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vZ1140 – A NEW UNUSUAL VARIABLE STAR IN M3

vZ1140 (von Zeipel 1908)=II-54 (Sandage 1953) is nearly located at the intersection of the horizontal branch and red giant branch in the C−M diagram of the globular cluster M3 (see Figure 1). The star positions in second of arc relative to the cluster center are: x=75, y=250. The magnitude and colors of this star are V=15.13, B−V=0.75, U−B=0.23 (Johnson and Sandage, 1956). According to Zhukov (1971), the proper motion of the star belongs to Ebbighausen class 3, showing that it is a cluster member.

Here we report the unusual light variation of II-54.

The star was observed by Yao Bao-an and Chen Fu-xiang with the TH-7882 CCD at the Cassegrain focus of the 2.16-meter reflector (f/9) at the Beijing Observatory in March 1993. This detector contains 576×384 pixels (pixel size 23×23 μm) at a scale 0.″244/pixel, thus covering a 2.′43×1.′56 field. Four series of 300-second or 600-second exposures taken in rapid succession over an interval of about 5.0, 4.2, 6.2 and 4.6 hours were obtained on 1993 March 16, 17, 18 and 19 (90 yellow, 5 blue). The seeing was between 1.″3 and 3.″2 (FWHM). After deleting 6 poorly guided exposures, 84 yellow CCD frames were used to analyse the light variation. The star AO (V=14.70, B−V=0.72) (Johnson and Sandage, 1956) was used as the comparison star. It is constant to at least within 0.01 mag by comparing with other stars during the nights we observed. Because the distance between II-54 and AO is only 83.″6 and the difference of B−V is only 0.03, as well as the observations were obtained with the air mass less than 1.3, so the differential extinction correction can be neglected. The CCD frames were reduced by DAOPHOT (Stetson, 1987) in IRAF which is mounted in the Sun 4/65 workstation of Shanghai Observatory. Only the aperture photometry was used because it is not a crowded star field for these stars. Scargle's (1982) modified periodogram was used to analyse the unevenly sampled data. A frequency $\nu_1 \cong 2.93$ was searched out with extremely low false alarm probability. After prewhitened with ν_1, the above procedure was repeated again in order to search for other possible period and a closely spaced frequency $\nu_2 \cong 2.62$ was found with low false alarm probability too. Then Breger's (1991) program PERIOD was used to run nonlinear least squares fitting to improve the values of the frequencies found above simultaneously.

The results so obtained are:

$$m(t) = Zeropoint + \sum_{i=1}^{2} a_i sin(2\pi t/p_i + 2\pi\phi_1)$$

Here P_1=0.^{d}35165, a_1=0.04808, ϕ_1=0.4187,
P_2=0.^{d}35840, a_2=0.04054, ϕ_2=0.2049,
Zeropoint=0.476

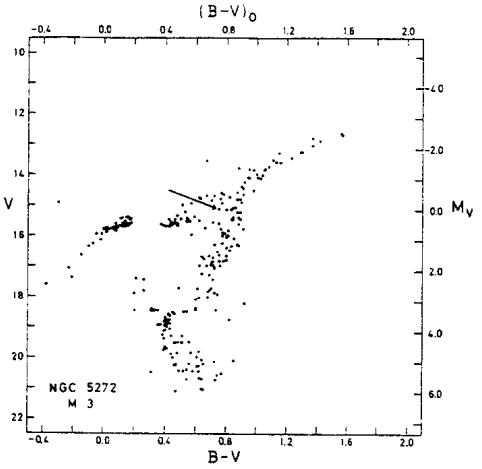

Figure 1

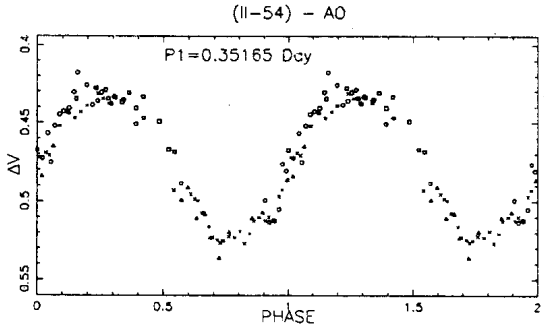

Figure 2

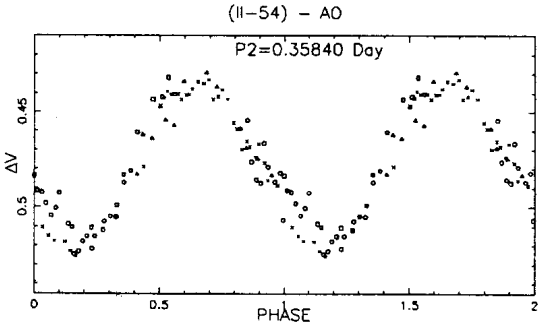

Figure 3

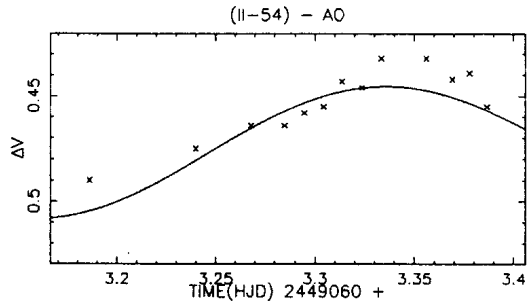

Figure 4

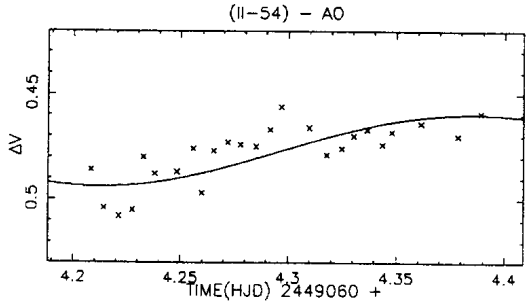

Figure 5

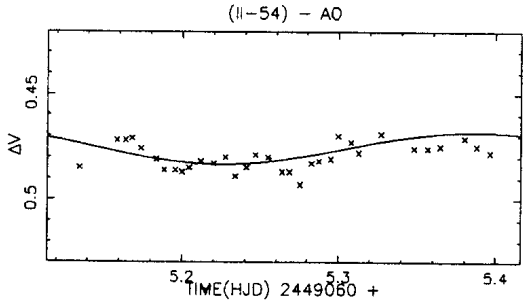

Figure 6

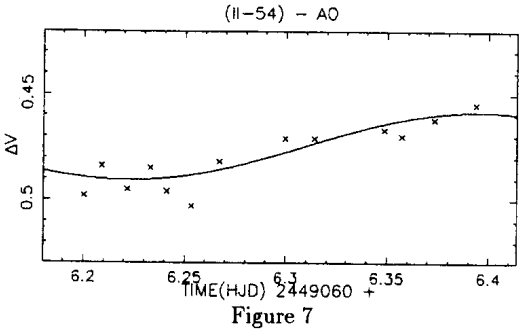

Figure 7

The zeropoint 0.476 represents the mean magnitude difference between II-54 and AO. The folded light curves are given in Figures 2 and 3. Each light curve is plotted with the data prewhitened with the other frequency.

Here the squares refer to observations on 1993 March 16, the circles on March 17, the X's on March 18 and the triangles on March 19. The "real time" light curves are given in Figures 4, 5, 6 and 7 where the continuous curves represent the calculated ones using the formula given above. Time refers to the heliocentric Julian date.

We note that the scatter in the folded light curves in Figures 2 and 3 can be reduced if a third frequency ν_3=3.269 is included with an amplitude of about 0.005 mag. However, a ν_3=6.547 seems to fit the observations too, so we will not include ν_3 into the calculation until more observations are obtained. Obviously, further observations are urged.

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