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PHOTOMETRIC VARIABILITY OF THE STARS USNO 0900-17903132, HD191674 AND HD 191616

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As part of a continuing search for photometric variations in stars which are known X-ray sources, we observed HD 191616 (=GSC 0503-0700). This star, also known as RXJ201043+045449, was discovered to be a source of X-rays by the ROSAT satellite (Voges et al. 1999). The Tycho catalog (ESA 1997) reported V_T=9$^{\mathrm{m}}_{.}$497 and B_T=10$^{\mathrm{m}}_{.}$724 for HD 191616 and V_T=9$^{\mathrm{m}}_{.}$000 and B_T=10$^{\mathrm{m}}_{.}$238 for one of the field stars, HD 191674 (=GSC 0503-1409), both consistent with a spectral type of approximately K0. The reported parallaxes favor dwarf luminosity class but do not exclude giant status.

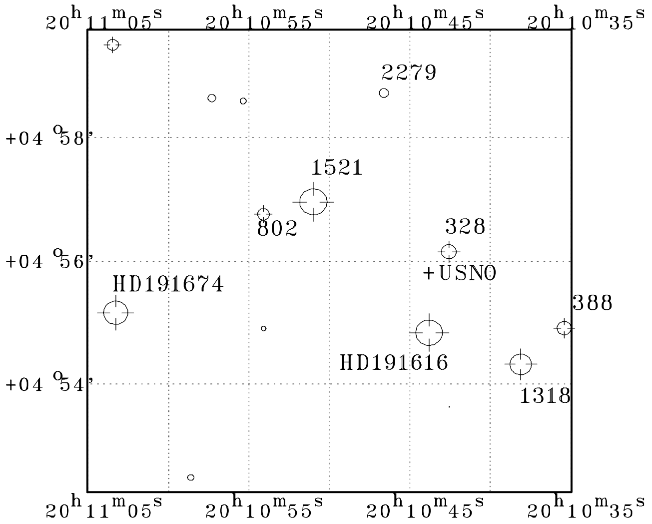

Figure 1. Finder chart labeled with the GSC identification numbers from region 0503.

The field of stars observed with the automated 0.5m telescope of the Climenhaga Observatory at the University of Victoria is shown in Figure 1. The data were reduced in a fashion similar to that described in Robb and Greimel (1999). Table 1 lists the stars' identification numbers, coordinates (J2000) and magnitudes from the Hubble Space

Table 1: Stars observed in the field of HD 191616=GSC 0503-0700 and HD 191674=GSC 0503-1409

Star Id	R.A. J2000	Dec. J2000	GSC Mag.	ΔR_c Mag.	Std Dev Between	Std Dev Within	$(R-I)$
HD 191616	$20^h10^m44^s$	$4°54'50''$	8.8	0.490	.022	.004	0.4
GSC 0503-1521	$20^h10^m51^s$	$4°56'57''$	8.6	-	-	-	0.4
HD 191674	$20^h11^m03^s$	$4°55'10''$	9.3	$-.222$	.025	.003	0.4
GSC 0503-1318	$20^h10^m38^s$	$4°54'19''$	10.0	1.447	.003	.003	0.4
GSC 0503-388	$20^h10^m35^s$	$4°54'55''$	11.9	3.428	.004	.007	0.2
GSC 0503-328	$20^h10^m43^s$	$4°56'09''$	11.7	3.060	.004	.009	0.4
USNO 900-17903132	$20^h10^m43^s$	$4°55'51''$	13.9	4.787	.157	.036	2.3
GSC 0503-802	$20^h10^m54^s$	$4°56'45''$	12.4	3.474	.002	.007	0.3
GSC 0503-2279	$20^h10^m47^s$	$4°58'44''$	13.1	4.579	.011	.019	0.2

Telescope Guide Star Catalog (GSC) (Jenkner et al., 1990). Observations were made using filters closely matching the Cousins R and I bands (Cousins 1981). The thirty-two Julian Dates of observation (-2450000) are 2121, 2122, 2129-2138, 2150, 2151, 2157-2166, 2168, 2169, 2175, 2176, 2179, 2180, 2182 and 2184.

Our differential ΔR_c magnitudes are calculated in the sense of the star minus GSC 0503-1521. 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 0503-1318 - GSC 0503-1521] is 0.003 magnitudes. This excellent photometry shows that night to night variations in either of these stars must be less than a few millimagnitudes. We observed no significant variations in these stars in plots of the individual nights' data and a "Std Dev Within" one night of 0.003 sets an upper limit on variations of an hourly timescale.

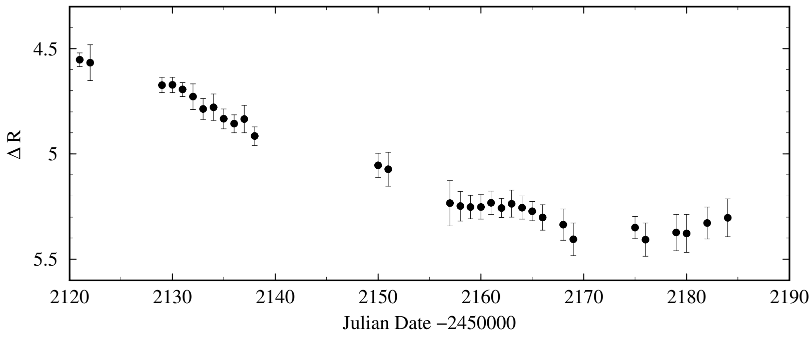

Figure 2. ΔR_c filtered light curve of USNO 0900-17903132 for summer 2001

In Figure 2 we have plotted the nightly mean and standard deviation of the ΔR_c brightness of the star USNO 0900-17903132. Obviously it is a variable star with a timescale of at least a hundred days and from our $(R-I)_c$ we estimate a spectral type of late M. We expect this star to be a long period variable and urge observers to monitor its brightness and discover its amplitude and periodicity, if any.

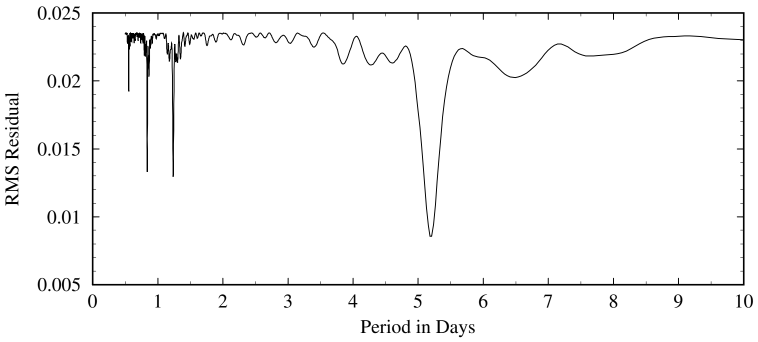

Figure 3. Periodogram for HD 191674 in 2001

The star HD 191674 had obvious night to night variations. The root-mean-square (RMS) deviation of a data point from a sine curve as a function of period is shown in Figure 3. From this periodogram we find the ephemeris to be:

$$\text{HJD of Maximum Brightness}= 2452118\overset{\text{d}}{.}3(9)+5\overset{\text{d}}{.}21(15)\times\text{E}.$$

where the uncertainties in the final digit are given in brackets and the RMS error of the fit is less than 0.01 magnitudes. The 3685 differential ΔR_c magnitudes phased at this period are plotted in Figure 4 with different symbols for each cycle.

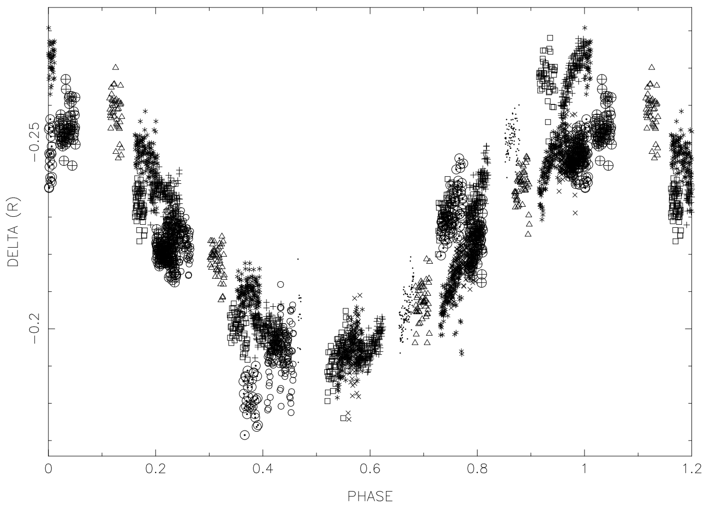

Figure 4. R_c filtered light curve of HD 191674

There are significant differences from cycle to cycle but doubling the period did not improve the fit. The $(R-I)_c$ is consistent with the Tycho B_T and V_T measurements indicating that the star is approximately K0 spectral type. Therefore we postulate that HD 191674 is a late type spotted dwarf rotating with a $5\overset{\text{d}}{.}21$ period.

Our observations of HD 191616 are plotted in Figure 5. with the error bars set to the standard deviation of the points during each night. The error of the nightly mean then would be about ten times smaller. Obviously HD 191616 is also a variable star, so Period98 (Sperl 1998) was used to find the period, amplitude and shape of the variations. The best model light curve found is of the form:

$$\Delta\text{R}=0.4611+0.0554*\sin(2\pi(\text{JD}-2112.0)/18.4638)+0.0198*\sin(2\pi(\text{JD}-2113.572)/9.2319)$$

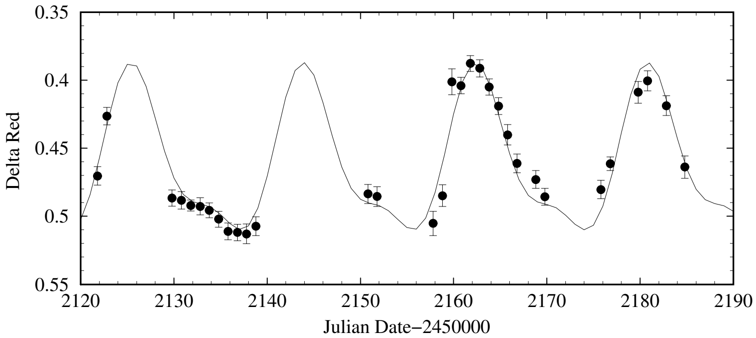

Figure 5. ΔR_c filtered light curve of HD 191616 for 2001 with model curve overplotted

Note that the second period was set to exactly half the dominant period, to modify the shape of the curve to best match the asymmetry in the distribution of the spots on the surface of the star. Spectroscopic observations made with the DAO 1.8m telescope were used to determine the spectral class to be K3, consistent with the $(R-I)_c$ and Tycho measurements. The spectrum displayed in figure 5 clearly shows the Hα emission line.

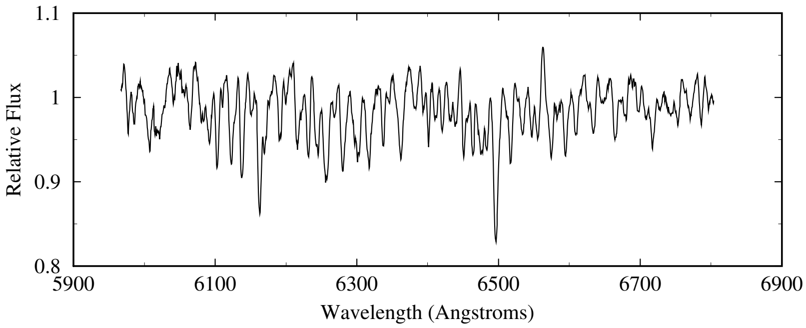

Figure 6. Spectrum of HD 191616 showing the Hα emission line at 6563$\mathring{A}$.

HD 191616 is an X-ray source, a K3 spectral type star with Hα emission, photometric variations with an $18\overset{\mathrm{d}}{.}5 \pm .4$ period and cycle to cycle differences typical of BY Dra stars. Photometric observations should be continued to monitor for flares, changes in the spot distribution and to determine the period more precisely.

References:

Cousins, A.W., 1981, SAAO Circ., **6**, 4
ESA, 1997, The Hipparcos and Tycho Catalogues, ESA SP-1200
Jenkner, H., Lasker, B., Sturch, C., McLean, B, Shara, M., Russell, J., 1990, *AJ*, **99**, 2082
Robb, R.M. and Greimel, R., 1999, *ASP Conf. Ser.*, **189**, 198
Sperl, M., 1998, Master's Thesis, Institut für Astronomie, Universität Wien
Voges, W., et al., 1999, *A&A*, **349**, 389