A statistical study of pulsating stars.

Second paper: *The irregular variable A.R. Her*

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Özet: Gayrımuntazam değişen küme tipi yıldız A. R. Her nin ışık eğrisine ait tam bir çalışma J. Balâsz ve L. Detre tarafından yapılmıştır. Bu yazarlar tarafından neşredilen ışık eğrisi otokorelasyon fonksiyonu ve müteakip kuvvet serileri metodu ile tetkik edilmiştir. Log P: A(2) diagramında değişken gayrımuntazam değişen sistemlerin normal kısmına düşer, fakat ışık eğrisinin seküler değişimi esnasında A(2) noktası korelasyon düzleminde aşağı yukarı yer değiştirir.

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Abstract: A very complete study of the light curve of the irregular cluster type star A. R. Her has been made by J. Balâsz and L. Detre. The light curves published by these authors have been analysed by the method of the autocorrelation function and subsequent power series. In the diagram log P: A(2), the variable falls in the normal region of the irregular systems, but during the secular changes of the light curve the point A(2) shifts up and down in the correlation plane.

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In the present paper we have anaysed the light curves of the irregular variable A. R. Her ($P = 0^d.4700$). The method used in this article has been exposed in the first paper of this series and all notations used here are identical to those used in the first paper. The light variations of A. P. Her. have been very carefully studied by J. Balâsz and L. Detre[1]. They find the main period to be 0.4700 days, but the light curve varies from one period to the other. This secondary variation also is periodic and a full cycle is 67 times longer than one single period and therefore is equal to $31^d.5$. Denoting the main period by φ and the longer secondary period by ψ, their results have been compiled by L. Balâsz and L. Detre in a double tabulation, which gives the shape of the light curve φ for different phases of ψ viz. $\psi = 0.00; 0.05; 0.10 \cdots 0.95$. They also give a mean light curve based on all observations together. For details and for a discussion of the way the complicated shape of the light curve might be explained, the authors refer to the study of Balâsz and Detre.

The authors of this paper have used the tables 4 and 5 of Balâsz and Detre, (1. c. pages 14 and 16) to determine the values $\pi(f)$ and $A(f)$, both for the mean light curve and the different curves φ corresponding to the different values in the phase of ψ.

The results are entered in the following table. For an explanation of the symbols $\pi(1)$, A(2), A(3) and A(4) we refer to the first paper of this series. The column under the reading ψ indicates the phase of the secular period. $\overline{\psi}$ denotes the mean curve.

TABLE

The values of π (1); A(2); A(3); and A(4) for different phases
The logarithm of the period of A. R. Her is log P = 0.672-1

ψ	π (1)	A(2)	A(3)	A(4)	ψ	π (1)	A(2)	A(3)	A(4)
0.00	0,812	0.402	0.190	0.105	0.50	0.766	0.488	0.247	0,095
0 05	.836	.407	134	.071	0.55	.778	.446	.232	.161
0.10	.862	.370	.100	.032	0.60	.779	.386	.217	.095
0 15	.871	.355	.145	.000	0.65	777	.415	283	.130
0.20	.879	.331	.110	.042	0.70	.822	.362	237	.134
0.25	.829	.395	.187	.063	0.75	770	.434	.245	.179
0 30	.786	.428	.195	.152	0 80	801	.395	.257	.122
0 35	.762	.498	245	.145	0.85	.771	.462	.211	.148
0.40	.801	.429	.141	.114	0 90	.767	439	.230	161
0.45	.736	.423	.290	.161	0.95	.825	.361	.155	.134
					$\overline{\psi}$	.837	.493	.141	.110

The values of the table are graphically represented in figures 1 and 2. In fig. 1 the values A(2), A(3) and A(4) are plotted against the phase ψ. The values A(2) are represented by black dots, the values A(3) by open circles, while open squares are used for indicating the values A(4). Owing to their smallness, the values A(4) are not very reliable.

Through the different points smooth curves were drawn, which therefore represent the mean variation of A(2), A(3) and A(4) through a complete cycle. There is a certain scatter of the individual points around these curves. This scatter may be attributed to the uncertainties in the determination of the different parameters.

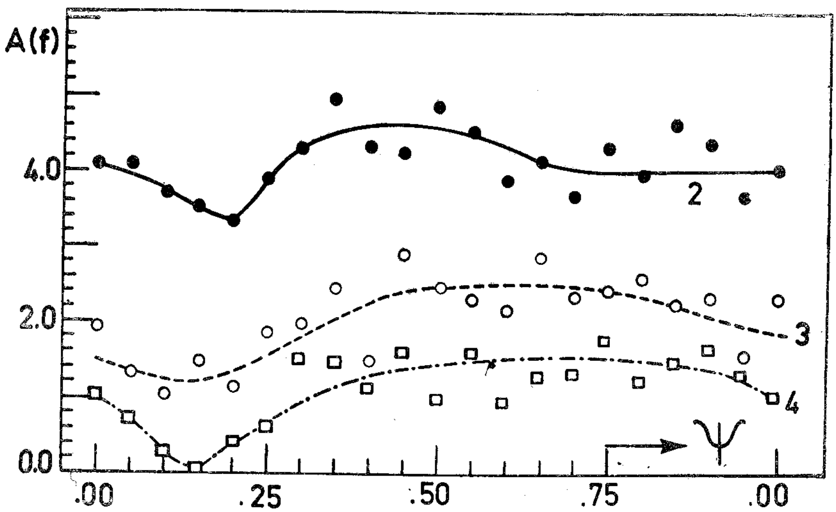

Fig. 1.

For the curve A(2) the scatter is rather large for the higher values of ψ and here the scape of the curve may be subject to some doubt. There is an indication of a secondary maximum, but as its existance is not confirmed by the curves A(3) and A(4), the A(1) curve has been drawn here as almost a straight line. All curves show a minimum near $\psi = 0.20$ and a very flat maximum around $\psi = 0.50$, but the exact position of the maximum is difficult to indicate. The three curves seem to be very nearly synchroon, though as compared with A(2) the curves A(3) and A(4) may have a small lag in the phase.

This impression is mainly due on the position of the minimum, but such a lag is not apparent with the position of the maxima. Anyhow, from fig. 1 it is seen that from our method of analysis also, it is at once evident that the shape of the light curve systematically varies from one period to the other.

Figure 2 represents part of the figure of the first paper in this series, where for the individual systems the values A(2) were plotted against the corresponding values log P. However, the points indicating the individual stars were omitted.

It was found that the points indicating the *c* type variables were arranged according to a certain level which was quite different from the level of the *a* and *b* type variables. Also there were indications that each of these two main levels consists cut of several sublevels. Provisionally the two groups of possible sublevels were designated as the levels c_1, c_2, c_3 and a_1, a_2 respectively. These provisional sublevels are indicated in fig. 2.

The broad vertical line at $\log P = 0.672 - 1$ indicates over what range for A. R. Her the parameter A(2) moves up and down in the diagram. The smaller horizontal bar indicates the value A(2) corresponding to the mean curve. With the variables in ω Cent. it was found that those designated as irregular, were confined to a small area of the correlation plane at the upper end of sublevel a_1.

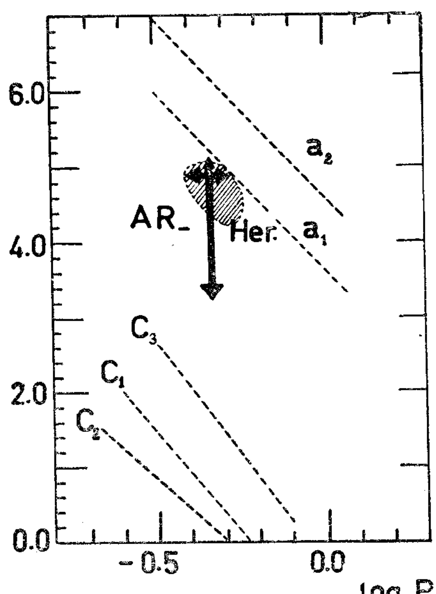

Fig. 2.

In fig. 2 this area has been shaded.

From the figure it is evident that the value A(2) corresponding to $\bar{\psi}$ is right in the shaded area and that therefore A. R. Her and the irregular variables in ω Cent. are of one and the same class. At the same time it is apparent that temporarily at least the value A(2) moves outside of the shaded area. For the other irregular variables the variations of A(2) hate not as yet been studied, but it seems possible that with the other systems also A(2) may not remain a constant, but moves up and down in the diagram.

If for A. R. Her. only one part of the light curve had been analysed, covering say only one or two periods of φ, the point representing A. R. Her, might be any point on the thick vertical line. But if the A(2) corresponding to other irregular systems move in the same way, the same will be true for these other systems. Consequently if for these other systems only a few periods are completely observed, the analysis of the curve may yield a point, which is shifted in downwards direction. Obviously the result would be an apparent broadening of the level a_1, especially at the upper end and in downward direction. From the results obtained, both from the mean curve of A. R. Her and of the mean curves of the irregular variables in ω Cen. we are inclined to think that the values A(2) derived from the mean curves will have no large scatter.

A few additional words should be said about the character of the irregularities. Balàsz and Detre (1. c.) state that the shape of the light curve is irregular and varies between those of the Bailey subtypes *a* and *b*.

The results given by the present method of analysis must be stated in a slightly different way. In the mean the light curve resembles that of the sublevel a_1, which mainly contains the irregular type *a* systems and *b* type systems. During the secular variation it partly moves over to the subtype c_3 but never reaches this sublevel. At its lowest point it has covered about 2/3 of the distance between a_1 and c_3.

It is too early to say whether systems like A. R. Her. and other irregular systems indicate a certain transition from type *c* to *b*, but this might be a reasonable explanation. By the study of other similar systems we hope to be able to clarify this point.

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[1] Balàsz J. and Detre 4: Mitteilungen Sterres. Budapest 8, 1939