TECHNIQUES FOR VISUAL OBSERVATION OF ECLIPSING BINARY STARS

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Abstract

Within the past few years amateur astronomers in the United States have demonstrated a marked increase of interest in the observation of eclipsing binary (EB) stars, and the AAVSO EB program has been a major focal point for this activity. Considerable experience has been gained in the various phases of the conduct of this program. This paper discusses some of the problems faced by the individual observer, how he can overcome them, develop his observing skills and assure he obtains the most accurate data possible.

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The visual observation of eclipsing binary (EB) stars by amateur observers is not intended to replace the more accurate and detailed work being done photometrically. Rather, it is a valuable and irreplaceable supplement to that work. There are far more EB stars than the well-equipped observatories could hope to follow on a continuing basis. Further, with rare exceptions, the photometric observer places higher priorities on projects other than the timing of EB minima. Thus, the amateur has fallen heir to this field of astronomy. Recognizing this, a few amateur astronomers have taken up the call and have brought a small portion of the EB stars under observation. Many more stars await their turn to be added to the list. Because a majority of these stars undergo changes of period, often due to unknown or only partially understood mechanisms, continued observation of most EB stars will be needed into the indefinite future. Those individuals who wish to participate in this endeavor should find the guidelines set forth here of some value in establishing their personal observing programs.

As a first step, a prospective EB observer should select a star based on criteria befitting his circumstances. Consider, for instance, whether your instrument and sky conditions will permit reaching the star's minimum magnitude. Is the star's declination such as to permit the required observing time from your latitude? Is the depth of eclipse sufficient to permit you to be confident of your data considering your experience and observing skill level? (An experienced observer will usually have little difficulty in timing an eclipse whose depth is one magnitude; he will have some difficulty if it is seven-tenths, and great difficulty if it is one-half magnitude or less.) Is the eclipse duration such that you will be able to allot sufficient observing time to define the light curve well astride the time of minimum? As a final criterion, select stars that are receiving the least attention by other observers. This may not be practical for beginning observers. Program stars which are infrequently observed often present some particular observing problem which has discouraged other individuals.

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After selecting a star, do some pre-eclipse preparation. Thus you can ensure reduction of those unforseen obstacles which can distract the observer and wreck an evening's efforts. Preparation should include a careful examination of the chart at the telescope and identification of the variable. Examine each of the comparison stars and verify the brightness sequence. Verification of the sequence could be critical. If the comparison stars do not appear "right" you should resolve the problem before observing for record. A sequence which appears to the observer to be incorrect can only lead to confusion and inconsistent data if used without modification. For eclipsing binaries, the observer may make interim adjustments in the comparison star sequence (usually by eliminating the offending comparison star), providing only a "preliminary chart" sequence is available for the star. This action should be noted on any resulting report of observation. Whenever a comparison sequence is found unsatisfactory the EB committee chairman should be notified.

A note of warning is in order at this point. Depending upon the configuration of the comparison stars the observer may find that he has a choice concerning which comparison stars will be used. If there is some difficulty with the sequence used on the declining leg of the eclipse there may be a temptation to use a different sequence on the rising leg. The rule to apply here is simple -- don't do it! If an adjustment must be made do it for subsequent eclipses, but not in the middle of one being observed for record. Adjustments in the comparison star sequences should be unnecessary and should not be attempted by the observer where final chart sequences have been established.

Observations should be made as specified in the Manual for Observing Variable Stars, Mayall (1970). Additional precaution may be necessary, however, to guard against observing bias which may develop as a result of the observer's expectations as the eclipse unfolds. Each observation must be made independently of all others in the series. Even the most experienced observer may occasionally allow himself to be trapped when his expectations get in the way of his objectivity. Always record what the eye sees, without modification. If, in spite of your best efforts, you should suddenly realize that you have been "forcing" your observations to conform to your expectations do not attempt to go back and change the observations to smooth the data. This only compounds the problem. Instead, simply resolve, beginning with the next observation, to record only what the eye sees. Report all data without regard to its discontinuity. A short note of explanation on the data sheet would be appropriate, although the plotted data usually tell the whole story during the reduction process. Such data can often be salvaged for measurement of time of minimum.

Generally, for data to be useful for timing a minimum of an EB star, observations must be extended through an interval sufficient to define the steeper portions of both legs of the eclipse light curve. This may vary from 80 or 90 minutes, for an eclipse of very short duration, to six hours or more for stars with a shallow eclipse of long duration. Most EB stars can be well observed by making brightness estimates at 10 to 12 minute intervals. In rare cases, intervals as short as 6 minutes may be justified. More frequent intervals only clog the data reduction machinery with excess baggage. Slower moving eclipses can be adequately observed at 15, 20, or even

30 minute intervals in some cases. When a star has a long flat minimum, such as U Cephei or V342 Aquilae, the observing interval may be lengthened to once each 30 or 40 minutes during the flat portion of the light curve without impairing the value of the data, but the pace should be picked up again shortly before the flat phase terminates so that the upturn in the light curve may be defined as sharply as possible.

Observations should be timed to the nearest minute. This permits considerable leeway (±30 seconds), but this should not be construed as a license to become sloppy. The observing clock should be accurate to ±10 seconds. The most highly recommended time source is WWV, found at 2.5, 5, 10, 15, and 20 megahertz in the short-wave band. It is a good policy to check the observing clock at the beginning and the end of an observing session.

The EB observer, unlike long period variable observers, cannot discontinue observations at will. He must press on to the conclusion of the eclipse or forfeit his data. For this reason problems which may be of only moderate concern to other observers can become critical for the EB observer. Therefore, it is imperative that he be prepared to deal successfully, for prolonged periods, with such discomforts and irritations as biting insects, fatigue, cold weather, and condensation on the eyepiece. Dew or frost on the eyepiece can be eliminated with an eyepiece heater of low-wattage electrical tape.

Additional observing problems may crop up during observing sessions. For instance, when concentrating your gaze on a star for more than a fraction of a second it may appear to increase in brightness (depending upon the color index). If this happens, do not be tempted to hold the gaze waiting for the apparent brightness to stabilize. Your first impression of the star's brightness is likely to be the most accurate. To dispell doubt and reinforce confidence in the "quick glance" the observer may look away briefly and then glance back to the star, repeating the process several times. When this technique is mastered consistent results should be obtained.

It is not uncommon even for the most experienced observer to fail on a first attempt to time a minimum of a given star. The observer of limited experience can certainly expect to have his depressing moments. Under such circumstances one is tempted to end the session in disgust and let the opportunity to learn a valuable lesson escape. If the observer fails in his attempt to time a minimum there certainly has to be a reason or combination of reasons for this failure. The individual who is determined to contribute useful data should carefully review the nature of his difficulty before leaving the telescope and plan corrective actions.

Data intended for reduction and publication through the AAVSO eclipsing binary program should be sent direct to the Eclipsing Binary Committee Chairman. The chairman or AAVSO Headquarters can provide detailed instructions for reporting these data as well as information for obtaining charts, EB Bulletins, ephemerides and a listing of "vital data" for AAVSO EB program stars.

REFERENCE

Mayall, Margaret W. 1970, Manual For Observing Variable Stars (Revised edition; Cambridge, Massachusetts: American Association of Variable Star Observers).