

EIGHT POPII CEPHEIDS RECENTLY IDENTIFIED IN GLOBULAR CLUSTERS

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The University of Toronto 24-inch telescope at the Las Campanas Observatory of the Carnegie Institution of Washington has been used for the study of variables in four southern globular clusters: NGC 6273=M19, NGC 6284, NGC 6293 and NGC 6333=M9.

The first three of these clusters lie about 2° from one another in the sky at southern declinations ranging from about 24.5° to 26.5° . They were investigated by one of us (Sawyer 1943) using photographs obtained at the Steward Observatory in Arizona in 1939. A number of variables were discovered, but even with additional David Dunlap plates, it was not possible to determine any periods because of the large southern declinations. At Las Campanas (latitude 29°S), they pass close to the zenith and therefore the periods are more readily determined. From our Las Campanas data, we have found that there are four Cepheids in NGC 6273, two in NGC 6284 and one in NGC 6293.

NGC 6333 with its declination of about 18°S can be studied more easily from the northern hemisphere than the others. Accordingly, one of us (Sawyer 1951) studied the variables in this cluster using plates obtained at the Steward Observatory in 1939 and at the David Dunlap Observatory during the period 1940 to 1949. Eleven periods were determined and all were thought to be of the RR Lyrae type. However, new data from Las Campanas have shown that one of the stars, V12 is a population II cepheid. At northern observatories, this cluster can be observed over such a limited range in hour angle that a spurious period was obtained for V12. However, at Las Campanas, it can be observed for as much as nine hours in one night. Our new period for this star, 1.34 days is related to the old by the relation: $1/P(\text{new}) = 1/P(\text{old}) - 1$.

Elements for the eight cepheids are presented in the table on the following page. The values of $E(B-V)$ for the clusters were taken from Zinn (1980). The other information is taken from the cited references where light curves and epochs of maximum light may also be found. We hesitate to quote absolute magnitudes for any of these stars because for some, the mean B magnitudes are uncertain due to the contamination of light by nearby stars and for all of them, the distances are uncertain. Of the four clusters, NGC 6273 is the only one with a published colour-magnitude diagram (Harris et al 1976). The diagram has a lot of scatter which the authors attribute partly to contamination from field stars, but mainly to differential reddening. The cluster has the largest ellipticity of any in the galaxy and they suggest that this is

caused by a thin absorbing lane on its east side. It is therefore difficult to estimate the distance modulus of NGC 6273 to an accuracy of better than 0.3 magnitudes. In the other three clusters, Racine (Diamond 1976) has made a few photoelectric observations on the B,V system, but in each case, there are only one or two standards in the appropriate magnitude range.

Elements for the Eight Variables						
Cluster	Var	P(days)	logP		E(B-V)	Reference
NGC 6273	1	16.92	1.23	13.73:	0.36	Clement & Sawyer-Hogg (1978)
	2	14.139	1.15	14.17		
	3	16.5	1.22	13.61:		
	4	2.4326	0.39	14.76:		
NGC 6284	1	4.48121	0.65	15.88	0.29	Clement et al(1980)
	4	2.81873	0.45	16.04		
NGC 6293	2	1.1575	0.06	16.91:	0.37	Clement et al(1982)
NGC 6333	12	1.340204	0.13	16.62	0.34	Clement & Ip(1984)

Cluster Membership

The cepheids in NGC 6273 and NGC 6284 have B magnitudes appropriate for cluster membership, when compared with the RR Lyrae variables in these clusters. However, both V2 in NGC 6293 and V12 in NGC 6333 have B magnitudes comparable to those of the RR Lyrae variables, and normally, we would expect them to be about a magnitude brighter if they were cluster members. Nevertheless, we believe that V12 is a member of NGC 6333 because it lies at the edge of a region of considerable obscuration southwest of the cluster. This obscuration is very marked on plates E and O1160 of the Palomar Sky Survey and so it is not surprising that V12 is faint. The case for V2 in NGC 6293 is more complicated. In our earlier paper (Clement et al.1982), we assumed that it was not a cluster member, but close examination of plates E and O192 of the Palomar Sky Survey indicates that there may be a small region of obscuration to the northwest of NGC 6293 where V2 lies.

Since all of these newly identified cepheids are in and around highly reddened clusters, it would be useful to study them in the infrared and Welch (1984) is planning to do this.

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