TWO MID-GIANT BRANCH VARIABLE STARS IN M15

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Abstract. High precision photographic photometry indicates that two stars lying on the giant branch in the C-M diagram of M15 are small amplitude ($\sim$0.2 mag) variables. The two stars are Kustner 64 and 152. This investigation is based on plates taken with three telescopes: the Dominion Astrophysical Observatory 1.8-metre reflector, the David Dunlap 1.9-metre reflector and the Yunnan 1-metre reflector in China. The existing data is not sufficient for period determination.

Introduction

Recently, there has been considerable interest in the possibility of the existence of small amplitude variation in globular cluster stars lying outside the instability strip in the colour-magnitude diagram. Before this conference, a number of these variables were suspected in M15 (Chu 1975 & 1977, Mosley & White 1975, Kraft 1981 and Sandage et al 1981). A systematic study of the globular clusters M3 and M13 was conducted by White (1981) who made photoelectric observations of asymptotic giant branch (AGB) stars brighter than V=14 during three observing seasons. He found that some, but not all, of these stars varied in their apparent light and determined periods ranging from 59 to 225 days for six of the variables in M3. In another investigation, Russeva et al. (1982) found a period of 21 days for an M13 star which lies between the instability strip and the AGB. As a result of these findings, we decided that it would be appropriate to make a systematic study of AGB stars in the globular cluster M15.

Investigation

Our study is based on 19 plates taken with the 1.8-metre reflector of the Dominion Astrophysical Observatory during the years 1932 and 1934, 25 plates taken with the David Dunlap 1.9-metre reflector in 1969 and 1971 and 22 plates taken with the Yunnan 1-metre reflector in 1979, 1981 and 1982. The original purpose was to investigate all the AGB stars with B magnitudes in the range 15.5 to 17.0. Accordingly, from the PDS photometry of Buonanno et al.(1983), we selected about 25 giant stars with B magnitudes in the appropriate range to use as comparison stars. The plates were all measured on a Cuffey iris astrophotometer and the data from the different telescopes were reduced separately using a procedure similar to that of Chu et al.(1982). We did not make any background measurements. Instead we closed the iris diaphragm to the minimum size possible around the stars to avoid background contamination.

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We computed the mean B and its σ for all the stars on each set of plates and found that the σ values for the stars with Kustner (1921) numbers 64 and 152 ($\sigma \cong 0.05$) were greater than for other stars with similar magnitude, colour and position in the cluster (for which $\sigma \simeq 0.03$). A C-M diagram is shown in Figure 1 and our newly suspected variables are indicated as open triangles. For K64, Sandage (1970) gives photographic V=15.27, B-V=0.83, while Buonanno et al (1983) give V=15.22, B-V=0.87 from PDS photometry based on Sandage's photoelectric standards. For K152, Buonanno et al give V=15.24, B-V=0.81, similar to values determined in earlier work on the m_{pg} system. It is therefore clear that neither of these stars lies in the instability strip of the C-M diagram. It is interesting to note, however, that both stars lie near gaps discovered by Sandage et al.(1968) in the giant branch. Cudworth (1976) has found that the membership probability is 99% for both stars. At this stage, it is difficult to determine periods or even the pattern of variation. However, for K64, the David Dunlap observations indicate rapid variation on two consecutive nights in 1969.

Figure 1. Colour-magnitude diagram for M15 plotted from the data of Buonanno et al (1983). The plus signs represent the RR Lyrae variables (Sandage et al 1981). Our new variables K64 and 152 are indicated by the open triangles. Other suspected variables are indicated: open circle (K1082, Chu 1977), the crosses (Sandage et al 1981) and the open square (Fillipenko's variable, Kraft 1981).

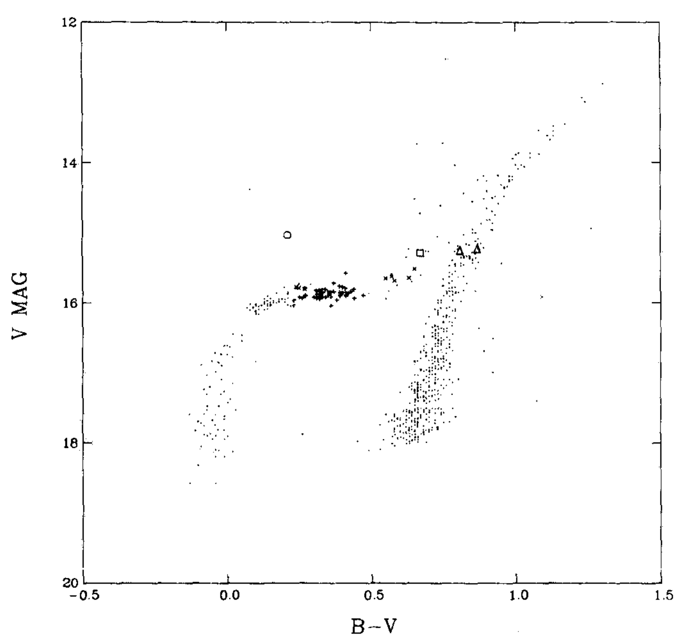

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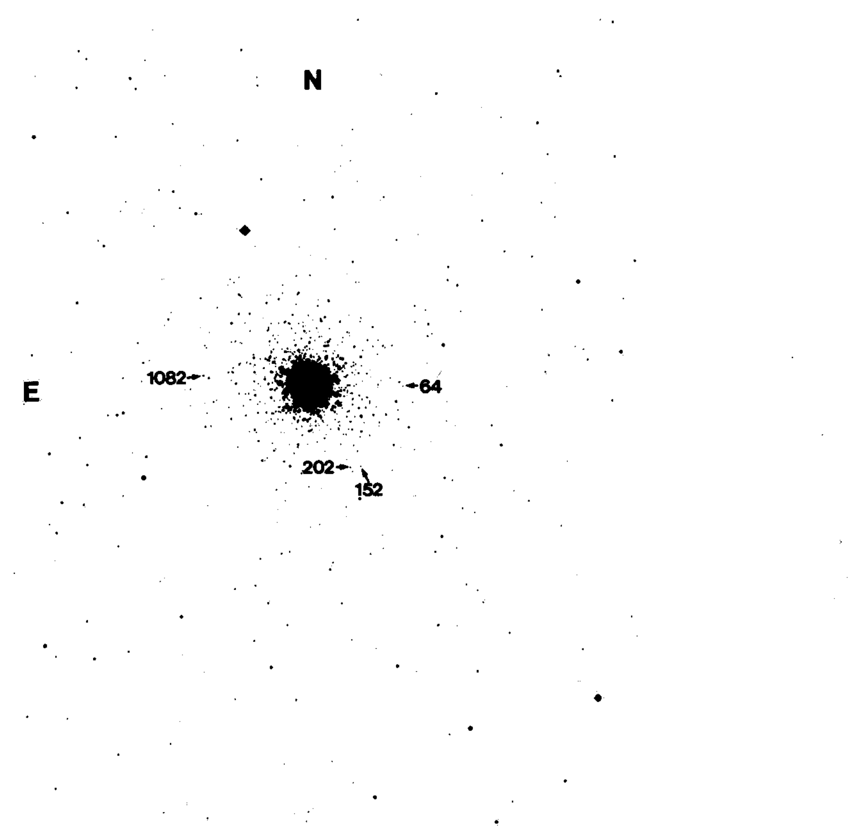
Figure 2, is a print of a plate taken with the Yunnan 1-metre reflector. Our two new suspected variables K64 and K152 are labelled, along with K202 a star we consider to be non-variable. Also indicated is K1082 a a star previously suspected to be a variable by Chu (1977). K1082 has subsequently been studied by Smith et al.(1979) and by Liller & Schommer (1980) who agree that it probably varies. From Figure 2, it can be readily seen that both K64 and K152 lie in uncrowded areas and so we can have confidence in the iris photometry.

Figure 2. A 25 minute exposure of M15 taken with the Yunnan 1-metre reflector on September 19, 1979. Our new variables K64 and 152 are labelled, along with K202, a star we consider to be non-variable (σ_B=0.02). Also indicated is K1082, a variable previously discussed by Chu (1977).



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