RY SGR: CAN THE TIME OF THE NEXT DEEP MINIMUM BE PREDICTED?

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ABSTRACT. The L magnitude of the RCB star, RY Sgr, varies with an amplitude of up to 2.0 mag on a time scale of about 1500 days. The last two deep optical minima have occurred approximately one year after a maximum in L. This behaviour may be characteristic of the star and may allow the time of onset of the next deep minimum to be predicted, in which case it will occur in the second half of 1986.

1. INTRODUCTION

RY Sgr has been observed in the infrared (JHKL) since about 1968, although there are only a few sporadic measurements before 1975 when fairly regular observations began at SAAO. It is evident from the data collected thus far that there are long-term trends in the flux from the dust shell which is presumed to surround the star. Virtually all of the flux in the L band comes from the dust shell while at J the flux at maximum is mostly stellar continuum. The J and L light curves differ markedly.

2. J, L LIGHT CURVES

In J the same range of phenomena are seen as in the visual region, viz, (a) periodic variations with P ~ 39 day and amplitude ~ 0.8 mag, presumably due to pulsation of the star, and (b) deep minima in which a decline of about 3 mag in a few tens of days is followed by a recovery to the pre-minimum brightness in about 2 years. During the recovery, the pulsation is still evident, so the event causing the deep minimum appears not to affect the photosphere in any marked way.

Although the pulsation is also evident in L (where it is presumably the result of periodic heating and cooling of the dust shell) there are no deep minima. On the contrary, the L magnitude tends to be near a local maximum when an optical minimum occurs and declines only slowly on a substantially longer time scale than is occupied by the recovery in the optical.

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Figures 1(a) and 1(b) show all the available J and L photometry plotted against Julian date. To make the variations in L a little clearer, the observations have been lumped into 38.57 day bins as shown in Figure 1(c) and a smooth curve has been drawn freehand amongst the points. This period was chosen as a compromise and is appropriate to the middle of the time interval considered here, according to the ephemeris derived by Kilkenny (1982).

Remarkably, the last two minima (1977, 1983) occurred about one year after a maximum in L. The earlier minima (1967, 1972) could plausibly have also occurred in the same relationship to L maxima but there are not enough data available to say. (The first infrared observations of RY Sgr were only made towards the end of the recovery from the 1967 minimum). At least, the L magnitude was very bright during this early period.

3. (J-L) COLOUR CURVE

It is somewhat more instructive to consider the behaviour of the star in the (J-L) colour, which shows both the phenomena of interest here. Again, the data have been binned into 38.57 day intervals and are plotted in Figure 1(d). The vertical lines in the figure indicate the times of onset of deep minima. The 1977 minimum occurred about 600 days after bluest (J-L),i.e. L minimum. The shell contribution at L had increased by about 1 mag in this time. On recovery from this optical minimum the (J-L) colour reached an extremum again at about JD 2444400 and some 600 days later the 1982 deep optical minimum occurred. Since then the star has returned to the optical pre-minimum level. Another extremum in (J-L) appears to have occurred around JD244600. If the earlier pattern of behaviour continues, another deep optical minimum can be expected near JD2446600, i.e., 1986 June.

The degree of obscuration of the star seems to be related to the maximum L magnitude achieved before a deep optical minimum. The minimum in 1977 (ΔV, $\Delta J \sim 2$ mag) was relatively weaker than that in 1982 ($\Delta V \sim 6$ mag, $\Delta J \sim 3$ mag) while those in 1967 and 1972 both had $\Delta V > 6$ mag. In the last three cases, Lmax was about 2.0 mag while before the 1977 minimum it was only $\sim$ 2.8 mag.

4. MECHANISM

The mechanism by which the deep minima occur is not yet well understood. Feast (1978) has discussed a model in which carbon-rich clouds are shot off the star in random directions at irregular intervals. In this case, deep minima are thought to be produced by clouds which happen to be ejected along the line of light to the star. The L magnitude would be due to the ensemble of clouds present around the star at any given time and would be little affected by the ejection of a new cloud. It is difficult to see how the timing of L maximum and the following deep minimum could be as closely tied together as has been suggested above.

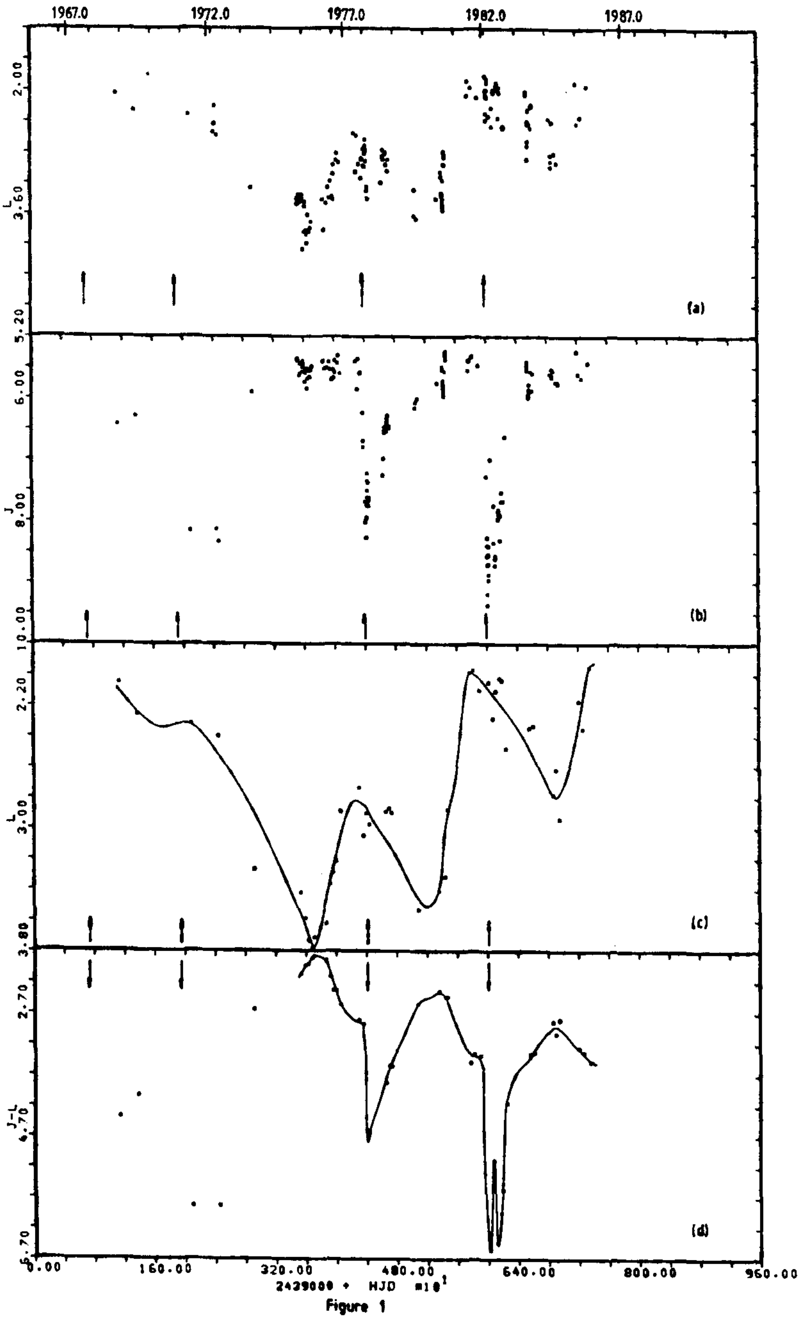

Figure 1

Figure 1 (a), (b) L, J light curves of RY Sgr.
(c), (d) L, (J-L) light curves binned into 38.57d intervals. The vertical bars indicate times of onset of deep optical minima. The continuous lines are freehand representations of the long term variations.

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5. CONCLUSION

With the long time scales involved in the RCB phenomenon, it is not easy to amass enough data to give a clearer picture of the mechanism involved. If the times of deep minima of RY Sgr are predictable, this will allow the star to be observed intensively before and during such an event. Spectra may give details of gas streaming motions and the onset of the chromosphere spectrum, while optical photometry may show whether the decline is related to a particular phase in the pulsation cycle.

6. ACKNOWLEDGEMENTS

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