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PHOTOMETRIC VARIABLE STARS FOUND IN FIVE SOUTHERN OPEN CLUSTERS

During the years 1985 to 1989 we have been carrying out photoelectric UBV observations of the following five southern open clusters : NGC 2437, NGC 2453, NGC 2539, Cr 223 and NGC 5749. These clusters were selected for observation because they have either not been previously observed photoelectrically or the existing data are far from being complete. The results of these photometric studies are being prepared for publication.

The aim of this note is to report the variability detected in twenty one stars in the region of the above mentioned clusters. Finding charts for the variable stars in NGC 2539, Cr 223 and NGC 5749 are shown in Figures 1 to 3. The new variables found in the field of NGC 2437 and NGC 2453 are shown in the finding charts published by Cuffey (1941) and Moffat and Fitzgerald (1974).

A total of 567 stars were observed in the UBV system in the field of these clusters. The measurements were performed during several observing runs with the 0.6 m, 0.9 m and 1.0 m telescopes of the Cerro Tololo Inter-American Observatory (CTIO), the 0.6 m Canadian telescope of the David Dunlap Observatory located in Las Campanas Observatory (LCO) and the 2.15 m telescope of the Complejo Astronómico El Leoncito (CASLEO) located in San Juan (Argentine). Dry-ice cooled RCA 31034A and 1P21 photomultipliers were used in these observatories with pulse-counting equipments and standard UBV filters. Mean coefficients were employed in LCO and CTIO to correct for atmospheric extinction, whereas the coefficients published by

Table 1 : Mean errors of the UBV photometry.

		External mean errors		
		ε_V	ε_{BV}	ε_{UB}
0.6 m (LCO)		0.009	0.006	0.011
0.6 m (CTIO)		0.012	0.009	0.009
0.9 m (CTIO)		0.011	0.005	0.013
1.0 m (CTIO)		0.008	0.009	0.010
2.15 m (CASLEO)		0.013	0.012	0.013
		Internal mean errors		
		σ_V	σ_{BV}	σ_{UB}
0.6 m (LCO)	$V \leq 12.0$	0.017	0.014	0.018
	$V > 12.0$	0.023	0.026	0.028
0.6 m (CTIO)	$V \leq 12.0$	0.015	0.014	0.016
	$V > 12.0$	0.018	0.022	0.026
0.9 m (CTIO)	$V \leq 12.0$	0.010	0.009	0.016
	$V > 12.0$	0.014	0.016	0.024
1.0 m (CTIO)	$V \leq 12.0$	0.013	0.012	0.011
	$12.0 < V \leq 13.0$	0.015	0.012	0.019
	$V > 13.0$	0.022	0.022	0.023
2.15 m (CASLEO)	$V \leq 12.0$	0.016	0.017	0.019
	$12.0 < V \leq 13.0$	0.021	0.019	0.022
	$V > 13.0$	0.022	0.024	0.029

Minniti et al. (1989) were used to reduce the CASLEO observations. The UBV standard system was established by nightly observing between 11 and 18 standard stars selected from the lists of Cousins (1967, 1973, 1974) and Graham (1982). The external (ε) and internal (σ) mean errors of the UBV photometry are summarized in Table 1.As shown

Table 2 : Individual UBV observations of new variable stars found in southern open clusters.

STAR	V	B-V	U-B	Sp. Type	Membership
		NGC 2437 (Cuffei 1941)			
174	10.640	1.110	0.882	K	pm
	10.727	0.964	0.869		
		NGC 2453 (Moffat and Fitzgerald 1974)			
50	10.519	2.037	1.756	K3II/Ib	m
	10.740	2.003	1.200		
		NGC 2539 (Clariá et al. 1991)			
1	12.793	0.540	-0.074	?	nm
	12.618	0.588	-0.195		
	12.630	0.615	0.044		
2	13.172	0.570	-0.116	F5	pm
	13.274	0.402	-0.038		
3	11.804	0.166	0.153	A3/5	m
	11.921	0.130	0.160		
	11.860	0.144	0.135		
4	13.504	0.155	-0.114	?	nm
	13.375	0.495	0.055		
5	13.348	0.392	0.000	F2	m
	13.315	0.409	0.136		
	13.427	0.373	0.096		
6	11.648	0.909	0.399	?	nm
	11.993	0.289	0.117		
	11.765	0.933	0.646		
7	13.016	0.298	0.192	A5/7	m
	12.206	0.187	0.165		
8	13.393	0.366	-0.078	F0	m
	13.504	0.330	0.110		
9	13.580	1.301	0.919	K	nm
	13.749	1.332	1.416		
10	12.432	0.305	0.087	F0	pm
	12.948	0.431	0.026		
	12.971	0.333	0.099		
11	12.954	0.384	0.074	F0/5	m
	14.179	0.486	-0.005		

Table 2 (continued)

			Cr 223 (Clariá and Lapasset 1991)		
10	12.629	0.772	0.250	G5	nm
	12.734	0.855	0.347		
	12.681	0.820	0.299		
41	12.716	0.168	-0.130	B8V	m
	13.054	0.136	-0.087		
42	12.709	1.660	1.736	G5/8	nm
	12.478	0.921	0.575		
105	11.683	0.105	-0.308	B6V	m
	11.781	0.054	-0.325		
	11.843	0.013	-0.357		
109	13.442	0.433	0.292	A7/9	nm
	13.668	0.426	0.197		
			NGC 5749 (Clariá et al. 1991)		
40	12.497	1.512	-	K4III	nm
	12.640	1.401	1.217		
64	12.972	0.444	0.276	B9V	m
	13.086	0.390	0.247		
	12.991	0.416	0.232		
82	13.051	0.413	0.247	B9V	pm
	13.736	0.689	0.339		

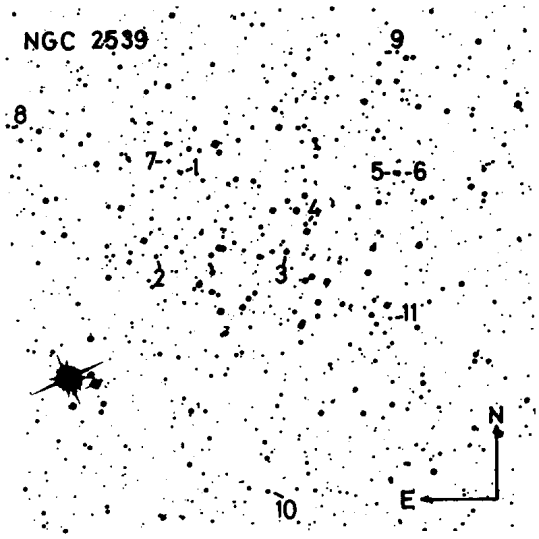

Figure 1 : Finding chart for the variables found in NGC 2539.

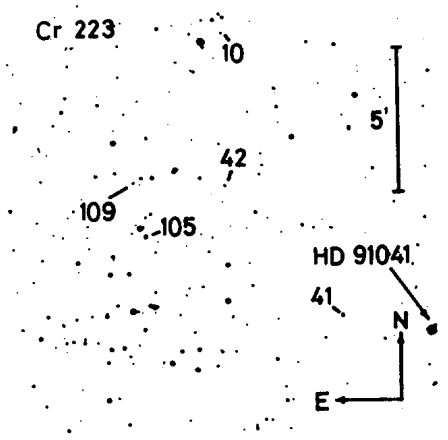

Figure 2 : Finding chart for the variables found in Cr 223.

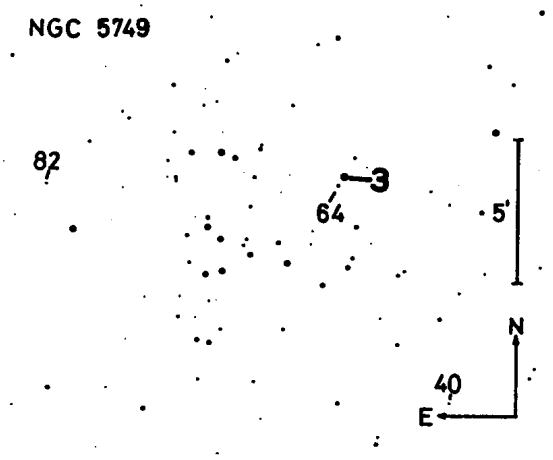

Figure 3 : Finding chart for the variables found in NGC 5749.

in this table, the mean external errors ε are all about 0.01 mag, independently of the telescope used. On the other hand, the mean internal errors σ_V , deduced from the night-to-night dispersion of the program stars, is about 0.02 mag, practically independent of the

V-magnitude and telescope used. There exists, however, a small increase in σ_{BV} and σ_{UB} with the V-magnitude.

We have considered a star to be a photometric variable when its individual V measures during different nights displayed variations greater than five times the mean internal error, i.e., $\Delta V > 0.1$ mag. To discern whether a star is a member (m), probable member (pm) or non-member (nm), we have applied two membership criteria described by Clariá and Lapasset (1986). The probable membership of the red variable stars in the field of NGC 2437 and NGC 2453 was evaluated from combined UBV and DDO (still unpublished) data by applying the criteria described by Clariá and Lapasset (1983). Among the new variables detected there are thirteen which are found to be members or probable members of the studied clusters (Clariá and Lapasset 1991, Clariá et al. 1991),whereas the remaining eight stars are very likely field stars. Four of the new variables exhibit ΔV variations greater than 0.50 mag, five show ΔV values between 0.20 mag and 0.50 mag, and the remaining twelve stars have ΔV variations in the interval 0.09 mag $< \Delta V <$ 0.20 mag.

The individual UBV measurements of the new variables are shown in Table 2. The references for star identifications are given at the head of each section of the table. Column (5) lists the spectral type as estimated from the UBV colours, excepting for stars of NGC 2437 and NGC 2453 wherein the MK spectral types were deduced from the unreddened DDO colours (Clariá et al. 1991). The last column of Table 2 indicates if the star is believed to be a cluster member, probable member or non-member field star.

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