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# OPTICAL OBSERVATIONS OF THE ACTIVE STAR RE J2131+233

The sky was surveyed in the extreme ultraviolet (EUV) region of the spectrum by the EUVE satellite (Malina et al., 1994) and the ROSAT satellite (Pounds et al., 1993) and catalogs of the sources included RE J2131+233 = EUVE J2131+233 = BD +22°4409 = VVO 163. The brightness given was 9.25 in V and the spectral type was K8 (Bowyer et al., 1995). The star was the subject of an extensive investigation by Jeffries et al. (1994), however there remained a slight doubt as to the period of the photometric variations.

The automated 0.5-m. telescope, Johnson V filter and CCD camera of the Climenhaga Observatory of the University of Victoria (Robb et al. 1992) was used to make these photometric observations. The frames were bias subtracted and flat fielded in the usual manner using IRAF[1]. The magnitudes were found from aperture photometry using the PHOT package. The x y pixel coordinates of each star for photometry were found from inspection of a few frames taken at the beginning, middle and end of the night. These positions were used as starting points for the Gaussian centering option which precisely centered the 6 arc second aperture on each star for each frame.

From the Hubble Space Telescope Guide Star Catalog (Jenkner et al., 1990) the coordinates of the comparison star are RA=$21^h31^m07^s$ Dec=23°18'01" V=10.7 and check star are RA=$21^h30^m55^s$ Dec=23°22'31" V=11.5. The mean and standard deviation of all the nightly mean differential V magnitudes are $-1.008 \pm 0.007$ ensuring the constancy of both comparison and check stars at this level. The precision of the differential variable star minus comparison star measurements are expected to be at this level. Due to the small field of view first order extinction effects were negligible and no corrections have been made for them. No corrections have been made for the colour difference between the stars to transform it to a standard system.

Photometric observations were begun 11 July 1995 UT and continued on five more nights in the next week. A "Phase Dispersion Minimization" routine modelled after that of Jurkevich (1971) reveals a minimum average sigma at a period of $0.4232 \pm 0.0075$ days as seen in Figure 1. A least squares fit of a single sine wave to the data also shows the deepest minimum at a period of 0.4233. Times of maximum light have been found from the method of Kwee and Van Woerden (1956) to be 2449914.8908 and 2449917.8546; and a time of minimum light to be 2449913.8295 with a formal error of about $\pm 0.0008$ and an uncertainty due to asymmetry in the extrema of about $\pm 0.008$. So the best ephemeris from our data is:

$$\text{HJD of Maxima} = 2449909.8059(33) + 0.4236(4) \times \text{E}$$

where the uncertainties in the final digit are given in brackets. This is in agreement with the 10.17 hour period found by Jeffries et al. (1994).

[1]IRAF is distributed by National Optical Astronomy Observatories, which is operated by the Association of Universities for Research in Astronomy, Inc., under contract to the National Science Foundation.

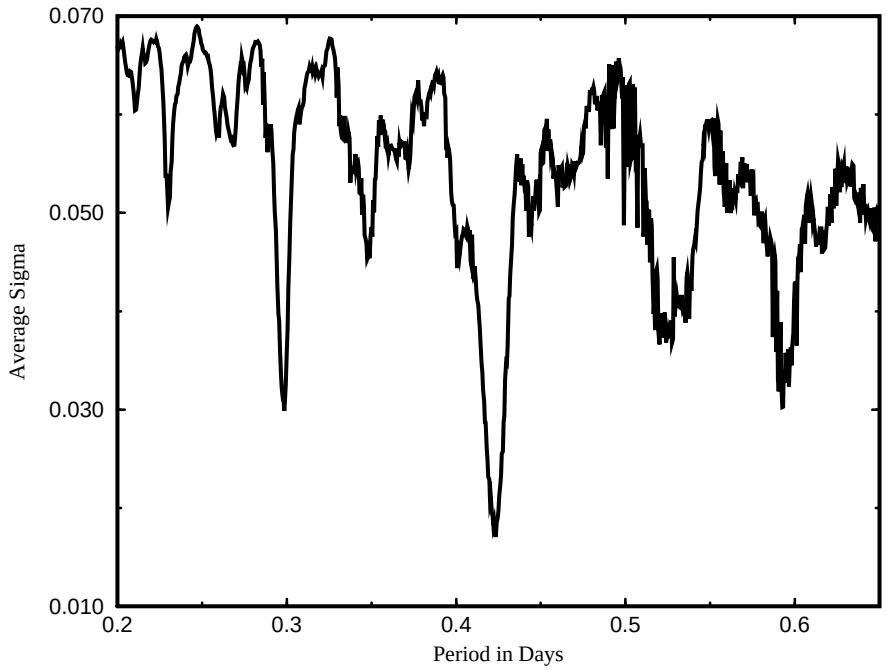


Figure 1. Average of standard deviations for various periods for RE J2131+233 for 1995

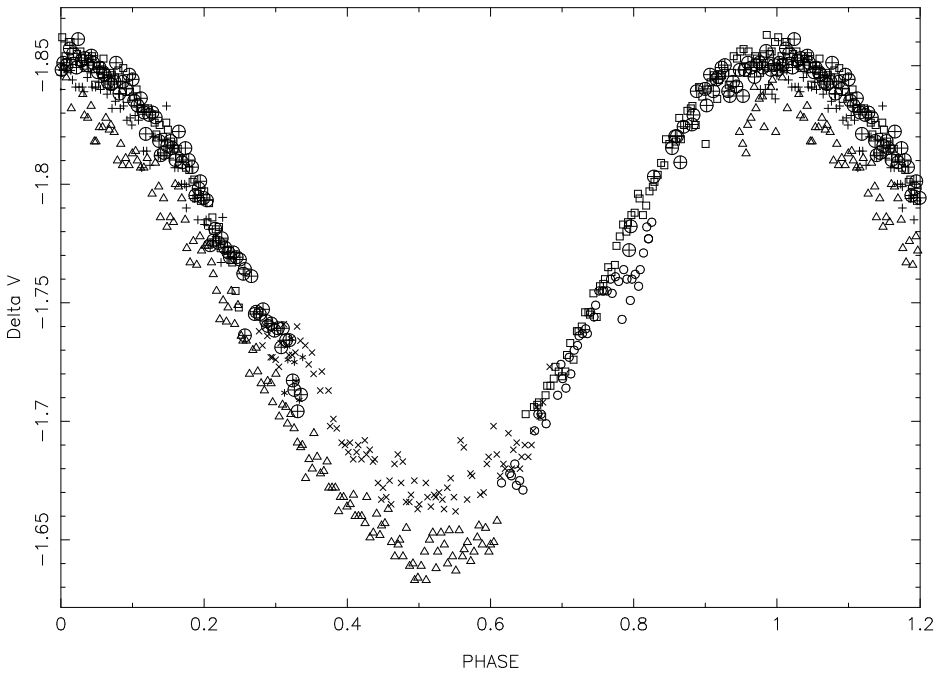


Figure 2. Light curve of 1995 V band data

A plot of the 633 differential V magnitudes for the 1995 data phased at this period is shown in Figure 2. The light curve is almost the same shape as that of Jeffries (1994), but the amplitude has increased from 0.15 to 0.20. Close inspection shows that the maxima repeat but one minimum lies 0.03 magnitudes fainter than the other observed two days later. This implies that the spots are changing in size and/or shape on a daily timescale.

Our large data sets completely eliminate the possibility of the 9.22 hour alternative period found by Jeffries et al. (1994) and confirms their 10.17 hour period. RE J2131+233 is a variable star with active regions on its surface causing brightness variations with a rotation period of 0.4236 days.

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References:

Bowyer, S., Lampton, M., Lewis, J., Wu, X., Jelinsky, P., Saba, V., Drake, J.J., Lieu, R., Malina, R.F., 1995, *ApJS* preprint

Jeffries, R.D., Byrne, P.B., Doyle, J.G., Anders, G.J., James, D.J, Lanzafame, A.C., 1994, *MNRAS*, **270**, 153

Jenkner, H., Lasker, B., Sturch, C. McLean, B., Shara, M., Russell, J., 1990, *AJ*, **99**, 2082

Jurkevich, I., 1971, *Ap. & Sp. Sci.*, **13**, 154

Kwee, K.K. and Van Woerden, H., 1956, *Bull. Astr. Inst. Neth.*, **12**, 327

Malina, R.F., et al., 1994, *AJ*, **107**, 751

Pounds, K. A., et al., 1993, *MNRAS*, **260**, 77

Robb, R. M. and Honkanen, N. N., 1992, in A.S.P. Conf. Ser. 38, Automated Telescopes for Photometry and Imaging, ed. Adelman, Dukes and Adelman, 105