A statistical study of pulsating stars

Fourth paper: *The variables in Messier 3*

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Özet : M3 değişen yıldız sisteminin kırk yıldızı tetkik edilmiştir. Neticeler tabloda verilmiş ve grafikle de şekilde gösterilmiştir.

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Abstract: Of the variable systems M3, fourty are analysed. The results are given in the table and are graphically represented in the figure.

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The variable stars in M 3 have extensively been studied by Bailey[1], Laring[2], Müller[3], Slavenas[4], Greenstein[5], Martin[6] and Hett[7]. In the present paper for the outer regions of the globular cluster I have used the normal curves as given by Hett[7]. For the central parts of the cluster the normal curves as given by Greenstein[5] were used, but I have excluded all systems for which Martin[6] cites improved periods.

The variables were analysed by the same method as used in the previous papers, viz. by the autocorrelation method and subsequent power series analysis. The symbols used for indicating the results also are identical to those used before. With M 3 also no attempt has been made to attain completeness. The systems to be analysed were chosen in such a way that all periods are represented. The variables of both the shortest and the longest periods were nearly all analysed and so were the systems near the transition from the subtype *c* to subtypes *a* and *b*. The systems which were analysed are enumerated in table 1. In this table the variables are arranged in order of increasing pe-

TABLE 1.

Variable stars in M 3 analysed in the present paper.

No.	log P	type	π(1)	A(2)	A(3)	A(4)	Ref.	Remarks
105	0.461—1	—	0 984	0.110	0.000	0.000	G	
86	0.467—1	*c*	.928	.257	.122	.063	H	
107	.490—1	*c*	.950	.164	.158	.055	H	
75	.497—1	*c*	.979	.127	.000	·032	G	
12	.502—1	*c*	.963	.130	.105	.063	G	
37	.514—1	*c*	.966	.164	.158	.055	H	
70	.515—1	*c*	985	.045	.032	.045	G	
56	.518—1	*c*	.960	.130	.118	.032	H	
97	.524—1	*c*	992	.071	.031	.031	H	
126	.542—1	*c*	.950	.032	.134	.118	G	
125	.544—1	*c*	.987	.078	.000	.032	H	
85	.551—1	*c*	.943	.212	.114	.063	H	
72	.659—1	—	.748	.440	.266	.216	H	
20	.691—1	—	.831	.333	.245	.071	H	irr.
118	.698—1	—	.717	505	.290	.145	H	
92	.702—1	—	.752	.429	.317	.128	H	irr.
50	.710—1	—	.849	.356	.245	.241	H	irr.
119	.714—1		.709	.475	.305	.235	H	
33	.721—1		.909	.276	.148	.000	G	irr.
81	.724—1		.717	.429	.297	.202	H	
45	.730—1		.742	.465	.259	.192	H	
80	.731—1		.743	.405	.300	.179	H	
89	.739—1		.775	.411	.263	.148	G	
40	.741—1		.628	.589	.405	.200	H	
38	.747—1		.788	.471	.148	.100	G	irr.
67	.754—1		.783	.444	.177	.095	G	irr.
63	.756—1		.603	.602	.389	.200	H	
17	.760—1		.882	.321	.212	.192	H	irr.
51	.766—1		.639	.569	.345	.243	H	
39	.769—1		.734	.455	.565	.202	H	
59	.769—1		.730	.407	.327	.212	H	
23	.775—1		.701	.506	.307	.184	H	
117	.778—1		.801	.400	.245	.110	H	
93	.780—1		.716	.517	.270	.077	H	
64	.782—1		.721	.498	.263	.141	H	
24	.804—1		.717	.452	.285	.170	G	
120	.806—1		.812	.387	.045	.145	H	
62	.814—1		.694	.471	.358	·230	H	
65	.824—1		.730	.409	.310	.126	H	
59	2.000:		.726:	.577:	.161:	.110:	G	uncertain

riod. The number in the first column by which the variable is indicated refers to the lists of Bailey, Greenstein, Hett a.o. The second column contains the logarithm of the period, while the third gives the Bailey subtype.

Only in a limited number of cases has this Bailey subtype been stated by Martin. The next columns contain the results of our present analysis e.g. the numerical values of $\pi(1)$; A(2); A(3) and A(4). In column 8 I have indicated whether for this analysis the normal curve given by Hett[7] or the one given by Greenstein[5] was used.

The final column contains remarks about the individual systems. The indications "irregular" were borrowed from Martin[6].

The cluster M 3 contains some variables of longer period viz. the Nos. 95 and 154. For the variables No. 95 Greenstein finds a period of about 100 days.

The last entry of our table gives the results of the present analysis of the light curve, but as the light curve is poorly determined, these numerical values are highly problematic.

The variable 154 seems to be a normal δ Cephei star of period 15 d, 7677 but as no good light curve is available, it had to be omitted from our present analysis and therefore does not appear in table 1.

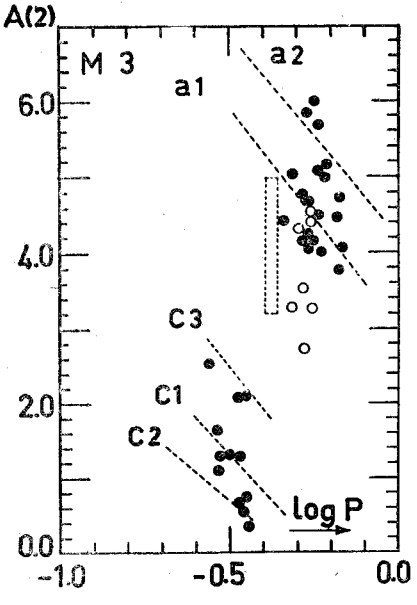

Fig. 1.

The results of our analysis are graphically represented in fig. 1, where the values A(2) are plotted against the corresponding logarithm of the period. The sublevels c_1, c_2, c_3, a_1 and a_2 which were provisionally adopted in ω Centauri, are indicated by dotted lines.

The elongated vertical rectangle indicates the range over which the A(2) value of the system A. R. Her. oscillates in the correlation plane,

according to the analysis of the curves determined by Balász and Detre[8].

In the figure the different variables are indicated by black dots, but for the irregular variables open circles have been used. The range in log P and A(2) of the variable stars in M 3 coincides with the corresponding ranges in ω Cen and M 5.

The distribution of the dots in the diagram for M 3 seems to be intermediate between those of ω Cen and M5, but more closely resembles that of ω Cen. All the three sublevels c_1 seem to be present and also the two sublevels a_1 and a_2.

However, just as with ω Cen and M5, the distinction between the sublevels a_1 and a_2 is rather vague. In M 3 the extension towards the longer periods is rather short, which is only partly due to the fact that the two long period variables had to be omitted.

Literature

[1] Bailey, J.: Harv. Ann. **78**, 3, 1913
[2] Laring, E.: Astr. Gbh Bergedorf, **2**, 6, 1921
[3] Müller, H.: Veröff. Berlin-Babelsberg, **11**, 1, 1933
[4] Slavenas, P.: A. N. **240**, 169, 1930
[5] Greenstein, Jesse L.: A. N. **257**, 301, 1935
[6] Martin, W. C.: Ap. J. **95**, 314, 1942
[7] Hett, J. H.: A. J. **50**, 77, 1942
[8] Balász, J. and Detre, L.: Mitteilungen Sternwarte Budapest, **8**, 1939

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December 1955.
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