RZ CASSIOPEIAE - THE ECLIPSE OF A BINARY STAR

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The 24th April was cloudless, but with an even milky haze covering the sky and a full moon, so it was definitely class 3 conditions, not ideal for observing my first binary eclipse. However the timing was convenient, with the minimum predicted in *Astronomy Now* for 23.00 UT.

I had been meaning for some time to try to observe this star, having checked out its position and the comparison stars, but so far something had always prevented me, so this time I was determined to give it a go. The sky was so bright, I realised I would not be able to follow it to minimum with my 8.5 x 44 binoculars alone, so I brought out my ETX90 telescope with a 40 mm eyepiece which magnifies 31 times.

Ideally to observe binary eclipses you need to be able to obtain Universal time accurately, to within seconds. A GPS receiver will enable you to do this, but I found the website: ***www.lagado.com/tools/time,*** which provided an accurate time for me. You need to remember to deduct an hour for summer time, but since some time inevitably passes between making the observation and checking the watch, it is difficult to be very accurate.

I started observing with binoculars, a bit later than I had intended, so I was not going to be able to cover the whole eclipse (4 hours 50 minutes), and as I did not carry on to the end due to deteriorating visibility, my observations only cover 3 hours 11 mins. My intention was to make an observation every 15 minutes, but I found it difficult to continue this regularly. In between the first 3 binocular observations I spent the time finding and recognising RZ Cas and the comparison stars in the ETX, which reverses the sky horizontally. With this star, I found it easier than expected as RZ Cas was more or less on an extended line from Delta and Epsilon Cas, through Iota, a bright star of magnitude 4.5, with the comparisons on either side of this line. See Figure 1 on the next page, for my diagram of how I found the target star.

The aim of following eclipsing binaries is to produce a light curve from which the time of the minimum can be deduced, for determination of the system's period. If a change to the orbital period is found, this is significant information which needs to be reported. The General Catalogue of Variable Stars elements gives the time of a minimum, from which other minima are predicted by adding multiples of the period. The mid-time of minimum can be deduced from your observations by computer software.

Another method used to determine the minimum is Pogson's method of bisecting cords. In this case, points on the falling and rising sides of the curve are noted at regular intervals and the times of the two points for each magnitude are averaged. Points are then drawn on the graph corresponding to each magnitude and averaged time, and a curve is drawn through them to meet the light curve. This point of intersection defines the time and magnitude of mid-minimum. With this method my mid-minimum worked out as 24.9617, approximately 2305 UT. Thus my minimum was 5 minutes late. Tony Markham, the Eclipsing Binary Secretary of the Variable Star section of the BAA said

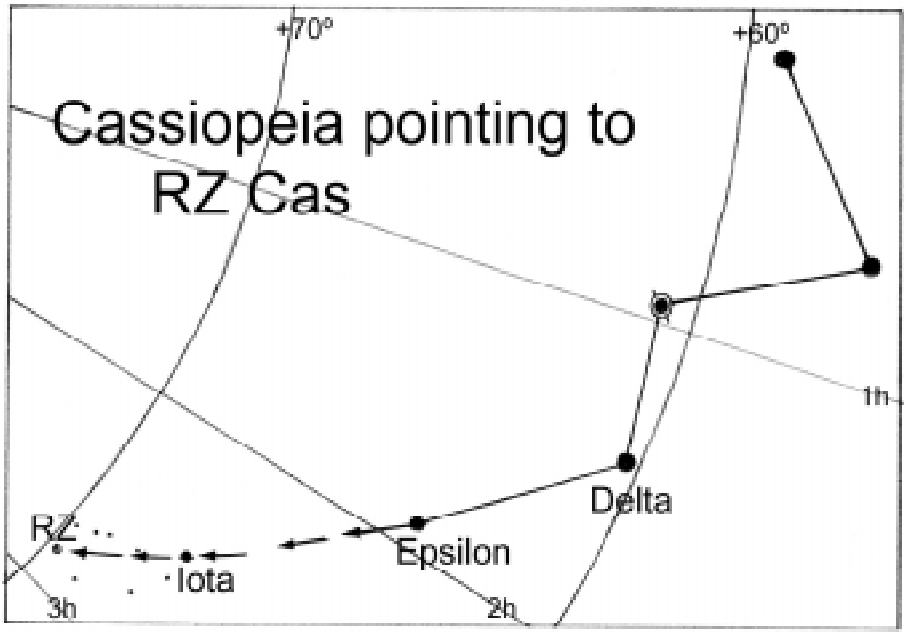

Figure 1: My Method of locating RZ Cas

that the elements for RZ Cas were over 10 years old, and that over the years the orbital period had been slowly increasing, so consequently a mid-eclipse a few minutes later than predicted was not unreasonable. My 8.0 magnitude minimum was slightly fainter than the normally quoted minimum, but that was also not considered a problem, as the time of mid-eclipse was more important than the exact magnitude.

Eclipsing Binaries are binary systems consisting of two stars that have an orbital plane that lies near to the line-of-sight of the observer. The components thus periodically eclipse one another, causing an apparent decrease in brightness, which is greatest when the faintest star passes in front of the brightest. The period of the eclipse, which coincides with the orbital period of the system, can range from minutes to years.

RZ Cas is a classic Algol-type eclipsing binary. In Algol-type stars, the beginning and end of the eclipse can be identified from the light curves. Between eclipses the light remains almost constant, or varies only slightly, due to reflection effects (the increased brightness on the side of the star facing a companion caused by heating from the radiant energy of the companion star). Variations can also occur due to the slightly ellipsoidal shape of components or to physical variations. A secondary minimum may be absent. Periods cover an extremely wide range, from 0.2 days to 10,000 days or more. Light amplitudes also range widely and may reach several magnitudes.

RZ Cas consists of a hot primary star and a cooler, evolved secondary component. The system is highly active and has a complicated history of period changes due to mass exchange between components, and ejection of material from the system. The period

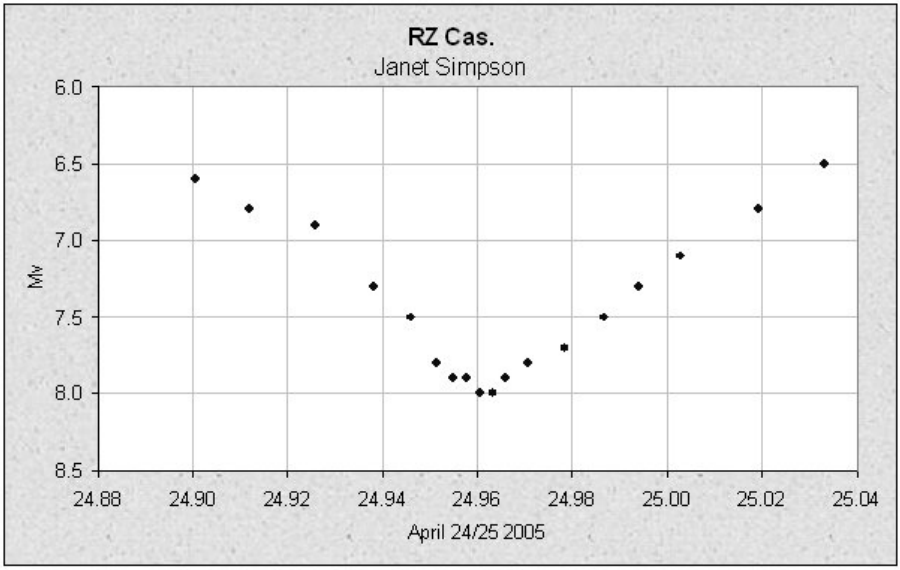

Figure 2: The Light Curve showing the Eclipse of RZ Cas, derived from my Observations

is known to have increased substantially around 1993. Even though RZ Cas is well observed, the AAVSO still need more data to define and confirm details in the period. Most light curves of RZ Cas at minimum have the rounded form of a partial eclipse, but occasionally the light curve seems to show a brief interval of constant light at minimum, which could indicate a total eclipse. However these light curves should be interpreted with caution. All minima are *flat* at the moment when the direction of the light change is reversed. The displacement of just one or two data points by observational scatter can strengthen the impression of a brief interval of constant light. In addition, the shape of the minima of highly active binaries like RZ Cas could be affected by circumstellar gas streams, accretion discs, and starspots.

RZ Cas is one of the most popular eclipsing binaries. It has a range of 6.2-7.8, and so it is normally bright enough for binocular observers. It is circumpolar, which means that it is visible all year round for observers situated in mid-northern latitudes. It has a short eclipse duration, and an unusually fast period of 1.195 days, which means there are several observable minima per month; and, it changes in time. The chart used for these observations is given in Figure 3 on the next page.

References

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Gerry A. Good, *Observing Variable Stars*,
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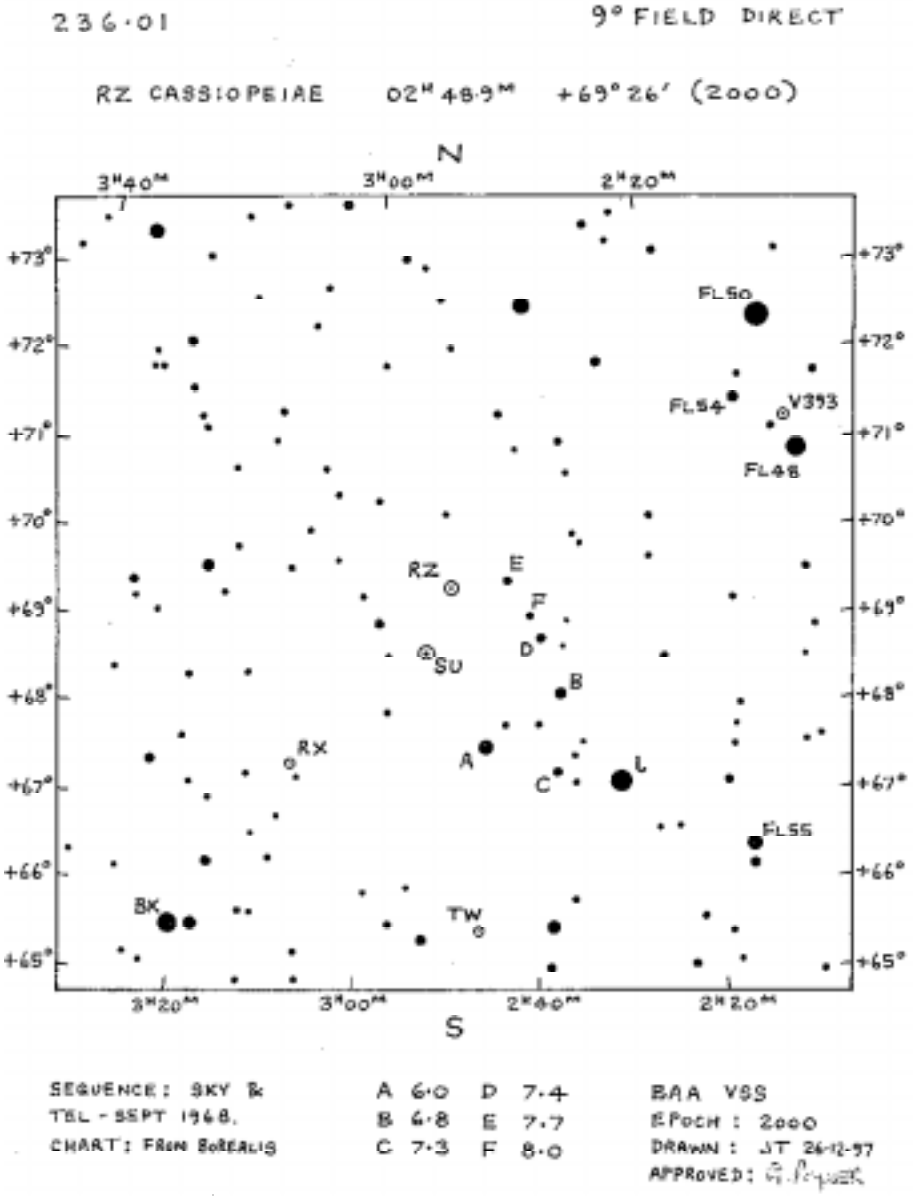

Figure 3: Chart used by the author for Observations of RZ Cas