

This book examines the fundamental principles and the modern working methods of determining the elements of eclipsing variable stars from their light curves. The principal elements are: The radius of each component star relative to the radius of the orbit, the luminosity of each star relative to their combined luminosity, and the inclination of the orbital plane to the plane perpendicular to the line of sight. When spectroscopic observations have also been made the combination of spectroscopic and photometric elements can be used to determine the absolute radii and masses of the components.

Tsesevich has written three chapters of the book. In Chapter I he gives a brief overview of the astrophysical data obtainable from eclipsing binaries. He describes the classifications of eclipsing binaries according to the shape of the light curve, and he mentions evolution and mass exchange in close binaries. Most of the balance of the chapter is devoted to the topic of period change and, in this regard, Tsesevich emphasizes the importance of contributions made by visual observers who time minimum light.

In Chapter II Tsesevich introduces the concept of photometric phase which is the decrease in the brightness of the system during eclipse. He demonstrates how this can be expressed in terms of the ratio of the radii of the stars and the projected geometrical distance between the stars' centers as seen by the observer. A good foundation in trigonometry and calculus is assumed in this and most of the remaining chapters.

Chapters III and IV were written by A.M. Shul'berg. In Chapter III he derives the fundamental equation that relates the geometrical distance between the stars' centers to elements of the system and the phase in the revolution of the stars. Since the photometric phase is a function of this geometric distance and the ratio of the radii of the stars, as shown in Chapter II, the fundamental equation provides a relation between photometric phase and revolution phase for given elements. Plotting photometric phase as a function of revolution phase gives the theoretical light curve for these elements. The practical methods developed by Russell and Merrill, and by Kopal and Piotrowski for determining the elements by comparing the observed light curve with theoretical light curves are examined in the rest of the chapter.

Shul'berg reviews limb darkening of stars in Chapter IV. He shows how the degree of limb darkening can affect the light curve, though only by a few hundredths of a magnitude even in the most extreme cases. In practice it is customary to assume a value for limb darkening from theory when computing the theoretical light curve even though limb darkening is an element that could be solved for in principle.

In Chapter V V.M. Tabachnik explores the use of minimizing functions in finding the best fit of theoretical light curves to the observed curve by electronic computers.

D. Ya. Martynov discusses in Chapter VI the phenomena that normally complicate the light curve of close binary systems. The most serious effects are tidal distortion of the component stars and reflection of the light of one star from the other. Martynov describes methods by which an observed light curve complicated by these effects can be rectified so that one can solve for the elements by the relatively simple methods outlined in Chapter III.

Tsesevich turns to the subject of "unique" systems of eclipsing binaries in Chapter VIII. Unlike the rest of the book this chapter deals largely with spectroscopy and mechanics as well as photometry. The term "unique" is used to refer to eclipsing binaries for which the spectroscopic or photometric observations can not be explained classically; the observed light curve of β Lyrae, for example, can not be fit with a theoretical light curve even if the normal rectification procedures referred to in Chapter VI are applied. Frequently the photometric and spectral peculiarities point to the presence of material which has escaped from one or both stars into circumstellar space. To understand unique systems with circumstellar matter one must understand the mechanics of particles under the gravitational influence of two bodies, the component stars. The most useful approach to this problem so far has been the Roche model which is used to identify a gravitational boundary for each component star. If particles of the outer layer of a component star exceed their boundary they will be lost to the star and occupy circumstellar space.

In Chapter VIII, A.M. Cherepashchuk discusses theoretical light curves for stars whose photospheres may not be thin compared to their radii. Like the unique systems, these can not be analyzed by the classical methods described in previous chapters of the book. The method of analysis is complicated. However, it promises to supply new information about stars because it does not suffer from the assumption that the photospheres are necessarily thin.

Martynov treats systems with elliptic orbits in Chapter IX. He discusses Russell's method for determining the elements of such a system, and derives the equation that predicts the effect of precession of an elliptic orbit on the times of minimum light.

This book will certainly become a standard reference for persons studying eclipsing variable stars for many years to come. Even as some of the classical methods become obsolete the fundamental principles involved in their formulations will point the way to improved methods. The power of <u>Eclipsing Variable Stars</u> lies in the fact that these principles, as well as the classical methods, are clearly spelled out.

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