ΑΣΤΡΟΝΟΜΙΑ.— **On the irregularities of period of S Bootis and R Camelopardalis***, *by* ***S. Plakidis*** Ἀνεκοινώθη ὑπὸ κ. Δ. Αἰγινήτου.

This paper is a continuation of an investigation on the irregularities of period of long-period variable stars. Nineteen such stars have already been investigated on the basis of a new method of mathematical analysis and two more are now added to the list. An account of the method in question, as it was applied on o Ceti and χ Cygni, may be found in a previous paper (M. N. *90*, 65, 1929) which was communicated in association with Professor Sir A. S. Eddington. A second paper summarising my conclusions as far as the remaining seventeen variable stars are concerned has appeared in M. N. *92*, 460, 1932[1].

The two stars which are now under consideration are those discussed by Mr. W. F. H. Waterfield (H. B. 880, 1930) in connection with changes of their periods. From the periodograms which he obtained by plotting the residuals of maxima against the epochs Mr. Waterfield draws the following conclusions:

a) In the case of S Bootis a change of period has taken place on two occasions, the first at about epoch 25, and the second at about epoch 60. Perhaps another such change is due in the near future, but this prediction will be proved or disproved by the next few maxima. At present it is beyond one's power to formulate any periodicity in the change of period of this star, but if any such exists, the next change of period should take place at or about epoch 95.

b) With regard to R Camelopardalis it seems evident from the plot that any attempt at present to explain the period changes of this star by a sine term is doomed to failure.

Having under consideration the classification of the possible types of irregularities of period, as it is given in the first of the above papers, I proceeded to determine the type of irregularity involved in the present case.

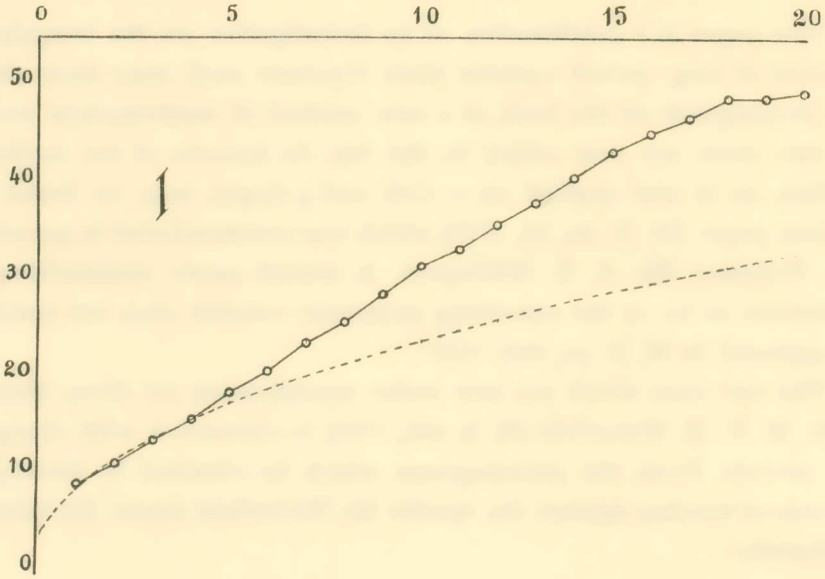
The results obtained by the application of the analysis mentioned above are summarised as follows:

By means of the residuals (O—C) derived by Mr. Waterfield through a

* Σ. ΠΛΑΚΙΔΟΥ. — Περὶ τῶν ἀνωμαλιῶν τῆς περιόδου τῶν S Βοώτου καὶ R Καμηλοπαρδάλεως.

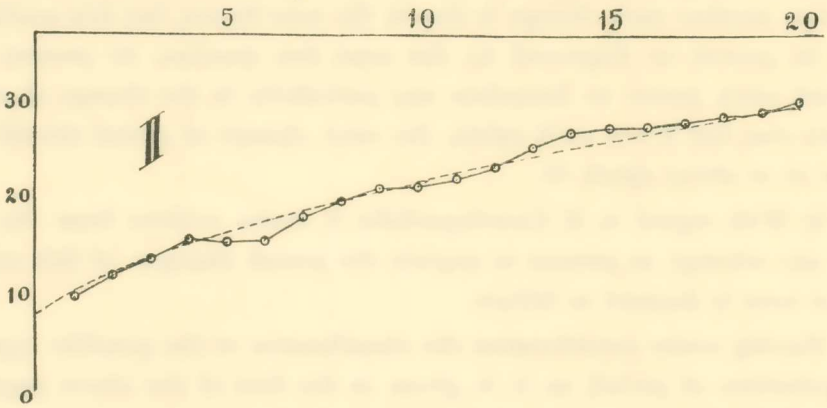
[1] See also: *Praktika de l'Akadémie d'Athènes*, **5**, 1930, p. 12 and *Annales de l'Obs. N. d'Athènes*, **12**, p. 36.

constant period of $269^d.9$ and $271^d.1$ for S Bootis and R Camelopardalis respectively I calculated the values of the $\bar{u}_x$ for these two stars. Plotting



S Bootis.

these values as ordinates against the values of x=1,2,3,...,20 as abscissae



R Camelopardalis.

I obtained the respective brocken curves I and II. The smooth curves represent the best fit with the theoretical formula:

$$\bar{u}_x = \sqrt{2\alpha^2 + x\epsilon^2},$$

in which the constants α and ϵ are:

For S Bootis	$\alpha = 1.^d90$	$\epsilon = 7.^d28$
For R Camelopard.	$\alpha = 5.\ 89$	$\epsilon = 6.\ 40$

As it is evident from the close fit of the theoretical curves with the left-hand part of the respective curves of the observed $\bar{u}_x$, the irregularities of the periods of the stars in question follow the law of accidental and independent errors, being combinations of permanent with temporary irregularities.

This is proved also by the negative values of the correlation coefficients:

$$r_x = \frac{\epsilon_s \, \epsilon_{s+x}}{\epsilon^2}$$

given in the following table:

VALUES OF r_x

r_x	S Boo	R Cam	r_x	S Boo	R Cam
r_1	− 0,06	− 0,23	r_{11}	+ 0,10	+ 0,02
r_2	+ 0,09	− 0,04	r_{12}	− 0,16	+ 0,05
r_3	− 0,21	− 0,07	r_{13}	+ 0,27	− 0,11
r_4	+ 0,07	− 0,05	r_{14}	− 0,01	− 0,02
r_5	+ 0,03	+ 0,01	r_{15}	+ 0,08	+ 0,06
r_6	− 0,01	+ 0,14	r_{16}	− 0,23	− 0,22
r_7	+ 0,23	+ 0,04	r_{17}	− 0,01	+ 0,02
r_8	+ 0,09	+ 0,01	r_{18}	− 0,15	+ 0,01
r_9	+ 0,21	+ 0,04	r_{19}	+ 0,10	+ 0,03
r_{10}	− 0,04	− 0,08	r_{20}	+ 0,22	+ 0,04

For reasons already explained in the case of o Ceti I am inclined to think that the sinuosities of the $\bar{u}_x$ curve for R Camelopardalis are rather spurious and may be assigned either to gaps in the list of the observed maxima or to the accidental errors committed in fixing the date of maximum.

The above values of the constants α and ϵ are in favour of the conclusions arrived at in my last investigation, viz.:

a) The flatness of the light-curve about maximum is here again to be held responsible for the high values of α. According to Müller and Hartwig[1], as far as light-curves are concerned, S Bootis belongs to the most regular variables of the Mira type, while R Camelopardalis shows all the peculiarities of the stars of the same type, some of its maxima being sharp and some so flat that their determination is liable to considerable error. Moreover, some abnormal ascents of the light-curve of this star combined with the great difference between the various observers in fixing the maximum are to be considered as entailing the great deviation of the dates of the observed maxima from those derived through a constant period. All these features account very well for the stronger value of the constant α in the case of R Camelopardalis compared with S Bootis.

b) Also for both these stars the ϵ terms are nearly in the same proportion as their periods, viz. the average deviation of an individual

[1] Geschichte und Literatur der veränd. Sterne, **1**, 382 und 387.

period of S Bootis from the mean is 2·7 per cent., while that of R Camelopardalis is 2·4 per cent.

The fact that there is no clear indication of the existance of some re'ation between the constant α and the period, or between the range of light fluctuation and the constants α and ε is again confirmed by the present case.

As a summary it may be added that the periodicity of the irregularity of period as shown by the periodograms of Mr. Waterfield does not seem to be supported by our analysis. The whole irregularity of both stars consists rather of a purely accidental fluctuation of period combined with a purely accidental fluctuation of phase. In other words, both these stars may be classed among those of the normal pattern, the mean deviation from their mean period being less than 3 per cent., and the deviation of their phase being comprised within the limits of range already found for the other stars, viz. between one and eight days.

ΠΕΡΙΛΗΨΙΣ

Ἡ ἀνωμαλία τῆς περιόδου τῶν δύο μεταβλητῶν ἀστέρων *S Βοώτου* καὶ *R Καμηλοπαρδάλεως* δὲν ἔχει περιοδικὸν χαρακτῆρα, ἀλλ' ἀκολουθεῖ τὸν νόμον τῶν τυχαίων σφαλμάτων, ἀποτελοῦσα συνδυασμὸν τυχαίων κυμάνσεων τῆς περιόδου καὶ τῆς φάσεως. Αἱ εἰς προγενεστέρας ἐρεύνας ἡμῶν ἐπὶ 19 ἄλλων μεταβλητῶν ἀστέρων εὑρεθεῖσαι σχέσεις μεταξὺ τῆς μέσης περιόδου καὶ τῆς μέσης ἐκτροπῆς αὐτῆς, ὡς καὶ ἡ ἐξάρτησις τῆς μέσης ἐκτροπῆς τῆς φάσεως ἐκ τῆς πλατύνσεως τῆς καμπύλης φωτὸς περὶ τὸ μέγιστον τῆς λάμψεως ἐπιβεβαιοῦνται καὶ ἐνταῦθα.

Κ. Α. Κς