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OPTICAL OBSERVATIONS OF THE ACTIVE STAR RE J1816+541

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 J1816+541 = EUVE J1816+541. The star's brightness was 11.83 in V and colors were (B−V)=1.45, (V−R)=0.96, (R−I)=1.05 (Schwartz et al., 1995). The star was the subject of an extensive investigation by Jeffries et al. (1995), who concluded the star was a "single, rapidly rotating dM1-2e star with a v sin i of 61km/sec" and was "one of the most magnetically active stars in the solar neighbourhood".

The automated 0.5-m. telescope, Johnson V filter and CCD camera of the Climenhaga Observatory of the University of Victoria (Robb and Honkanen, 1992) was used to make photometric observations of RE J1816+541. 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 and magnitudes of the comparison star are RA=$18^h16^m29^s$, Dec=54°07′44″, V=11.1 and of the check star are RA=$18^h16^m07\overset{s}{.}$, Dec=54°10′54″, V=13.1. The standard deviation of the difference between the check and the comparison star during a night was about $0\overset{m}{.}014$. The mean and standard deviation of all the nightly mean differential V magnitudes are -1.844 ± 0.006 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 differential 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 the V magnitude to a standard system.

Photometric observations were begun 28 July 1995 UT and continued on five nights in the following week and three nights a month later. Brightness variations were evident both during a night and from night to night. A "Phase Dispersion Minimisation" routine modelled after that of Jurkevich (1971) reveals a minimum average sigma at a period of 0.4588 ± 0.0012 days, as seen in Figure 1. The other deep minima are aliases of the true period and the diurnal period of the observations. A least squares fit of a single sine wave to the data also shows a deep minimum in chi squared at a period of $0\overset{d}{.}458$. Times of

[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

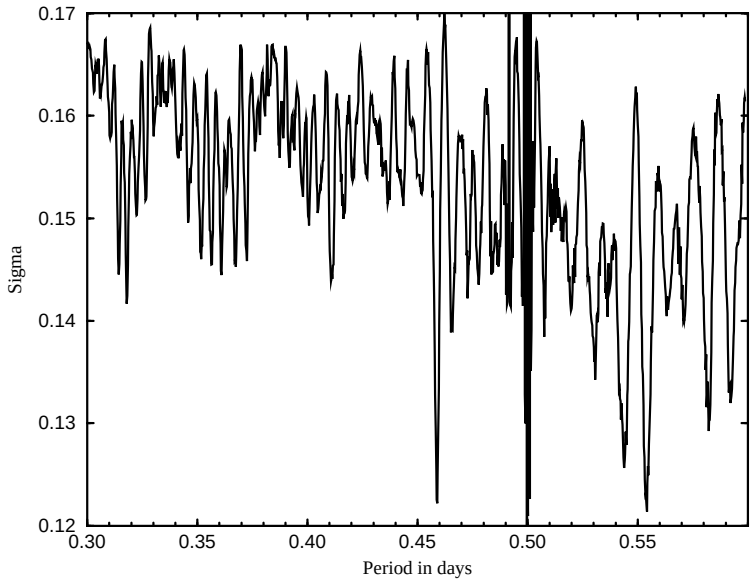

Figure 1. Average of standard deviations for various periods for RE J1816+541 for 1995

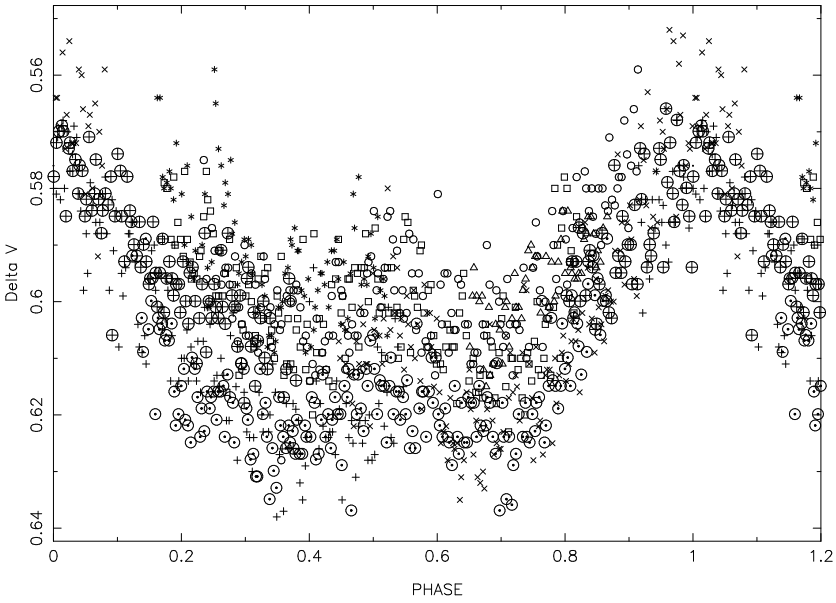

Figure 2. Light curve of 1995 differential V data of RE J1816+541

maximum light have been estimated from the light curve to be 2449927.752, 2449930.958 and 2449954.842. A plot of the light curve also shows a secondary maximum and its times of occurrence are estimated to be 2449929.823, 2449930.75, and 2449962.854. All these estimates have an uncertainty of about ± 0.02 days. So the best ephemeris from our data is:

$$\begin{array}{c} \text{HJD of Maxima} = 2449927.752 + 0.4589 \times \text{E} \\ \qquad\qquad\qquad\quad \pm.020 \quad \pm.0008 \end{array}$$

A plot of the 1202 differential V magnitudes phased at this period is shown in Figure 2 with different symbols for each of the different nights. Close inspection of the "$\star$" points at phase 0.25 shows a small flare, which was ignored during the period finding runs. The light curve also shows shifts of 0.01 magnitudes in mean level from night to night.

From the $v\sin i$, spectral type, and our period we find the inclination of the axis of rotation to be $66^\circ \pm 4^\circ$. From the unusual W shape of the light curve, the flare, the spectral type, and the brightness in the EUV, we conclude that this star has large active regions on it causing the brightness variations. The shape also implies that there are at least two large spots or groups and further photometric observations will be interesting to detect any changes in the light curve shape due to differential rotation or spot evolution.

REJ1816+541 is a variable star with active regions on its surface causing brightness variations with a period of 0.459 days.

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