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# OBSERVATIONS OF HD 279684

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Our understanding of the solar dynamo can be furthered by studying stars with active regions. These stars can be discovered by searching for X-ray sources with periodic sinusoidal photometric variations. The star HD 279684 is catalogued as the X-ray source 1RXSJ041702.1+353116 by the ROSAT satellite (Voges et al., 1999). It is in the TYCHO Catalogue (ESA, 1997) as TYC 2379-665-1 and has its parallax measured to be 162±62 mas giving a nominal distance of about 4 to 10 parsecs and $(B-V)$ of 1.1, which agrees with the HD spectral class of K0. 2MASS measurements of HD 279684 reveal that J=8.75, H=8.20 and K=8.07 all with an uncertainty of about ±0.02. All these colour measurements are consistent with a spectral class of K4V±1 Assuming a main sequence K4 star implies an absolute magnitude of about $M_V = 7.0 \pm 0.1$ so with an apparent magnitude of $V_T = 10.72 \pm 0.1$ a second estimate of the distance would be about $50 \pm 5$ parsecs, which is probably more accurate than the Hipparcos parallax.

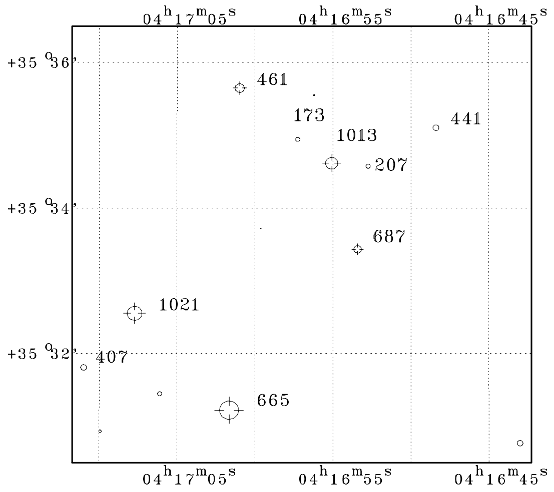


**Figure 1.** Finder chart labelled with the GSC identification numbers from region 2379.

The University of Victoria observations were made with our automated 0.5m telescope, Star I CCD and reduced in a fashion similar to that described in Robb and Greimel (1999). The field of stars observed is shown in Figure 1.

Table 1: Stars observed in the field of HD 279684=GSC 2379-0665

| Star GSC Id | R.A. J2000 | Dec. J2000 | GSC Mag. | $\Delta R$ Mag. | Std Dev Between | Std Dev Within |
|---|---|---|---|---|---|---|
| 0665 | $04^h17^m01.8^s$ | $35°31'17.1''$ | 10.5 | $-0.787$ | 0.041 | 0.005 |
| 1021 | $04^h17^m07.7^s$ | $35°32'33.3''$ | 11.5 | – | – | – |
| 1013 | $04^h16^m55.0^s$ | $35°34'37.0''$ | 12.1 | 0.969 | 0.005 | 0.004 |
| 0461 | $04^h17^m00.9^s$ | $35°35'39.3''$ | 12.9 | 1.558 | 0.010 | 0.005 |
| 0687 | $04^h16^m53.3^s$ | $35°33'26.7''$ | 13.2 | 1.988 | 0.014 | 0.013 |
| 0441 | $04^h16^m48.3^s$ | $35°35'06.1''$ | 13.6 | 2.257 | 0.006 | 0.014 |
| 0207 | $04^h16^m52.7^s$ | $35°34'34.7''$ | 14.0 | 2.573 | 0.011 | 0.018 |
| 0173 | $04^h16^m57.2^s$ | $35°34'56.5''$ | 14.0 | 2.917 | 0.022 | 0.029 |
| 0407 | $04^h17^m10.9^s$ | $35°31'48.7''$ | 13.7 | 2.389 | 0.023 | 0.018 |

The Julian Dates of observation (-2450000) are 2682, 2683, 2694, 2695, 2697-2700, 2726 and 2734. Table 1 lists the stars' identification numbers and magnitudes from the Hubble Space Telescope Guide Star Catalogue (GSC) (Jenkner et al., 1990) and positions from the USNO-A 2.0 catalogue (Monet et al., 1998). All observations were made using a filter identical to the Cousins R.

Our differential $\Delta R$ magnitudes are calculated in the sense of the star minus GSC 2379-1021. Brightness variations during a night were measured by the standard deviation of the differential magnitudes and are listed for the most photometric night in the last column as "Std Dev Within". A "Std Dev Within" one night of 0.004 sets an upper limit on variations of an hourly timescale. For each star the mean of the nightly means is shown as $\Delta R$ in Table 1. The standard deviation of the nightly means is a measure of the night to night variations and is called "Std Dev Between" in Table 1. The smallest "Std Dev Between" is 0.005 magnitudes. This excellent photometry shows that night to night variations in GSC 2379-1021 must be less than a few millimagnitudes.

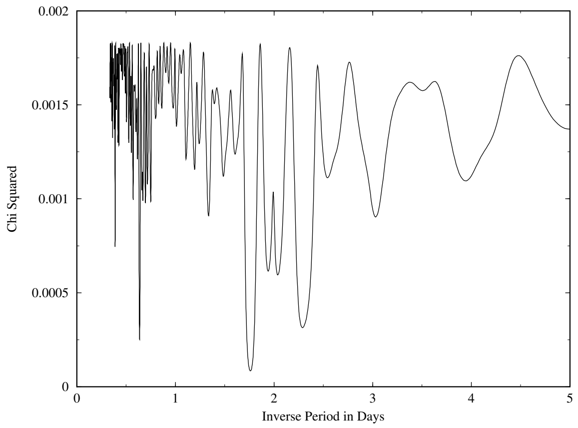


**Figure 2.** Periodogram for sine curve fit to photometric data

The star HD 279684 varied in brightness during some nights and had obvious variations from night to night. Sine curves of various periods were fitted to the data and the chi squared value is plotted as a function of period in Figure 2. Plots of the light curve at the period corresponding to each of the minima of chi squared showed that the only reasonable period was approximately 1.75 days. A plot at twice this period did not show any improvement in the scatter. Our best estimate of the ephemeris is:

$$\text{HJD of Maximum Brightness} = 2452681^{\rm d}\!.05(7) + 1^{\rm d}\!.75(1) \times \rm E.$$

where the uncertainty in each final digit is given in brackets. In Figure 3 the differential $\Delta R_C$ magnitudes phased at this period are plotted. The light curve is typical of stars with active regions and/or spots such as BY Dra. Spot size and/or position changes that are usual on active dwarf stars explain the discontinuities on the light curve, which was observed during 30 rotations.

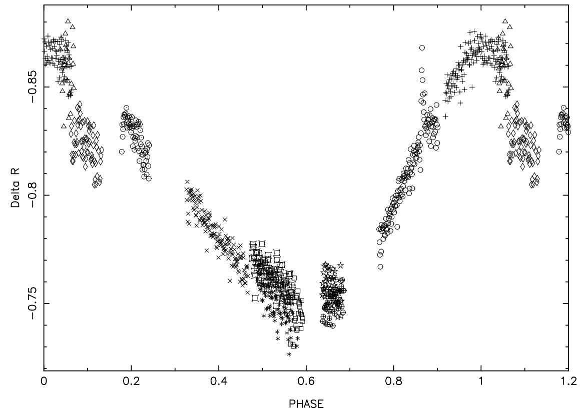


**Figure 3.** *R* filtered light curve of HD 279684 with different symbols for different nights.

The night shown in open circles in Figure 3 is replotted at a larger scale in Figure 4. We see that the brightness variation is caused by a flare on the star, occurring at Heliocentric Julian Date 2452694.813 with an amplitude of 0.04 magnitudes in *R* band.

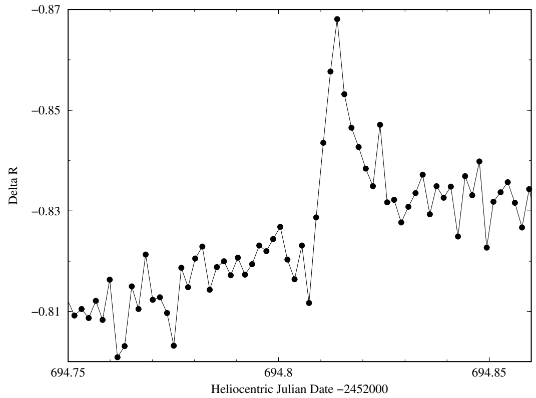


**Figure 4.** Flare on the star HD 279684

A spectrum of HD 279684 observed with the Dominion Astrophysical Observatory's 1.8m telescope is shown in Figure 5. The time of observation was 9:00 UT 18 Jan 2003, which corresponds to a phase of approximately 0.75. The obvious H$\alpha$ emission line is a characteristic of stars with active regions. The great number and strength of the CaI and FeI absorption lines are consistent with late type stars.

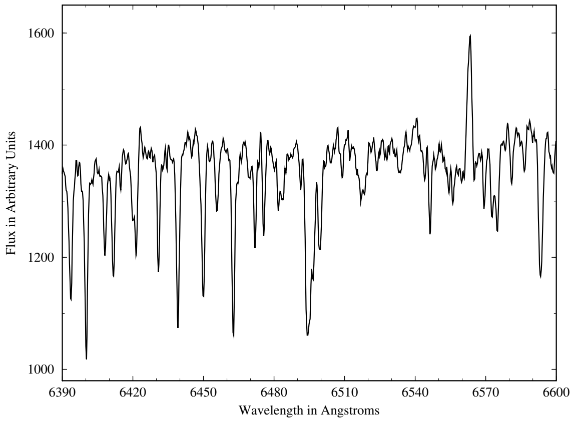


**Figure 5.** Spectrum of HD 279684 showing the H$\alpha$ emission line at 6563Å

HD 279684 seems to be a fairly rapidly rotating late type dwarf star with active regions covering a significant part of its surface and energizing a hot corona producing X-rays. While it is at about the distance of the Hyades cluster and in the direction to be an outlying member, radial velocity and proper motion studies will be necessary to establish its membership. Further spectral observations will be of interest to see if the H$\alpha$ emission will vary in intensity with phase. Photometric observations will be important to tell if differential rotation will modify the period and/or shape of the light curve.

**Acknowledgements**

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This research has made use of the USNOFS Image and Catalogue Archive operated by the United States Naval Observatory, Flagstaff Station[1].

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[1]`http://www.nofs.navy.mil/data/fchpix/`