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APT OBSERVATIONS OF SMALL-AMPLITUDE RED VARIABLES

Small-amplitude red variables (SARVs) are M giants which are pulsating with small amplitudes (<2.5 mag) and with periods of 20 to 200 days. SARVs are believed to be part of a sequence of red variables extending from the so-called σ Librae stars (periods 10 - 20 days, V amplitudes typically 0.1 mag) to the Mira stars. Along this sequence of red variables, the incidence of variability, and the period and amplitude of variability, tend to increase with later spectral type, but the correlation is not an exact one.

There are 164 known and 136 suspected variables among the approximately 500 M giants in the Yale Catalogue of Bright Stars. In order to clarify the variability status of these 500 M giants, one of us (JRP) has been conducting a search for SARVs using the 0.4 m "teaching telescope" of the University of Toronto (Percy and Fleming 1992; Percy and Shepherd 1992), and using the American Association of Variable Star Observers (AAVSO) network of photoelectric photometrists (Percy et al. 1994). Several SARVs which had not been assigned to a student observer or to the AAVSO observers were monitored for one season with an automatic photoelectric telescope (APT).

The seven SARVs listed in Table 1 were monitored automatically with the Phoenix 10 0.25 m reflector through the APT Service of the Fairborn Observatory, exactly as described by Percy (1993). Table 1 lists the program (P), comparison (C) and check (K) stars, their properties, the standard deviations of the differential U, B and V magnitudes of the program and check stars relative to the comparison stars, and the assessment of the variability of each star. A few observations were omitted for a priori reasons, e.g. if there was a large internal standard error, if the APT quality control information indicated that the night was a poor one, and/or if the observation was incomplete. The standard deviations of the constant stars (0.005 to 0.01 in B and V, 0.01 to 0.02 in U) are typical for observations of cool stars with this telescope.

In addition to the results given in Table 1, there are the following notes on individual stars; sample light curves are given for three stars:

HR 5123. VAR? (YCBS). The variability is marginal, at best.

HR 5150. VAR? (YCBS). The star varies on time scales of ~20 and >100 days (Figure 1); there is also a distinct peak in the power spectrum at ~6 days.

HR 5154. NSV 06389; V = 4.63 - 4.73 (NSV). We find a similar range. The variability is irregular, with a characteristic time scale of 20 days (Figure 2). The highest peak in the power spectrum is at 18 days.

HR 5215. VAR? (YCBS). The most obvious variability is on a time scale of ~100 days, but there is some evidence for more rapid variability as well (Figure 3).

HR 5226. CV Dra; V = 4.46 - 4.94 (YCBS). Our observations show a much smaller range (but over a limited time interval). The power spectrum shows no dominant peak.

HR 5299. BY Boo; Lb? V = 5.1 - 5.28 (YCBS). The dominant peak in the power spectrum is at 30 days.

Table 1. APT Observations of Small-Amplitude Red Variables.

Star (HR)	SpT	V	σ(U)	σ(B)	σ(V)	Result	ΔV	Period (days)
P 5123	M2 III	5.74	0.0204	0.0096	0.0093	constant?	0.04	
C 5102	G8 III	6.11	–	–	–	constant		
K 5149	G9 III	5.62	0.0091	0.0057	0.0047	constant		
P 5150	M2 III	5.01	0.0546	0.0321	0.0262	variable	0.09	6+longer
C 5111	G6 III	5.73	–	–	–	constant?		
K 5178	K5 III	6.05	0.0373	0.0091	0.0108	constant?		
P 5154	M2 III	4.66	0.0155	0.0170	0.0204	variable	0.08	18?
C 5177	F7 IV-V	6.50	–	–	–	constant		
K 5142	A3 Vn	5.46	0.0075	0.0068	0.0061	constant		
P 5215	M2 III	5.87	0.0307	0.0198	0.0207	variable	0.07	~100?+shorter
C 5195	K0 III	5.62	–	–	–	constant		
K 5161	G5 III	5.98	0.0117	0.0048	0.0085	constant		
P 5226	M3.5 III	4.65	0.0248	0.0352	0.0317	variable	0.10	
C 5256	K3 V	6.37	–	–	–	constant		
K 5213	G3 V	5.96	0.0080	0.0058	0.0045	constant		
P 5299	M4 III	5.27	0.0329	0.0510	0.0547	variable	0.17	30
C 5335	gK3	6.24	–	–	–	constant		
K 5271	K2 III	6.27	0.0232	0.0120	0.0063	constant		
P 5300	M1.5 III	5.25	0.0308	0.0228	0.0230	variable	0.10	19
C 5271	K2 III	6.27	–	–	–	constant?		
K 5280	A2 V	6.15	0.0199	0.0074	0.0136	constant?		

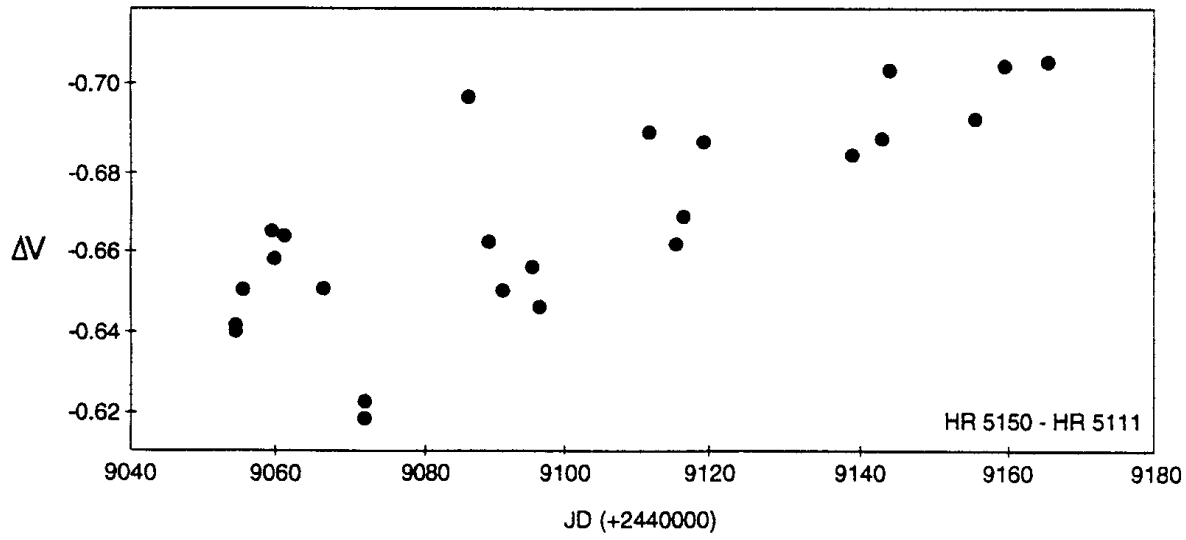

Figure 1. The V light curve HR 5150 relative to HR 5111.
The standard error of the measurements is 0.010.

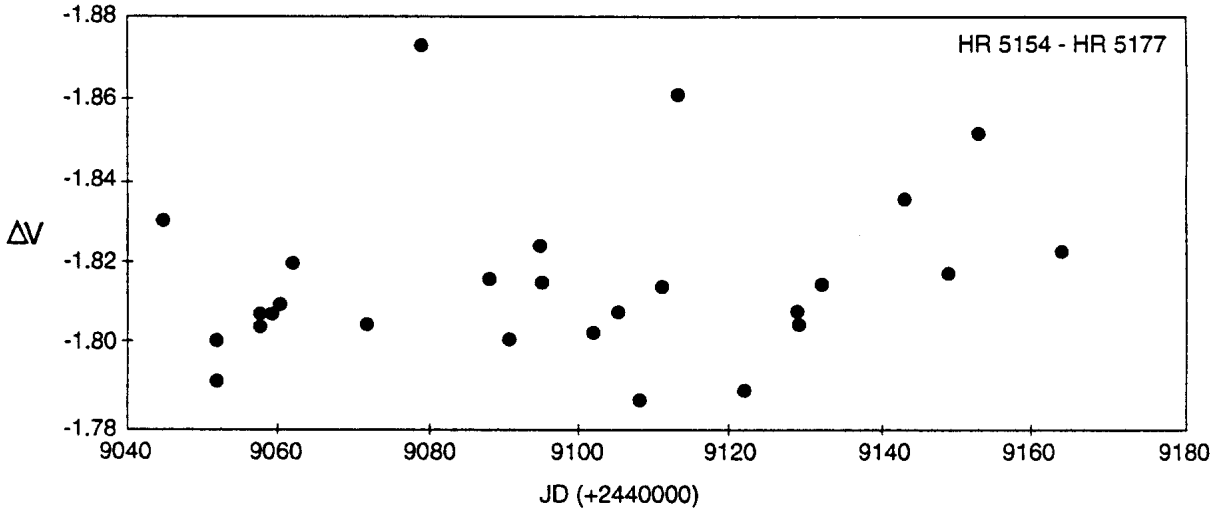

Figure 2. The V light curve of HR 5154 relative to HR 5177.
The standard error of the measurements it 0.006.

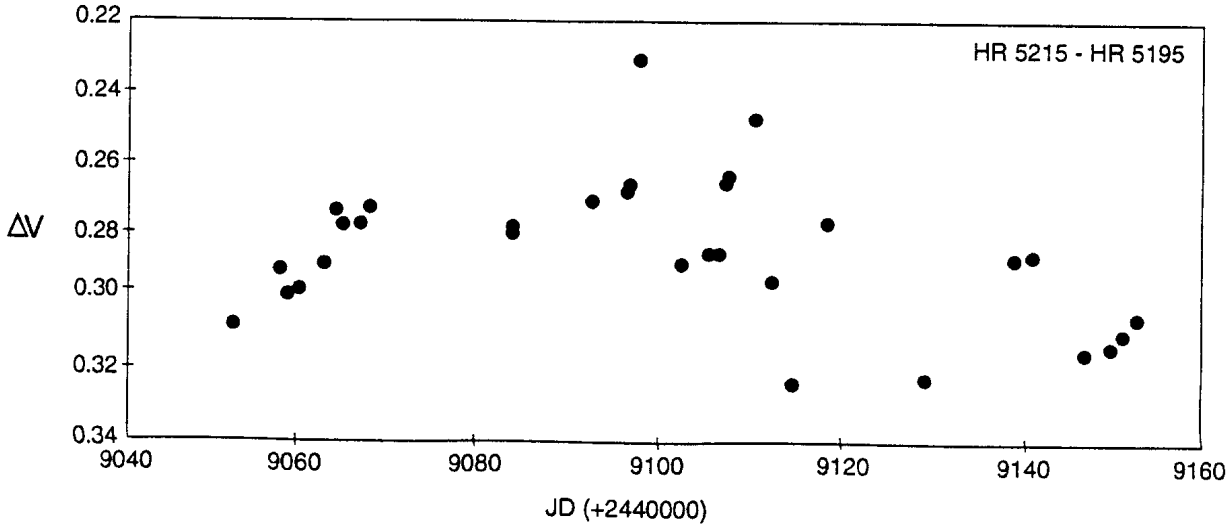

Figure 3. The V light curve of HR 5215 relative to HR 5195.
The standard error of the measurements is 0.008.

HR 5300. CF Boo; m_{pg} = 7.0 - 7.13 (YCBS). The dominant peak in the power spectrum is at 19 days.

Because of the limited span of the observations, it is not possible to derive precise information about the amplitude and time scales of the variability. The observations have, however, given estimates of the amplitude of short-term (days to months) variability which are useful for statistical purposes. Most of these stars are early M giants, and the amplitudes are relatively small, and the time scales short. HR 5150, for instance, shows some evidence of very short time scale variability. A few of the stars show conspicuous time scales of variability of order weeks. At least two show variability on a time scale $\geq$100 days. The origin of these long-term variations is not known. In general, the incidence, amplitude and time scales of variability, as a function of spectral type, are consistent with previous results.

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