

VARIABLE STARS IN NGC 4590 *

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Abstract. The globular cluster NGC 4590 has been observed at Haute Provence Observatory (photographic photometry, 80-cm reflector, $F/6$) and at the European Southern Observatory (image-tube, 152-cm reflector, $F/15$).

- A sequence of red magnitudes, m_r ($\lambda_{\text{eff}} \cong 6400 \text{ \AA}$) has been established around the cluster. It comprises 28 stars with magnitudes between 11.66 and 16.50.
- Five new variable stars were discovered in a one square degree field, centered on the cluster.
- Four other variable stars (No. 39, 40, 41, and 42) were discovered in the cluster.

1. Introduction

According to Hogg (1972), 38 variable stars have been discovered in NGC 4590 ($\alpha = 12^{\text{h}}36^{\text{m}}8$; $\delta = -26^{\circ}28'$, 1950) (Shapley, 1919; Hogg, 1939; Rosino and Pietra, 1954; Hogg, 1955; van Agt and Oosterhoff, 1957).

All these variables are RR Lyrae stars (Hogg, 1972), except for FI Hya, which is a field star of type M ($\max_{\text{pg}} = 10.2$, $\min_{\text{pg}} = 17.4$; $P = 324.1 \text{ d.}$, $\text{Sp} = \text{M4e}$).

In 1968 we began photographic observations of NGC 4590 to search for new variable stars.

2. Observations and Measures

I. HAUTE PROVENCE OBSERVATORY OBSERVATIONS

The first photographic observations were begun in 1968 (A.T.) and these were continued in 1970 (A.T., Ch.O.) and 1972 (A.T., B.R.) at the newtonian focus of the 80-cm reflector ($F/6$) in Haute Provence Observatory. These observations were made in the red wavelength range using Kodak 103 aE Plate + RG 1 (2 mm) filter, $\lambda_{\text{eff}} \cong 6400 \text{ \AA}$.

First, we established a red photographic standard sequence in the field of the cluster, and then we searched for new variable stars in the cluster as well as in the surrounding field.

(a) Red Sequence

We have established a new standard red sequence by photometric transfer from SA 61 to the cluster field.

In SA 61, we have used the red magnitudes measured by Yoss (1955). Yoss's red wavelength range is centered on 6200 \AA , which is very similar to ours (6400 \AA).

* Observations made in part at Haute Provence Observatory (C.N.R.S.).

The transfer from one field to the other was made by using 7 independent photometric pairs. We have adopted the process described in a preceding study by Terzan (1965). The new standard m_r sequence in the field of NGC 4590 contains 28 stars in

TABLE I
Sequence of m_r magnitudes near the cluster NGC 4590

No.	m_r	No.	m_r	No.	m_r	No.	m_r
1	11.66:	8	14.00	15	15.04	22	15.94
2	12.36	9	14.02	16	15.16	23	15.99
3	13.10	10	14.24	17	15.24	24	16.14
4	13.29	11	14.38	18	15.38	25	16.27
5	13.51	12	14.56	19	15.51	26	16.36
6	13.70	13	14.66	20	15.66	27	16.39
7	13.85	14	14.86	21	15.80	28	16.50:

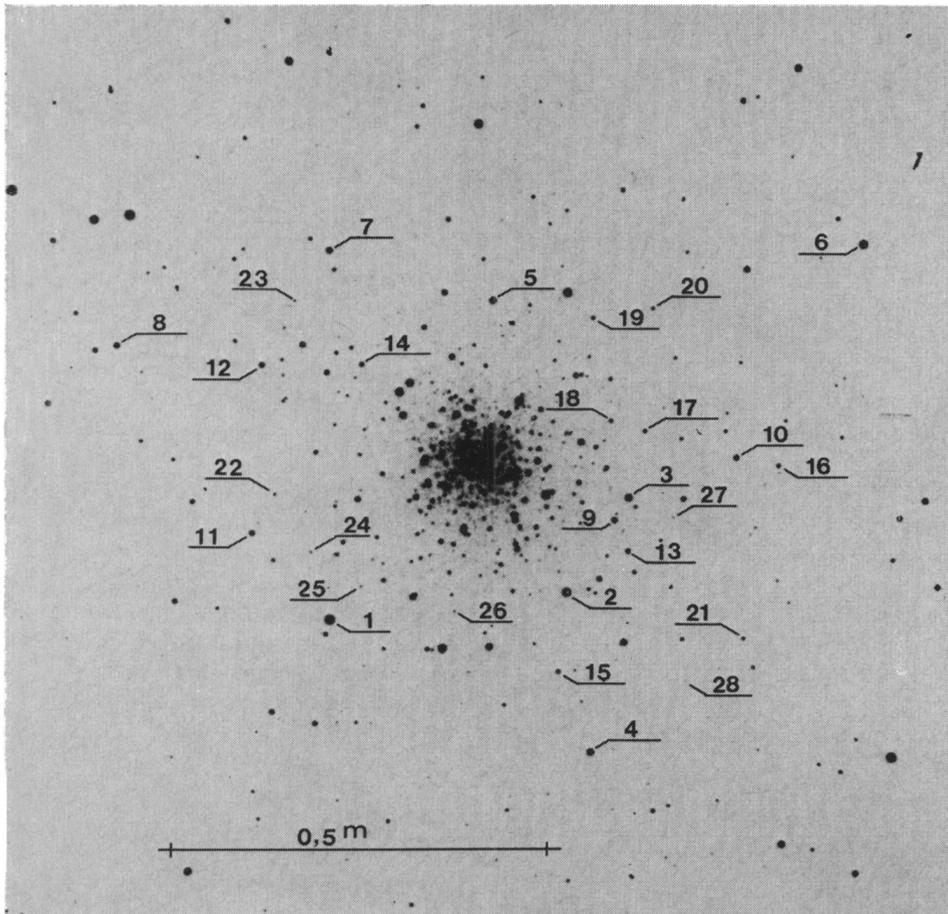


Fig. 1. Identification chart of new standard m_r sequence in the field of NGC 4590.

TABLE II
Positions and magnitudes of five new variables

No.	α	δ	m_r	
			m_1	m_2
1	12 ^h 36 ^m 01 ^s	-26°52'11"	14.8	15.5
2	12 36 19	-26 43 53	15.0	15.4
3	12 36 23	-26 10 40	14.4	14.9
4	12 38 32	-26 22 51	14.6	15.3
5	12 38 36	-26 04 10	15.0	15.7

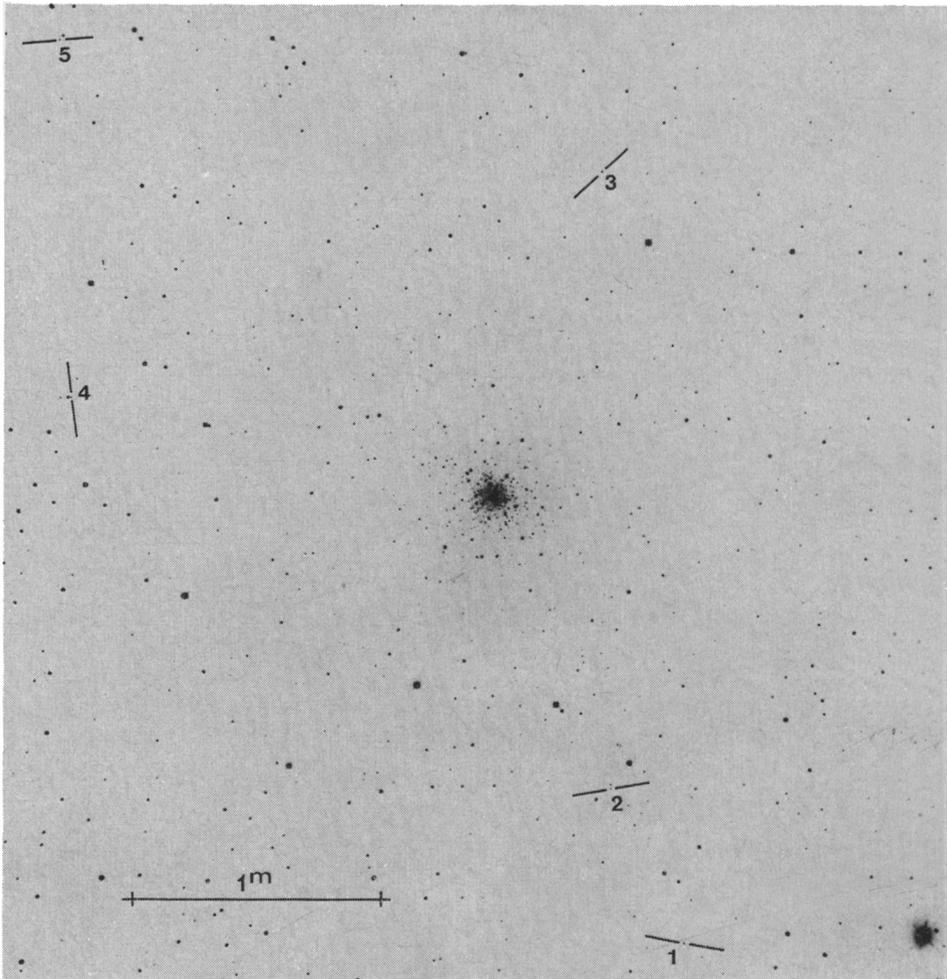


Fig. 2. Identification chart of 5 new variable stars detected near the globular cluster NGC 4590.

the magnitude range 11.66–16.50. The accuracy of our measurements is about ± 0.04 mag. (Table I, Figure 1).

(b) *Search for new Variable Stars*

The search for new variable stars has been made with the blink microscope of the Lyons Observatory. We have not been able to study the central part of the cluster because the resolution on the plates is not sufficient. On the other hand, we have detected 5 new variable stars in a one square degree field centered on the cluster (Figure 2).

We have determined the magnitudes of these five variable stars from 25 plates. Table II contains the equatorial coordinates and the extreme magnitudes m_{r1} and m_{r2} of these stars.

We intend to carry out further studies of these stars to obtain light curves, periods, amplitudes and types of variability.

II. EUROPEAN SOUTHERN OBSERVATORY OBSERVATIONS

In 1972, Terzan made new observations of the cluster with an image tube, attached at the Cassegrain focus of the ESO 152-cm reflector ($F/15$). The image tube characteristics are as follows: ITT type, $F - 4708$, single stage, extended red, S-20. The field observed is circular with a diameter of 6'2 (40 mm).

We obtained two series of plates in the wavelength ranges B and IR:

B = image tube + BG 12 (2 mm) filter, $\lambda_{\text{eff}} \cong 4200 \text{ \AA}$.

IR = image tube + RG 695 (2 mm) filter, $\lambda_{\text{eff}} \cong 7600 \text{ \AA}$.

The observations were made in 1972 (April 14, 15, 17, 18 and 19).

The exposures were less than 20 min in B and 10 min in IR.

With these plates, we have been able to detect 4 more variable stars that are cluster members.

These stars have been numbered 39, 40, 41 and 42 (Figure 3) to add to the list of previously discovered variable stars in this cluster. In Table III, we give the rectangular coordinates (in seconds of arc) calculated by a method used by Hogg in the *Catalogue of Variable Stars in Globular Clusters*.

A preliminary study suggests that these stars are short period ($P < 1\text{d}$) and small amplitude ($< 1\text{mag}$.) variable stars.

We suspect five other possible variables in the cluster, and new observations will enable us to check this.

3. Discussion

These preliminary results display the efficiency of our image tube in the search for variable stars in globular clusters.

Although the plates do not have good photometric quality, they permit us to determine light curves using comparative photometry between the variable star and two other stars of the cluster.

These two comparison stars must be chosen near the variable star and must have a magnitude difference equal to or greater than the amplitude of the variable star.

Moreover, the mean exposure time of each plate is only about 20 min in B and 10 min in IR. Therefore we can get a large number of plates on each night and detect very short period variable stars.

TABLE III
Rectangular coordinates of four new variables

No.	x''	y''
39	-50	-8
40	-1	-52
41	+4	+80
42	-3	+37

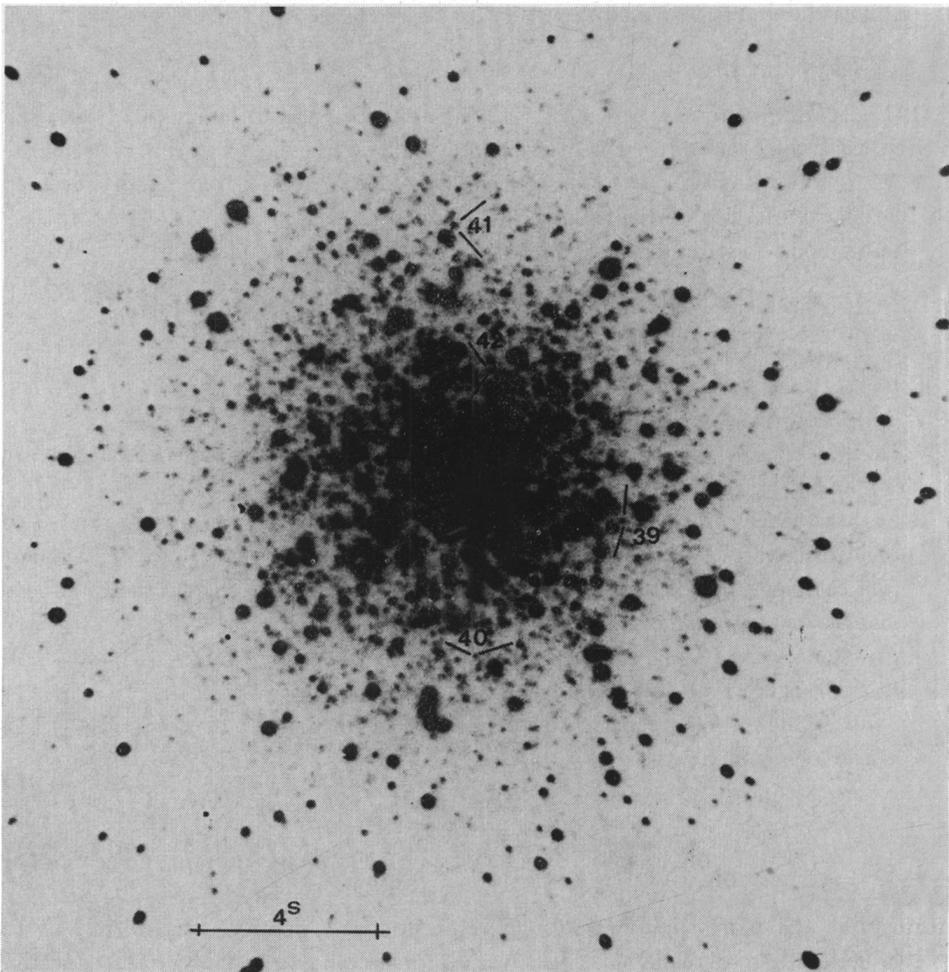


Fig. 3. Identification chart of 4 more variable stars detected in NGC 4590.

Further observations will permit us to continue the search for and the study of new variable stars in NGC 4590, as well as variables in other globular clusters situated or seen projected near the galactic center.

Acknowledgements

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DISCUSSION

Cox: Have you found only nine variables so far?

Terzan: Five other new 'suspected' variable stars have also been detected in the cluster.