COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5079

Konkoly Observatory
Budapest
16 May 2001

HU ISSN 0374 – 0676

THE DISCOVERY OF BRIGHTNESS VARIATIONS OF HD 280340 AND GSC 2895-1173

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* Guest User, Canadian Astronomy Data Centre, which is operated by the Herzberg Institute of Astrophysics, National Research Council of Canada

We observed HD 280340 as part of a continuing search for photometric variations in stars which are known X-ray sources. The star HD 280340 = RXJ 050147+380541 = GSC 2895-1453 was discovered to be a source of X-rays by the ROSAT satellite (Voges et al. 1999). The Tycho catalog (ESA 1997) includes HD 280340 with V_T = 10.677 and B_T = 11.342 and the primary comparison star, HD 280341 = GSC 2895-0471, with V_T = 10.095 and B_T = 10.753 both consistent with the spectral type of approximately G3.

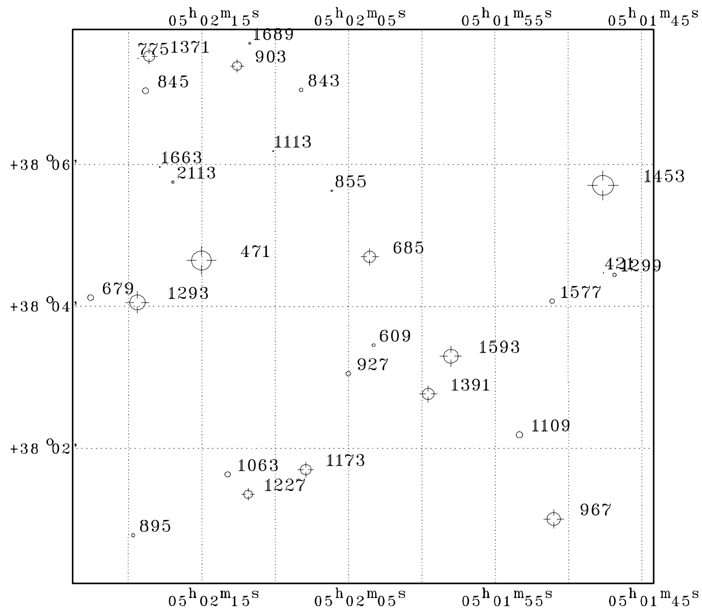

Figure 1. Finder chart labeled with the GSC numbers

Figure 1 shows the field of stars observed with the automated 0.5-m telescope of the Climenhaga Observatory at the University of Victoria and reduced in a fashion similar to

Table 1: Stars observed in the field of HD 280340

GSC No.	R.A. J2000	Dec. J2000	GSC mag	ΔR_c mag	Std. Dev. Between	Std. Dev. Within
HD 280340	$05^h01^m48^s$	$+38°05'42''$	10.6	0.306	0.021	0.004
HD 280341	$05^h02^m15^s$	$+38°04'38''$	10.0	-	-	-
2895-1293	$05^h02^m19^s$	$+38°04'03''$	11.0	1.326	0.006	0.011
2895-0679	$05^h02^m23^s$	$+38°04'07''$	13.6	3.473	0.014	0.014
2895-0685	$05^h02^m04^s$	$+38°04'42''$	12.0	2.743	0.002	0.007
2895-1593	$05^h01^m58^s$	$+38°03'18''$	11.3	2.238	0.003	0.005
2895-1391	$05^h02^m00^s$	$+38°02'46''$	12.0	1.866	0.007	0.006
2895-1109	$05^h01^m53^s$	$+38°02'11''$	13.5	3.333	0.004	0.015
2895-0967	$05^h01^m51^s$	$+38°01'00''$	11.6	2.558	0.003	0.008
2895-2113	$05^h02^m17^s$	$+38°05'45''$	14.6	4.671	0.024	0.040
2895-1063	$05^h02^m13^s$	$+38°01'38''$	13.8	3.696	0.022	0.024
2895-1227	$05^h02^m12^s$	$+38°01'21''$	12.9	3.839	0.014	0.024
2895-1173	$05^h02^m08^s$	$+38°01'42''$	12.4	3.549	0.039	0.017
2895-0927	$05^h02^m05^s$	$+38°03'03''$	14.0	4.091	0.028	0.028
2895-0609	$05^h02^m03^s$	$+38°03'27''$	14.4	4.244	0.023	0.035
2895-1577	$05^h01^m51^s$	$+38°04'04''$	14.0	3.938	0.011	0.024
2895-1299	$05^h01^m47^s$	$+38°04'27''$	14.3	3.967	0.019	0.025

that described in Robb and Greimel (1999). The Julian Dates ($-$ 2450000) of the nights of observations were 1925, 1932, 1935, 1936, 1937, 1947, 1950, 1951, 1952, 1953, 1954, 1959, 1960, 1961, 1963 and 1966. Table 1 lists the stars' identification numbers, coordinates (J2000) and magnitudes from the Hubble Space Telescope Guide Star Catalog (GSC) (Jenkner et al. 1990). Observations were made using a filter closely matching the Cousins R band (Cousins 1981). Our differential ΔR_c magnitudes are calculated in the sense of the star minus HD 280341. 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'. For each star the mean of the nightly means is shown as ΔR_c 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 'Std. Dev. Between' for stars GSC 2895-0685$-$HD 280341 is $0\overset{m}{.}002$, so we feel this shows that night to night variations in both these stars are less than a few millimagnitudes. A 'Std. Dev. Within' of 0.005 indicates that HD 280341 is constant at this level and we observed no significant variations in plots of the individual nights' data. Therefore we conclude that HD 280341 is constant in brightness at the millimagnitude level at the daily and hourly time scales. Stars with a 'Std. Dev. Within' approximately equal to the 'Std. Dev. Between' and which showed no obvious variations in the nightly plots, we believe were constant for the time period observed and at the precision of the standard deviations calculated.

The star HD 280340 had obvious variations during some nights and obvious variations from night to night and is a new variable star. Shown in Figure 2 is the chi-squared of a fit of the data to sine curves as a function of period. Thus we find the ephemeris is:

$$\text{HJD of Maximum Brightness} = 2451925\overset{d}{.}00(10) + 2\overset{d}{.}85(5) \times E$$

where the uncertainties in the final digit are given in brackets and the root-mean-square error of the fit is $0\overset{m}{.}01$. The 2517 differential R_c filtered magnitudes phased at this period are plotted in Figure 3 with different symbols for each of the nights. HD 280340 is a late type star, and an X-ray source with a small amplitude photometric variation consistent with typical BY Dra stars. The large apparent scatter is attributable to the small amplitude of the variation and possibly changes in the morphology and position of the spots. Photometric observations should be continued to monitor for flares, changes in the spot distribution and period changes.

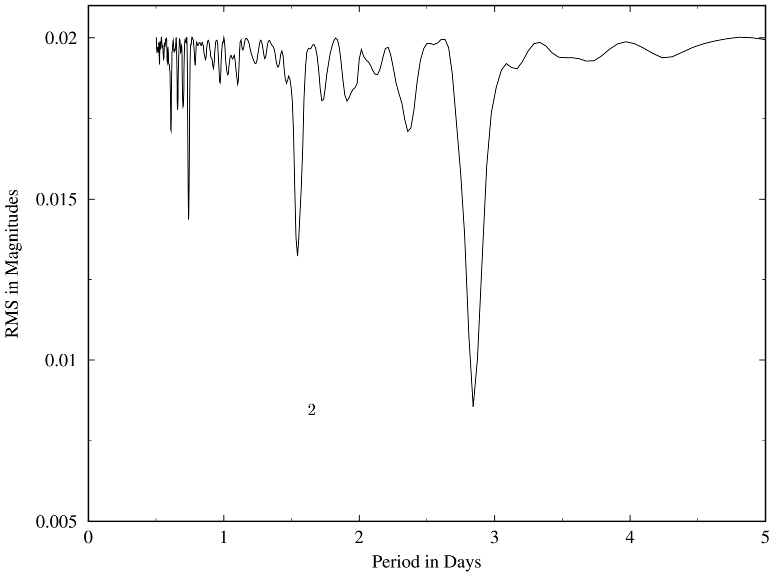

Figure 2. Periodogram for HD 280340 in 2001

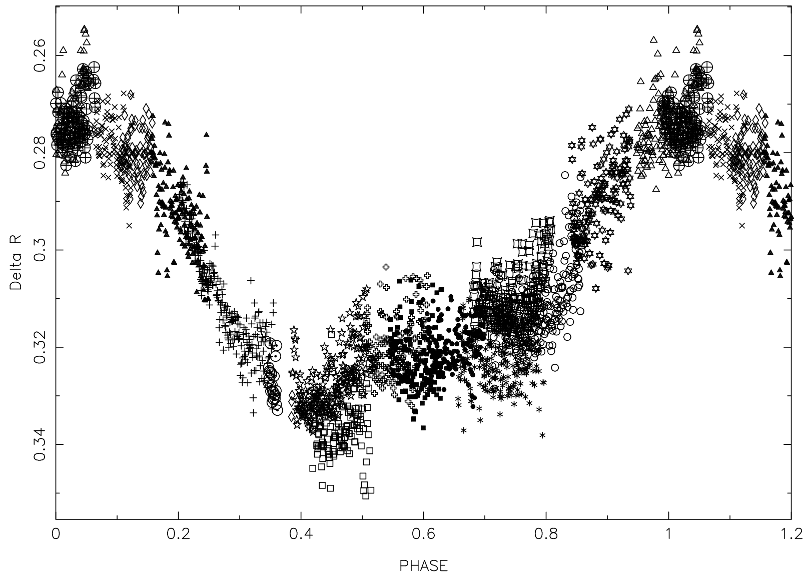

Figure 3. R_c filtered light curve of HD 280340 for winter 2001

The field star GSC 2895-1173 = (USNO2 1275-04179369) has a larger standard deviation from night to night than its standard deviation during a night indicating night to night variability. Its light curve is shown in Figure 4 with error bars of $0^{\mathrm{m}}.01$, which we estimate to be approximately the correct uncertainty.

The color of GSC 2895-1173 from the USNO2 catalog (Monet et al. 1996) is $B-R=1.9$ and for HD 280340 (G3 spectral class) the USNO2 gives $B-R=1.4$ implying that GSC 2895-1173 has a late-type spectral class. While we cannot be certain what kind of variable star it is we expect it to be either a very low amplitude Cepheid or a K-giant variable (Robb and Cardinal 1998).

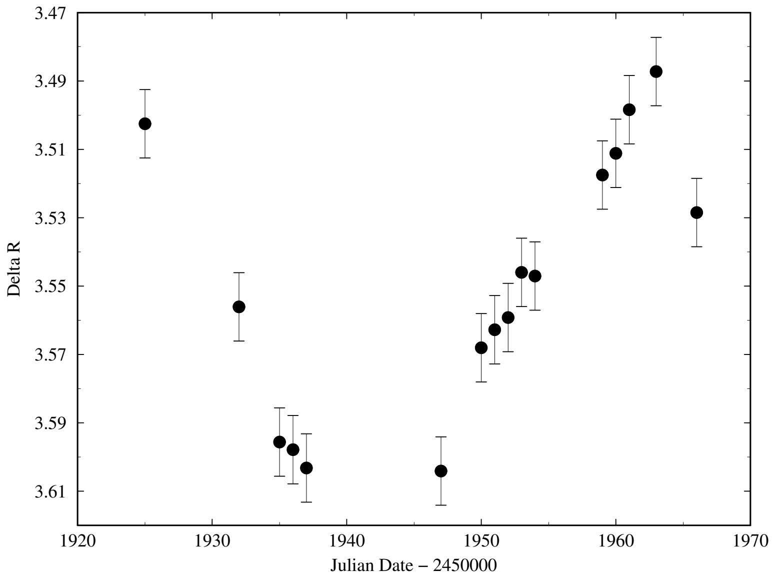

Figure 4. R_c filtered light curve of GSC 2895-1173 – HD 280341 for winter 2001

Continued photometry is important to ascertain the reason for the variability of GSC 2895-1173. Spectroscopic observations will be valuable to determine a precise spectral class for the stars and to measure radial velocities to check for duplicity.

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