ASTRONOMY & ASTROPHYSICS
SUPPLEMENT SERIES

Astron. Astrophys. Suppl. Ser. **123,** 25-30 (1997)

Photoelectric $uvby-\beta$ photometry of the open cluster NGC 2422

E. Rojo Arellano, J.H. Peña, and D. González

Instituto de Astronomía, UNAM, 04510 Mexico D.F., Mexique

Received December 20; accepted July 2, 1996

Abstract. New and previously observed $uvby-\beta$ photometry has been utilized to determine membership in the cluster. Reddening and age of the cluster has been determined.

Key words: open clusters: individual NGC 2422 — stars: *uvby* — stars: distances

1. Introduction

Although the pulsation mechanism in intrinsic variable stars is well known, doubts still remain with respect to why some stars pulsate while others with the same age, chemical composition, and physical characteristics do not. In view of this, and as a part of a larger research project, the open cluster NGC 2422 was observed through Strömgren photometry to first identify member stars as well as to determine physical characteristics that could differentiate the causes that provoke pulsation in the stars. In the past, several papers reporting photoelectric photometry have been devoted to NGC 2422: Hoag et al. (1961) presents *UBV* photometric values for 20 stars and photographic photometry for 95 stars; Smyth & Nandy (1962) (hereinafter S & N) report photographic photometric values of 81 stars in three colours and a distance modulus of 8.4 mag considering both their data and that of Hoag et al. (1961). A thorough compilation of open clusters, including NGC 2422, was made by Mermilliod (1976). More recently, and with the advent of Strömgren photometry, Shobbrook (1984) reports measurements for 28 B and A stars and derives a distance modulus of 8.0 and a mean reddening value $E(b-y)$ of 0.06. The most recent photometric study of NGC 2422 found is that of Nissen (1988) who reports Strömgren photometric values for several clusters including NGC 2422. With 19 stars of F spectral type, he derives a mean distance modulus of 8.14 mag and a mean reddening $E(b-y)$ of 0.053.

Send offprint requests to: E. Rojo Arellano

2. Observations and reductions

The observations were carried out at the 1.5 m telescope at the San Pedro Martir Observatory during an observing season between 11 and 18 of March, 1994. In particular the observations of the stars in NGC 2422 were carried out on the night of 16/17 March. The telescope was fitted with a spectrophotometer which allows simultaneous obtention of data in the *uvby* filters and, almost simultaneously, in the narrow (N) and wide (W) filters which define Hβ.

The reported values for each star are the mean of three ten- second integrations followed by one ten-second integration of the sky. A set of 31 of the brightest stars in the direction of NGC 2422 was measured. To be sure that the brightest stars were observed, concentric circles were drawn from the center of the cluster on the ID chart of Hoag et al. (1961) and all the stars in the inner circles were observed outwards. During the entire season, and in particular on this night, several standard stars were observed with the same telescope-photometer system in order to transform the instrumental magnitudes of the stars in the direction of NGC 2422 into the standard system. The photometric values for the standard stars were taken from the American Ephemeris and Nautical Almanac, 1994. The reduction was carried out following a previously described standard procedure (see for example Peña & Peniche 1994) which utilizes the Nabaphot package of Arellano Ferro & Parrao (1989) and Damadap of Parrao et al. (1996). The final results are presented in Table 1. The accuracy of each reported data point can be determined through the following considerations: the dispersion of the standard stars which gives the repeatability of the season and whose uncertainties are listed in Table 2 and the statistics for the fluxes measured for each star as a function of magnitude which are presented in Table 3.

3. Discussion

In order to carry out an exhaustive analysis of the NGC 2422 cluster, all $uvby-\beta$ photometric data available must be included in the study. There are two other

Table 1. $uvby-\beta$ photometry of NGC 2422

rpg[1]	V	$b-y$	m_1	c_1	β
8	10.328	.111	.137	1.037	2.958
7	10.142	.100	.133	1.013	2.954
31	10.531	.089	.185	.996	2.951
21	10.477	.087	.178	1.010	2.946
25	10.829	.125	.182	.968	2.938
6	10.006	.096	.133	1.034	2.929
18	10.804	.174	.159	.922	2.923
9	9.758	.072	.113	.988	2.899
4	9.962	.065	.119	.991	2.899
24	12.509	.191	.121	1.100	2.893
23	11.035	.173	.189	.850	2.891
19	9.455	.049	.125	.940	2.869
26	9.199	.077	.135	.899	2.864
30	8.788	.025	.141	.884	2.862
27	9.435	.072	.113	.890	2.854
10	8.784	.049	.098	.814	2.827
20	8.740	.042	.104	.808	2.817
3	11.807	.325	.138	.550	2.779
2	9.583	.267	.059	1.465	2.779
13	7.782	.039	.093	.583	2.740
17	7.400	.029	.098	.617	2.717
33	8.897	.028	.121	.636	2.713
14	11.490	.306	.127	.697	2.705
15	12.231	.372	.117	.461	2.703
28	7.036	.014	.109	.546	2.694
11	6.993	.042	.091	.672	2.690
22	11.637	.337	.147	.601	2.668
5	7.868	.793	.407	.215	2.590
32	7.941	.639	.354	.287	2.581
12	9.056	.510	.250	.273	2.570
1	8.196	.055	.013	.058	2.464
29	8.024	.008	.128	.528	

[1] Present paper.

Table 2. Accuracy of season from the dispersion of the standard stars

	V	$b-y$	m_1	c_1	β
No. of stars	53	67	54	56	14
std. dev	0.012	0.011	0.012	0.013	0.006

sources of $uvby-\beta$ photometric data which have been already mentioned: Nissen (1988) and Shobbrook (1984). A comparison between the different measurements was necessary and desirable. To begin with, a homogenization of the identification had to be done since each previous observer lists the observations carried out with different identification numbers. The observations by Nissen were given in x and y coordinates from the map of Hoag et al. (1961); Shobbrook (1984), on the other hand, gives his data in van Shewick's and Smyth & Nandy's numbers; Smyth & Nandy (1962) report their own identification chart. Hence, in view of this chaos, we have constructed a cross identification table (Table **??**) in which all the observations with $uvby-\beta$ photometry and their different nomenclature have been summarized.

Nissen (1988) was looking for the metal content determination for different clusters; hence he observed only late type stars, much fainter than those measured here or by Shobbrook (1984). Therefore there was no overlap between these sets.

Table 3. Uncertainties versus magnitude for the observed stars

V	δu	δb	δv	δy	δN	δW
6.8	0.004	0.002	0.003	0.004	0.014	0.019
7.77	0.006	0.006	0.009	0.007	0.008	0.007
8.7	0.009	0.015	0.012	0.011	0.015	0.007
9.7	0.006	0.009	0.016	0.012	0.029	0.012
10.8	0.048	0.030	0.043	0.028	0.022	0.037
11.6	0.053	0.074	0.064	0.021	0.099	0.015

A detailed discussion of the comparison to Shobbrook's (1984) data is necessary. To begin with, the intersection of both sets is seventeen stars, a significant number given the size of the sets (about 30 stars in each one). A comparison of the magnitudes and the colour indexes of both sets was carried out for the stars in the intersection, with the idea of taking mean values for these stars. The following findings were obtained: for V, m_1, c_1 and β the relationship was linear with correlation coefficients on the order of 0.9 and slopes close to 45 degrees. However, the relationship for the index $b-y$, showed an abrupt jump; a difference between the sets was found since the numerical values obtained by Shobbrook (1984) were systematically lower than those obtained here. As a first approach to confirming which set was correct, we compared the goodness of our transformation of the photometric values for our standard stars with those of Crawford (1970) in all the colour indexes and, in each case, the correlation coefficients R^2 were better than 0.997.

We carried out further comparisons of the photometric data from Shobbrook (1984) and the present paper to the previous photometric data of NGC 2422, both photographic (van Schewick 1966; Smyth & Nandy 1962) and photoelectric (Hoag et al. 1961, and the compilation of Mermilliod 1976). The following was found:

A comparison of Shobbrook's V magnitudes with those of Mermilliod's (1976) and Smyth & Nandy's (1962) gave excellent linear relations. Correlation coefficients were of R^2 equal to 0.999 and 0.853, respectively. Problems arose, however, when the $b-y$ colour index of Shobbrook was compared to the $B-V$ values of Mermilliod (1976) and Smyth & Nandy (1962). In each case the correlation coefficients were rather poor, R^2 equal to 0.647 and to 0.837, respectively. More puzzling is the fact that the curve that best adjusts to the $b-y$ colour index of Shobbrook (1984) and the $B-V$ index of S & N is not a straight line, but a quadratic fit. In fact, the quadratic adjustment gives an R^2 of 0.866, numerically better than in the linear case.

In view of this, a $B-V$ versus $b-y$ plot was constructed from the standard stars that appear in the American Ephemeris and Nautical Almanac with data in both colour indexes. In this sample a set of 45 stars within a range in

Table 4. Nomenclature of the stars observed in $uvby-\beta$

No	rpg[1]	BD	HD	S & N[2]	SAO	Hoag	V Sh	Nssn[3]	Shobb[4]
01	31	-14,02004				10	55		
02	21			32		9			
03	8	-14,02028		31			88		88
04	7	-14,02023		28			81		81
05	25			15		13	58		
06	6	-14,02003					52		
07	18			34					
08							69		69
09		-14,02033		14		14	93		93
10	4			27			54		54
11							47		47
12				29			92		92
13		-14,02024		26			82		82
14	9	-14,02032		12		12	91		91
15	24			55					
16	23			35					
17	19	-14,02015		25			70		70
18	26	-14,02010	60941	11	153120	11	62		62
19	30	-14,02018	60999		153135	6	75		75
20	27	-14,02014	60942	24	153131		68		68
21							121		121
22								12	
23	10	-14,02019	60996	10	153140	7	78		78
24							67		67
25							32		32
26	3			17					
27	2	-14,01996					43		
28	20	-14,02012	60940	22	153131		65		65
29							73		73
30								13	
31	13	-14,02022		5		3	79		79
32						17		1	
33	29	-14,02029	61045	9	153150	9	89		89
34	17	-14,02021	60998		153143				ADS6216
35									6216S
36									6216N
37	14			42					
38	33	-14,01994	60856		153115		42		42
39	15			49					
40	11	-14,02025	61017	3	153145	2	83		83
41	28	-14,02016	60969	4	153133		71		71
42						18		2	
43	22			16					
44		-14,02053	61224	2	153172		125		125
45								6	
46								4	
47								5	
48						19		3	
49								8	
50								10	
51								9	
52	5	-14,02002	60898	7	153121	4	50		
53	32	-14,02001	60899	8	153120	5	53		
54	12	-14,02017	60968	23			72		
55	1	-14,01999	60855	1	153118	1	45		45
56								7	
57								11	
58								14	
59								15	
60								16	
61								17	
62								18	
63								19	

[1] Present paper.
[2] Smyth & Nandy (1962).
[3] Nissen (1988).
[4] Shobbrook (1984).

Table 5. Compilation of the photometry of the stars with large scatter in V

No	rpg[1]	Shobb[2]	S & N[3]	BD	SAO	HD	Mrmll[4]
20	9.435	0.237	9.16	9.6	9.4	–	9.16
34	7.0	6.255	–	–	–	–	–
38	8.897	7.948	–	8.5	8.5	8.5	7.91
40	6.993	6.704	6.68	8.0	7.9	7.9	6.72

[1] Present paper.
[2] Shobbrook (1984).
[3] Smyth & Nardy (1962).
[4] Mermilliod (1976).

$b-y$ between -0.25 and 1.5 is found. A linear regression with a correlation coefficient R^2 of 0.9953 was obtained. A direct comparison of the line obtained from Shobbrook's data to S & N's was done and it became immediately evident that the slopes were totally different and that the $b-y$ interval of Shobbrook's data is very narrow. On the other hand, the comparison of our data to that of S & N gave a straight line parallel and basically equal to that of the standard stars; our $b-y$ coverage is much broader, from -0.2 to 1.3. Hence, since the standard stars of Shobbrook (1984) were chosen in a similar manner as the observed stars, i.e. with a very narrow range in $b-y$, this might be the cause of the differences of the $b-y$ values in his photometry from all the other photometric sets on NGC 2422. In view of the systematic difference of his data with all other data sets, a linear regression with our data was established as $(b-y)_{\rm pp} = 0.0310 + 0.9453(b-y)_{\rm shobbrook}$ and all the stars measured by Shobbrook (1984) were transformed in the $b-y$ index according to the previous relation into our system, which, as has been previously proved, is equivalent to the standard system of Crawford (1970). Finally, mean values for the stars observed in common were obtained for magnitude and all the colour indexes. The correctness of the criteria of considering mean values is established by the fact that the mean values of the differences between Shobbrook's data and the present paper's are -0.001,-0.003,-0.004,-0.005, and 0.005 in V, $b-y$, m_1, c_1 and β, respectively. However, there are a few stars, particularly in V, which show large differences. A brief review of the values in different photometric compilations, presented in Table 5, supports the evidence that the scatter is large and might be due to intrinsic variability of these stars. Another example of possible variability is that of star 28 whose large difference of 0.1 mag in β indicates a variable, such as Be star. The results presented in Table 6 are the values obtained from Nissen (1988), Shobbrook (1984), the mean values of Shobbrook (1984) and our photometry for those stars observed in common once the $b-y$ values of the former were translated to our (Crawford's 1970) system and those obtained in the present research. In Table 6 the sequence number of the observed stars in decreasing β is listed in Col. 1; the remaining columns list the photometric values obtained; the last column lists the source of the photometry reported.

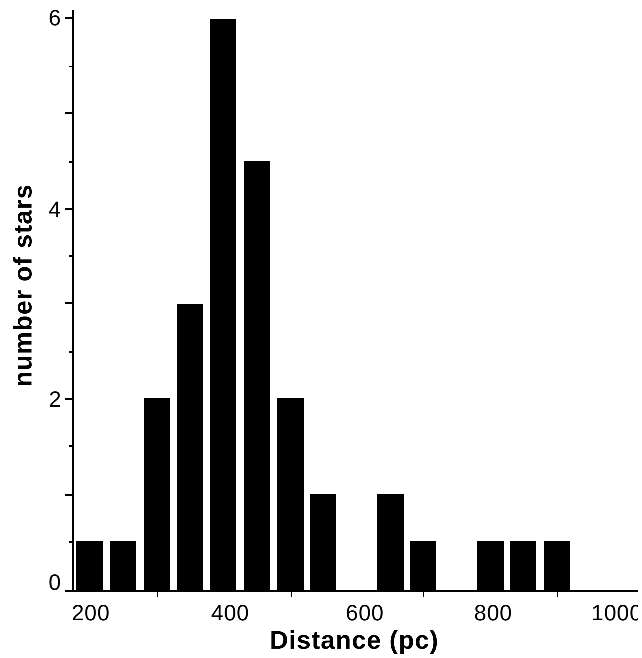

Fig. 1. Histogram of the distance of the stars in the direction of NGC 2422

4. Results

Since the purpose of the research at this stage is to establish the physical characteristics of those stars that belong to NGC 2422, the first step is, consequently, to determine which of the stars belong to the cluster. Strömgren photometry provides a safe method for determining the absolute magnitude of each star. The method used has been previously employed and is basically an extension of Crawford's calibrations (Crawford 1975, 1979) for A and F stars using a technique modified by Nissen (1988). A method developed by Shobbrook (1984) has been employed for the early type stars (see Peña & Peniche 1994 for details).

The final results, after the reddening and the absolute magnitude for each star were determined, are presented in Table 7. In this analysis star 34 (ADS 6216) was not considered. The data are presented in the following fashion: Col. 1 gives the identification number for each star, reddening $E(b-y)$ and the unreddened indices; M_v, Distance Modulus (DM), distance and metal content are also presented.

With the distances for each star established, a histogram of the distances (in parsecs) for the early type stars, the late A and F stars was carried out and is shown in Fig. 1. From this figure it is evident that the majority of the stars lie around 450 pc. A statistical probability was

Table 6. Combined $uvby-\beta$ photometry of NGC 2422

No	V	$b-y$	$m1$	$c1$	β	Source	No	V	$b-y$	$m1$	$c1$	β	Source
1	10.531	0.089	0.185	0.996	2.951	1	32	12.010	0.255	0.150	0.674	2.735	3
2	10.477	0.087	0.178	1.010	2.946	1	33	8.017	0.003	0.119	0.517	2.723	1,2
3	10.339	0.108	0.150	1.036	2.945	1,2	34	6.828	0.030	0.090	0.617	2.715	1,2
4	10.158	0.098	0.140	1.016	2.938	1,2	35	6.896	0.019	0.102	0.638	2.711	2
5	10.829	0.125	0.182	0.968	2.938	1	36	7.070	0.055	0.055	0.600	2.707	2
6	10.006	0.096	0.133	1.034	2.929	1	37	11.490	0.306	0.127	0.697	2.705	1
7	10.804	0.174	0.159	0.922	2.923	1	38	8.423	0.031	0.102	0.628	2.704	1,2
8	9.952	0.075	0.133	1.020	2.906	2	39	12.231	0.372	0.117	0.461	2.703	1
9	10.518	0.083	0.133	1.019	2.906	2	40	6.849	0.043	0.083	0.667	2.696	1,2
10	9.931	0.062	0.128	0.990	2.903	1,2	41	7.038	0.020	0.093	0.531	2.695	1,2
11	9.771	0.080	0.138	0.987	2.899	2	42	12.590	0.325	0.147	0.584	2.695	3
12	10.132	0.110	0.126	1.085	2.896	2	43	11.637	0.337	0.147	0.601	2.668	1
13	9.725	0.034	0.126	0.972	2.896	2	44	6.535	0.070	0.058	0.775	2.654	2
14	9.770	0.065	0.124	0.988	2.895	1,2	45	12.390	0.355	0.150	0.410	2.651	3
15	12.509	0.191	0.121	1.100	2.893	1	46	12.120	0.387	0.160	0.361	2.633	3
16	11.035	0.173	0.189	0.850	2.891	1	47	12.430	0.379	0.176	0.354	2.631	3
17	9.455	0.053	0.124	0.935	2.871	1,2	48	12.830	0.393	0.161	0.338	2.629	3
18	9.178	0.081	0.130	0.906	2.868	1,2	49	12.740	0.386	0.167	0.343	2.621	3
19	8.785	0.041	0.123	0.889	2.853	1,2	50	13.180	0.431	0.176	0.317	2.616	3
20	9.336	0.070	0.114	0.890	2.849	1,2	51	12.950	0.441	0.184	0.326	2.611	3
21	8.914	0.058	0.102	0.866	2.823	2	52	7.868	0.793	0.407	0.215	2.590	1
22	11.470	0.194	0.172	0.975	2.821	3	53	7.941	0.639	0.354	0.287	2.581	1
23	8.794	0.046	0.104	0.807	2.820	1,2	54	9.056	0.510	0.250	0.273	2.570	1
24	9.134	0.062	0.107	0.845	2.816	2	55	5.668	0.067	0.055	0.129	2.509	1,2
25	8.824	0.049	0.100	0.792	2.807	2	56	12.430	0.359	0.159	0.387		3
26	11.807	0.325	0.138	0.550	2.779	1	57	13.570	0.403	0.145	0.482		3
27	9.583	0.267	0.059	1.465	2.779	1	58	12.560	0.365	0.129	0.473		3
28	8.733	0.042	0.107	0.800	2.766	1,2	59	13.100	0.456	0.221	0.310		3
29	8.660	0.050	0.086	0.806	2.759	2	60	12.540	0.313	0.149	0.502		3
30	11.340	0.242	0.164	0.719	2.758	3	61	12.730	0.384	0.165	0.353		3
31	7.778	0.036	0.093	0.566	2.737	1,2	62	12.870	0.279	0.180	0.618		3

[1] Rojo, Peña & Gonzalez.
[2] Shobbrook (1984).
[3] Nissen (1988).

assigned by adjusting a Gaussian distribution to the histogram of the distances to the stars in the range between the interval 250 to 600 pcs in which the majority of the stars are found.

Mean values and a standard deviation for the member stars were determined for $E(b-y)$ (in magnitudes), distance (in parsecs) and metal content. The numerical values were of 0.089 ± 0.026; 470.8 ± 4.8 and 0.016 ± 0.171, respectively.

As in the previous papers, several conclusions can be drawn from the data in Table 6 with respect to the number of Ap stars, the number of binaries, the mean metallic content and the age of the cluster. Diagram $V_0-\beta$ provides information on the binaries, but none were found and no Ap stars were determined in the $[m_1]-[c_1]$ diagram since these stars lie in well-determined regions in such diagram. To establish the age of the cluster we first decided which stars were the hottest by plotting them on the theoretical grids of Relyea & Kurucz (1978) and of Neri et al. (1993) compiled from Kurucz (1989) and Mihalas (1972). Once the earliest stars, 36 and 41, were determined along with their effective temperatures, gravities and luminosities, their position in the evolutionary tracks of Meynet et al. (1993) was unambiguously established and the age of the cluster fixed. The numerical values of the temperature for the hottest stars is 14 000 K; the value of gravity for basically all the stars is 4.0; the mean metal content [Fe/H] of the cluster is 0.016 with a standard deviation of 0.171. With all these values, the position of these stars in the evolutionary tracks gives an age of 10^8 yr. These values are in excellent agreement with those of Lang (1992) who lists an $E(B-V)$ of 0.08, which corresponds to an $E(b-y)$ of 0.056, a distance of 480 pc and an age of 78 10^6 yrs. Problems still remain with respect to the evolutionary effect pointed out by Shobbrook (1984) which shows an exceedingly large trend in the $V_0-\mathrm{DM}$ diagram. This is most surely due to defects in the reddening calibration of the early type stars. In fact, the calibration employed here and that of Crawford (1970) show a systematic difference as a function of Hβ. This would definitively be an important problem to tackle in the future.

5. Conclusions

The open cluster NGC 2422 has been established as a relatively well-populated young cluster 470 ± 5 pc away, with a mean reddening $E(b-y)$ of 0.089 ± 0.026 and an age of 10^8 yrs. The majority of the stars measured proved

Table 7. Reddening and unreddened photometry of NGC 2422

No	$E(b-y)$	$(b-y)_0$	C_0	β	m_0	V_0	M_V	DM	Dist.	[Fe/H]
1	.107	-.018	.976	2.951	.220	10.07	1.69	8.38	474.2	
2	.102	-.015	.991	2.946	.212	10.04	1.65	8.39	476.1	
3	.117	-.009	1.014	2.945	.189	9.83	1.64	8.20	435.8	
4	.112	-.014	.995	2.938	.177	9.68	1.59	8.09	414.8	
6	.105	-.009	1.014	2.929	.168	9.55	1.51	8.04	406.3	
7	.205	-.031	.883	2.923	.227	9.92	1.49	8.43	486.2	
8	.087	-.012	1.004	2.906	.162	9.58	1.32	8.26	449.6	
9	.095	-.012	1.001	2.906	.164	10.11	1.32	8.79	573.2	
10	.080	-.018	.975	2.903	.154	9.59	1.30	8.29	454.0	
11	.099	-.019	.968	2.899	.171	9.34	1.27	8.08	412.2	
12	.103	.007	1.065	2.896	.160	9.69	1.19	8.50	502.1	
14	.084	-.019	.972	2.895	.152	9.41	1.23	8.18	432.6	
17	.080	-.027	.920	2.871	.150	9.11	1.03	8.08	414 0	
18	.112	-.031	.885	2.868	.167	8.70	1.01	7.68	344.2	
19	.073	-.032	.875	2.853	.147	8.47	.87	7.60	331.9	
20	.103	-.033	.871	2.849	.148	8.90	.83	8.07	410.8	
21	.092	-.034	.848	2.823	.132	8.52	.55	7.96	391.7	
23	.084	-.038	.791	2.820	.132	8.43	.55	7.88	377.1	
24	.098	-.036	.826	2.816	.139	8.71	.48	8.23	442.4	
25	.088	-.039	.775	2.807	.129	8.44	.41	8.04	405.3	
28	.081	-.039	.785	2.766	.134	8.39	-.16	8.54	511.1	
29	.088	-.038	.789	2.759	.115	8.28	-.27	8.55	513.1	
31	.090	-.054	.549	2.737	.123	7.39	-.43	7.81	365.6	
33	.062	-.059	.505	2.723	.139	7.75	-.63	8.38	474.0	
34	.080	-.050	.602	2.715	.116	6.48	-.83	7.31	289.9	
35	.067	-.048	.625	2.711	.124	6.61	-.93	7.54	321.5	
36	.107	-.052	.580	2.707	.090	6.61	-.96	7.57	326.1	
40	.090	-.047	.650	2.696	.113	6.46	-1.28	7.74	354.0	
41	.077	-.057	.516	2.695	.119	6.71	-1.13	7.84	369.0	
44	.110	-.040	.754	2.654	.094	6.06	-2.77	8.83	582.7	
30	.056	.186	.708	2.758	.181	11.10	2.68	8.42	482.4	
39	.133	.239	.434	2.703	.157	11.66	4.03	7.62	335.0	-.105
45	.053	.302	.399	2.651	.166	12.16	3.65	8.52	504.9	-.019
46	.056	.331	.350	2.633	.177	11.88	4.09	7.79	361.7	.009
47	.041	.338	.346	2.631	.188	12.25	4.16	8.10	416.3	.119
48	.056	.337	.327	2.629	.178	12.59	4.35	8.24	444.0	-.006
49	.040	.346	.335	2.621	.179	12.57	4.19	8.38	474.0	-.048
50	.069	.362	.303	2.616	.197	12.88	4.50	8.39	475.8	.096
51	.070	.371	.312	2.611	.205	12.65	4.30	8.35	467.4	.137

to be early type stars although several stars belonging to the cluster were determined to be A and F stars; hence they are candidates to be monitored in order to determine which of them belongs to the Delta Scuti group. No binaries nor chemically peculiar stars were found and no traces of any blue stragglers were discovered. 36 member stars were fixed as belonging to the cluster.

Acknowledgements. We would like to thank the staff of the OAN and H. Noriega for their assistance at the observations, R. Peniche for assistance and fruitful discussions, C. Guzman for his computing advice and J. Miller for revising the English version. This work was partially supported by CONACyT grant 3925E. One of us, ER, thanks M. Martos for partial support through DGAPA grant No. IN109095. This was a class project at UNAM.

References

Arellano Ferro A., Parrao L., 1989, Rep. Tec. No. 57. Inst. Astron. UNAM, Mexico
Crawford D.L., 1970, AJ 75, 978
Crawford D.L., 1975, AJ 80, 955
Crawford D.L., 1979, AJ 84, 1858
Hoag A.A., Johnson H.L., Iriarte B., et al., 1961, Pub. US Naval Obs. Vol. XVII, Part VII Washington
Kurucz R.L., 1989 (private communication to Neri)
Lang K.R., 1992, Astrophysical Data: Planets and Stars. Berlin: Springer-Verlag
Mermilliod J.C., 1976, A&AS 24, 159
Meynet G., Mermilliod J.C., Maeder A., 1993, A&AS 98, 477
Mihalas D., 1972, ApJ 176, 139
Neri L.J., Chavarria-K C., de Lara E., 1993, A&AS 102, 201
Nissen P., 1988, A&A 199, 146
Parrao L., Peña J.H., Schuster W., 1996 (in preparation)
Peña J.H., Peniche R., 1994, Rev. Mex. A&A 28, 139
Relyea L.J., Kurucz R.L., 1978, ApJS 37,45
Shobbrook R.R., 1984, MNRAS 211, 659
Smyth M.J., Nandy K., 1962, Pub. R. Obs. Edinburgh 3, No. 2, 23
van Schewick H., 1966, Veroff. Astr. Inst. Bonn No. 74