THE TWO POPII CEPHEIDS IN THE GLOBULAR CLUSTER MESSIER 10

C.Clement, H.Sawyer Hogg
David Dunlap Observatory, Univ. of Toronto, Toronto M5S 1A7

K.Lake
Dept. of Physics, Queen's University at Kingston,Ont.K7L 3N6

The globular cluster Messier 10 has three known variables. The first two of these were discovered by one of us (Sawyer 1933) and the third by Arp (1955). Two of the variables, V2 (P=18.7226) and V3 (P=7.831), are population II cepheids while V1 appears to be an irregular variable. Another star which lies in the Schwarzschild gap on the horizontal branch is a suspected variable (Voroshilov 1971).

In this investigation, we examine the variations in the periods of the two cepheids over the interval 1912 to 1983 (for V2) and 1931 to 1983 (for V3). The study is based on photographs obtained with seven different telescopes - the Mt.Wilson 100-inch and 60-inch (1912 to 1919), the Dominion Astrophysical Observatory 72-inch, the David Dunlap 74-inch and 19-inch, the 16-inch at the University of Toronto downtown campus and the University of Toronto 24-inch at the Las Campanas Observatory of the Carnegie Institution of Washington. Some of our magnitudes have already been published (Sawyer 1938) and the remaining ones will be submitted to the Astronomical Journal for publication. We have also included material published by Arp (1955,1957) in our study.

Our phase shift diagrams are shown on the next page. To derive these, we have plotted light curves at various epochs for each star and then measured the shift relative to Arp's 1952 observations (Arp 1955). From the diagrams, we can see that the periods for both stars have fluctuated during the observed interval so that we can not determine a value for β, the rate of period change.

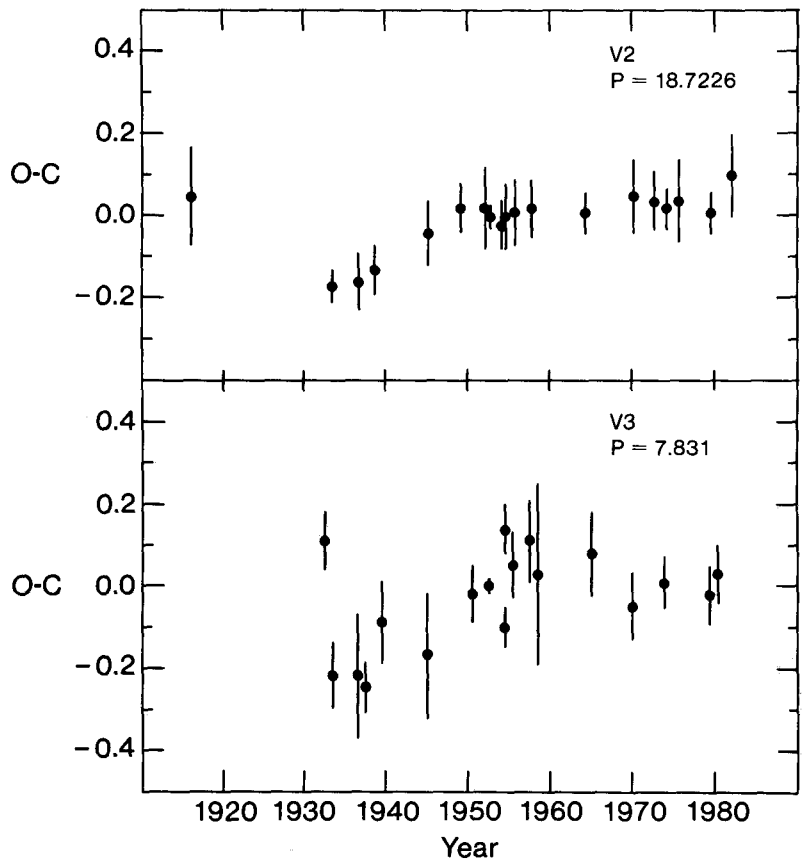
V2, with P=18.7 days, is a 'loop' cepheid, i.e. one which enters the instability strip when thermal instabilities in the helium burning shell of an asymptotic red giant branch star cause it to loop to the left in the HR diagram (Schwarzschild and Harm 1970). The period for V2 has been constant since 1945, but before that, it varied. Because of the gap in observations between 1919 and 1931, we can not determine the nature of this variation.

The period of V3, 7.8 days, is very unusual for a population II cepheid in a globular cluster. This makes it difficult to decide whether it is a 'loop' cepheid or a 'suprahorizontal branch' cepheid, i.e. one which passes through the instability strip on its way to the asymptotic giant branch after the exhaustion of helium in its core (Strom et al.1970). However, the random character of its period fluctuations resembles the variation observed in the 'loop' cepheid V84 in

https://doi.org/10.1017/S0252921100109467 Published online by Cambridge University Press

Messier 5 (Clement and Sawyer Hogg 1977). Furthermore, in Norris and Zinn's (1975) table of luminosities for population II cepheids in globular clusters, there is a gap between 2.16 and 2.43 solar luminosities and V3 belongs to the brighter group. We therefore conclude that V3 is a 'loop' cepheid.

Fig.1 Phase-shift diagrams for the two cepheids in M10:O-C (in fractions of a period) vs. time (in years)



References
Arp, H.C. (1955). Astron.J.60, 1-17.
Arp, H.C. (1957). Astron.J.62, 129-36.
Clement,C. and Sawyer Hogg,H. (1977). J.Roy.Astron.Soc.Can.71, 281-97.
Norris,J. and Zinn,R. (1975). Astrophys.J.202, 335-45.
Sawyer,H.B. (1933). Publ.Amer.Astron.Soc.7, 185-6.
Sawyer,H.B. (1938). David Dunlap Publ.1, 59-68.
Schwarzschild,M. and Harm,R. (1970). Astrophys.J.160, 341.
Strom,S.E.,Strom,K.M.,Rood,R.T.,and Iben,I.Jr. (1970). Astron. and Astrophys.8, 243-50.
Voroshilov,Y.V. (1971). Astron.Circ.623, 7-8.

https://doi.org/10.1017/S0252921100109467 Published online by Cambridge University Press