

## A. Statistical investigation of pulsating stars.

Seventh paper: *The variables in M 2*

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**Özet :** M 2 yıldız kümeleri birçok Cepheid değişen yıldızlarını ihtiva etmektedir. A 2 değerlerinin dağılımı ayrı bir özellik gösterir. Küme değişenleri ile noktaların çoğu a 2 seviyesi üzerindedir. M 2 deki Cepheidlerin A 2 değerleri sistematik olarak diğer kümelerde bulunan Cepheidlerinkinden büyüktür.

\* \* \*

**Abstract :** The cluster M 2 contains several Cepheid variables. The distribution of the values A (2) is peculiar. With the cluster type variable nearly all points are on the level a 2. With the Cepheid variables in this cluster the values A (2) seem to be considerably larger than with the Cepheids in other clusters.

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The globular cluster M 2 does not contain a very large number of variable stars, but among its variables several Cepheids occur. As for the Cepheids in clusters out dates are still very incomplete, M 2 has been included into our program. The elements and the shape of the light curves of seventeen variables in the cluster have been given by *H. B. Sawyer*[1].

In the present investigation two of these stars were excluded. Of these the first is N 11, Chevremont variable, which has a very unusual shape and for which there are large deviations between the fotografic and visual light curves. The second is the variable No. 2, which is the component of a binary system and for which according to *H. B. Sawyer* the estimates of the magnitude are strongly affected by the light of the companion.

This leaves us the fifteen systems which are enumerated in table 1. In this table the variables are arranged according to

increasing periods. The values  $\pi(1)$ ;  $A(2)$ ;  $A(3)$  and  $A(4)$ , which appear in the table, were computed in the usual way. It should be observed that with some of the light curves given by *H. B. Sawyer*, the scatter of the individual observed point is considerable so that it is difficult to draw a wholly satisfactory mean light curve. This is especially the case with the variables Nos. 10, 4, 1, 5 and 9, and consequently in the table the corresponding values have been indicated as uncertain.

For the variable N 15, the value  $A(2)$  which is obtained, seems to indicate that the variable belongs to Bailey's subtype *c* and this result is supported by the small amplitude of the observed light curve.

With variable N 10, the scatter of the individual points is such, that one might suspect it to be an irregular variable. Its period is such, that it falls into the interval in which the irregular variables occur. Moreover the value  $A(2)$  which is obtained for this variable, strongly points in the same direction. In the table I have therefore indicated N 10 as a possible irregular variable of the R. W. Dra type.

With variable No. 4 there also occurs a large scatter of the individual points, but for the rest it seems normal. Still, I have thought it better to indicate it in the table as being uncertain.

The variables 1, 5 and 6 are cluster type Cepheids and therefore statistically important. Still I feel compelled to indicate the results of our present analysis as being uncertain. There is no uncertainty about the periods, but with our method of analysis it is necessary that over the whole range of the period the shape of the mean light curve is well determined. But with the variables 1, 5 and 6 there clearly remains some ambiguity as how to draw the mean light curve around maximum and minimum light. Evidently using the general information which is available about the shape of the light curves of these periods it is possible to draw a fairly satisfactory curve, but then this curve cannot be considered to represent an independent observation.

Figure 1 shows a plot of the tabulated individual values  $A(2)$  against the corresponding values  $\log P$ . The dotted lines in the figure indicate the provisionally adopted sublevels  $c_1$ ,  $c_2$ ,  $c_3$ ,

a 1 and a 2. With the periods  $P \geq 1$  day in order to make a comparison possible in the figure there have also been indica-

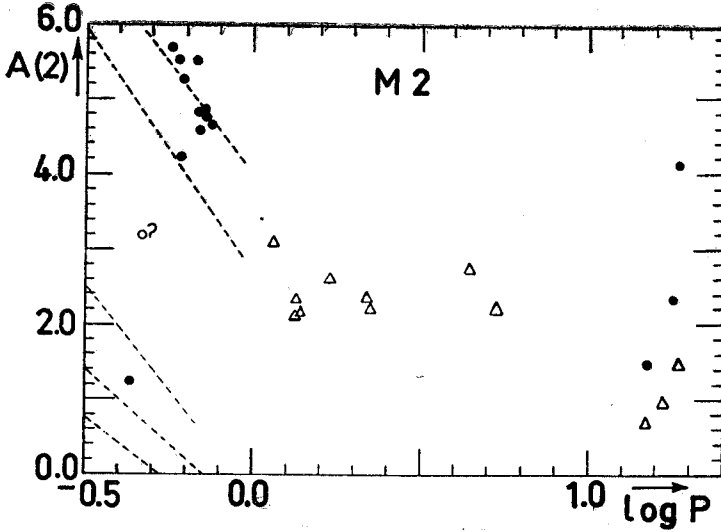


Fig. 1

ted all  $\delta$  Cepheï stars analysed in previous papers (first and sixth paper of this series).

TABLE 1  
Variable stars in M 2

No.	log P	$\pi$ (1)	A (2)	A (3)	A (4)	Remarks
15	0.633-1	0.963	.112	.071	.033	
10	.669-1	.895	.310	.134	.055	irr ?
4	.751-1	.683	.569	.253	.170	uncertain
7	.774-1	.666	.552	.285	.195	
9	.785-1	.880	.414	.200	.100	
3	.792-1	.687	.526	.324	.195	
17	.804-1	.717	.559	.287	.122	
8	.809-1	.786	.457	.324	.118	
16	.817-1	.737	.483	.300	.192	
12	.824-1	.733	.485	.247	.195	
14	.841-1	.719	.482	.297	.170	
13	.849-1	.686	.469	.272	.217	
1	1.193	.981	.152	.118	.089	uncertain
5	1.245	.927	.287	.118	.089	uncertain
6	1.286	.885	.414	.180	.033	uncertain

From the figure it appears that in the cluster M 2 the distribution of the individual points largely deviates from the ones obtained previously. In this case the variables with short periods are almost exclusively on the sublevel  $a_2$ . As already mentioned previously, one of these variables (N 15) may be of type  $c$ , but as the results of our analysis are uncertain, it is doubtful whether it is on the sublevel  $c_1$  or  $c_3$ .

Variable 10, which also has previously been mentioned, falls between the levels  $c$  and  $a$  and its position in the diagram exactly coincides with the area occupied by the irregular systems. Consequently there can hardly be any doubt that this variable also should be classified as being of the R. W. Dra type, but *H. B. Sawyer* does not especially classify it as such. For the rest the sublevels  $c_2$ ,  $c_1$ ,  $c_3$  and  $a_1$  are conspicuously devoid of stars. From figure 1 it appears further that in M 2 the distribution of the points representing the  $\delta$  Cepheids in this cluster, deviates from the corresponding distribution in the other clusters. In M (2) the values  $A(2)$  are systematically larger than in those other clusters. As remarked before and as indicated in the table, the numerical values obtained from the analysis are subject to some doubt, because there is some ambiguity in the way the mean light curve must be drawn. On the other hand the differences are so large, that I suspect part of the effect at least to be real.

### Literature

Sawyer, H. B.: *Dom. Astr. Obs. Victoria*, 6, 279, 1935

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January, 1956. E. A. Kreiken