VARIABLE STARS IN THE GLOBULAR CLUSTER NGC 6934

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In the first program of direct photography with the 72-inch telescope of the Dominion Astrophysical Observatory, 1931-1934, the compact and distant globular cluster NGC 6934 in Delphinus was searched for variables for the first time by HSH. The 51 discovered were published in 1938 (Sawyer-Hogg 1938). From 1935 to 1964 the observational program was continued with the 74-inch telescope of the David Dunlap Observatory and a total of 161 plates was accumulated. In addition, six Mount Wilson plates from 1911 to 1917 were available to us.

It appeared early that most of the variables were RR Lyrae type, and periods for 30 have already been published. Harris and Racine (1973) showed that V15 is at the top of the red giant branch, an irregular.

Period determination for the 50 RR Lyraes has now been completed, with light curves, and is being submitted by us to the *Astronomical Journal*. There are 45 RR*ab* and 5 RR*c* stars in an Oosterhoff Type I cluster. Our independent magnitudes are in excellent agreement with those of Harris and Racine. The period frequency diagram is remarkably similar to that of M3 with an average period for the RR*ab* of 0.552 day compared with 0.551 for M3 as given by Cacciari and Renzini (1976).

Forty-four B plates of NGC 6934 were taken with the 1.2 m telescope of the University of Western Ontario from 1976 to 1978. Magnitudes were obtained from iris photometer measures for about half of the 51 variables and from eye estimates for the rest. These magnitudes were combined with the magnitude estimates made by HSH on the older plates in order to derive period changes.

James E. Hesser (ed.), Star Clusters, 455–457.

The data were divided into nine groups spanning the years 1911 to 1978 and O-C diagrams were constructed. Period changes were derived for each star by two methods, one assuming a continuous period change, and the other an abrupt change. In the first case the period change was derived by a least squares fit to a parabola and in the second case two straight lines were fitted to the O-C diagram. In general, the period changes found by the latter method were smaller but in both cases some changes are too large to be explained by evolutionary theory. The distribution of the period changes is compatible with the theory of Sweigart and Renzini (1979) that small discrete mixing events involving the semiconvective zone can cause random abrupt period changes superposed upon evolutionary changes.

Of the total of 50 RR Lyrae variables, 6 were found to be increasing in period, 11 decreasing and 31 were constant within the errors of the study. Two variables appeared to change period so irregularly that no simple period change could be derived for them. The mean positive change is 0.03 days/10^6 y, the mean negative change is 0.08 d/10^6 y, and the mean of all 48 period changes is 0.00. These results were compared with period changes observed in eight other globular clusters and the only systematic difference immediately obvious is that ω Cen and M 15 exhibit considerably more positive than negative changes. However it should be noted that the mean absolute value of the period changes is smaller for NGC 6934 than for any of these other clusters.

A paper concerning the period changes will be submitted to the *Astronomical Journal* by C. Stagg and A. Wehlau. In conclusion we wish to acknowledge the support of the National Research Council of Canada (now NSERC).

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DISCUSSION

KING: I just wondered if the erratic behaviour of V2 is because its period is close to the transition period where that behavior is sometimes seen?

WEHLAU: No, actually there are always erratic stars in every globular cluster, if you ask me, and this one seems to have fewer than average number of erratic members. Well, its period certainly is shorter because it's 0.48d, but the c's have much shorter periods, $\sim$ 0.3d.

WALLERSTEIN: How do you avoid the problems of phase jitter? RR Lyrae's 41 day cycle may be shown by an early rise or a late rise. And if you have only half a dozen plates during a year, you may in one year find you're getting a star when it's rising a little bit early and then on another year you'll find it when it happens to be rising a little bit late. But the overall period may still be constant, but it may be rising one or two tenths of a cycle too early. Can you avoid that problem?

WEHLAU: Well, actually I think there is a lot of scatter in the results, but that will average out. You don't have that small a number of points in each one of these groups that we have. You never completely lose phase, either, but you don't mean that?

WALLERSTEIN: No, I don't mean that. I mean an early rise which will give the impression of a slightly shorter period or a late rise which gives an impression of a slightly longer period.

WEHLAU: You observe it over many periods in each one of these groups. If you had all the ones that year with early rises, you could get that effect. Or if you had all late rises. But for each one of these groups you might have 30 points, or so, covering maybe 20 different periods and the effect averages out.

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