New observations and improved elements for twenty variable stars in or near the constellation Scutum

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New observations and improved elements for twenty variable stars in or near the constellation Scutum, by *P. Th. Oosterhoff.*

The first results of an investigation of the Scutum region for variable stars have been published in *B.A.N.* No. 355. During the course of this work several known variables have been rediscovered in the blink comparator. Some of these stars have been the subject of extensive study by different authors, but others have been less completely observed, whereas for some of them nothing is known besides the fact of variability. It was therefore decided that all variables which were found in the blink comparator should be estimated on the plate material, available at the Leiden Observatory, which has been fully described in *B.A.N.* No. 355. In the present article the results for twenty known variables are discussed.

TABLE 1.

variable	α (1855)	δ (1855)	type	period	m.e. in last decimal place	reciprocal period	J.D. of epoch −2420000	number of observations	m.e. of one observation	brightness at maximum	brightness at minimum
	h m s	° ′		d		d^{-1}	d		s	s m	s m
UZ Sct	18 23 12	−13 1·5	δ Cep	14·7442	±10	·0678233	7975·9 *	87	±·74	2·4 12·0	9·8 13·2
VX Sct	18 25 53	−12 1·3	Algol	33·623	4	·029743	7926·6	224	·59	2·7 13·6	5·6 14·2
Y Sct	18 30 9	− 8 29·3	δ Cep	10·341486	20	·0966988	8380·25 *	273	·63	2·0 10·6	9·1 11·8
XY Sct [1]	18 33 20	− 6 12·4	W UMa	·7852563	18	2·546934	8729·5293	269	·82	·6 13·8	4·9 14·5
RU Sct	18 34 17	− 4 14·7	δ Cep	19·69781 [2]	11	·05076	3236·0 *	272	·66	1·5 10·5	12·0 11·9
TY Sct	18 34 27	− 4 25·6	δ Cep	11·05302	24	·090474	8755·4 *	237	·67	·4 11·4	9·3 13·0
Z Sct	18 35 12	− 5 57·5	δ Cep	12·90165	7	·077509	7964·2 *	316	·65	-- ·8 10·4	8·0 12·1
SS Sct	18 35 52	− 7 52·2	δ Cep	3·671253	16	·27239166	8538·55 *	317	·84	−4·3 8·9	− ·1 9·8
AC Sct	18 38 1	−10 23·8	Algol	4·797584	33	·2084367	8817·143	281	·91	4·5 10·0	21·2 13·0
AE Sct	18 39 19	− 7 53·6	Algol	4·664435	39	·2143917	7984·521	265	·95	2·9 14·0	12·0 15·4
AF Sct	18 40 14	−14 6·5	RR Lyr	·52896	5	1·89051	8067·718 *	59	·77	1·6: 13·0:	10·7 14·4
CF Sct	18 40 34	− 8 31·4	Algol	31·9415		·0313072	9434·9	278	·66	1·1 13·4	8·1 15·0
BS Sct	18 44 19	− 6 24·7	Algol	3·821000	6	·2617126	8815·500	318	·68	·4 10·5	10·3 13·0
AN Sct	18 44 52	− 6 45·5	δ Cep	32·733	7	·03057	8728·0 *	264	·80	2·8 13·8	8·3 15·1
AP Sct [1]	18 45 14	− 8 52·3	semi-reg.	105				275		1·5 13·9	7·0 14·8
AY Sct [1]	18 46 43	−10 21·1	RR Lyr	·5446323	8	1·83611	8727·513 *	226	·92	1·0 14·0	8·9 15·3
TT Sct	18 46 44	−12 22·0	RR Lyr	·4529390	8	2·207803	8671·548 *	217	·86	4·1 13·6	11·6 15·0
BN Sct	18 50 49	− 8 32·0	Algol	14·61155	14	·068439	8745·175	285	·60	1·3 11·5	18·1 15·0
VZ Aql [3]	18 57 15	− 7 3·6	δ Cep	1·668226	13	·599439	8727·60 *	220	·86	2·8 13·0	10·9 14·4
IM Aql	19 00 9	− 6 58·5	RR Lyr	·4569565	13	2·188392	8064·695 *	210	·80	4·4 13·4	11·4 14·8

The main data about these variables have been collected in Table 1. The reciprocal period in the seventh column has been actually used in the computation of the phases according to the formula:

$$\text{(A)} \quad \text{phase} = P^{-1} \text{ (J.D.} - 2420000)$$

Not always does it correspond exactly with the period which has been finally adopted. The epochs marked with an asterisk are epochs of maximum, for the eclipsing variables the epoch of primary minimum has been given. More accurate epochs for special points of the light curve are given below for each star separately. J.D. stands for J.D. hel. M.A.T. Gr. The mean error of one observation has been derived from the differences in brightness between observations following each other in phase.

Table 2 gives information about the comparison

*) The epochs marked with an asterisk are epochs of maximum, while the others are epochs of minimum.

[1]) There is some uncertainty in the identification. See remark.

[2]) The period increases with 12 seconds per year. See remark.

[3]) The light curve is very peculiar. See remark.

TABLE 2.

			$\Delta\alpha \cos\delta$	$\Delta\delta$	brightness
			′	′	s
UZ Sct	a		+ 5·5	− 4·4	·0
	b		− 1·6	− 6·6	3·6
	c		− 4·9	− ·1	5·3
	d		− 2·0	+ ·6	9·1
	e		− ·4	+ ·7	12·8
VX Sct	b		− 1·4	− 2·2	·0
	c		− 5·6	− 1·8	3·0
	d		− 3·8	+ ·9	5·7
	e		− 1·0	− ·6	7·9
Y Sct	a	B.D. − 8° 4665	+ 5·9	−14·3	·0
	b	,, − 8 4658	− 6·3	− 3·8	4·6
	c	,, − 8 4659	− 5·9	+ ·2	8·0
	d		+ 2·8	+ 8·3	10·7
XY Sct	a		− 2·0	+ 1·6	·0
	b		+ 4·0	− 1·0	2·1
	c		+ ·1	+ 1·7	4·0
	d		+ ·2	− 2·6	5·2
RU Sct	a	B.D. − 4° 4548	−15·4	+ 1·6	·0
	b	,, − 4 4554	+ 1·9	−26·5	3·9
	c	,, − 4 4550	− 9·0	− 6·8	7·2
	d	,, − 4 4558	+ 6·8	− 6·0	11·1
TY Sct	a	B.D. − 4° 4558	+ 3·8	+ 5·2	·0
	b		+ 2·2	+ 2·3	5·0
	c		− ·2	− 3·2	6·8
	d		− 2·5	+ 3·8	10·0
Z Sct	a	B.D. − 6° 4853	+ 4·8	−12·3	·0
	b	,, − 6 4840	−11·8	− 6·4	3·6
	c		− 4·1	+ 7·8	7·7
	d		+ 4·8	+ 1·4	10·2
SS Sct	b	B.D. − 7° 4688	+12·8	+ 8·9	·0
AC Sct	a	B.D. −10° 4793	+ 5·8	− 4·9	·0
	b	,, −10 4783	− 7·5	+ 7·1	8·4
	c		+ 4·0	+ 5·1	13·4
	d		− 4·4	+ 2·0	16·7
	e		− 1·0	− 1·2	21·0
AE Sct	a		+ ·6	− 1·3	·0
	b		+ ·1	+ 1·0	4·8
	c		+ ·4	+ ·3	8·3
	d		− ·4	− ·0	10·0
AF Sct	a		−10·8	+ 6·6	·0
	b		+ ·2	+ 3·5	4·1
	c		− 2·4	− 1·6	6·8
	d		− 4·1	+ 3·5	9·6
CF Sct	a		+ ·2	+ ·8	·0
	b		+ 1·7	− 1·7	2·9
	c		+ 3·0	− 2·8	4·1
	d		− ·4	− ·1	5·8
	e		+ 2·5	− ·6	7·8
	f		− 1·3	− ·4	9·0
BS Sct	a		+12·2	− 9·3	·0
	b		+ 7·5	− 5·7	5·1
	c		− ·6	− 2·4	7·6
	d		− 1·0	− 7·4	10·2
AN Sct	b		+ 3·6	− 2·4	·0
	c		− ·9	− 3·1	4·6
	d		− ·0	+ ·9	7·6
	e		+ ·2	− ·6	9·3
AP Sct	a		+ 3·0	− ·6	·0
	b		+ 2·4	+ ·0	3·7
	c		+ ·5	+ ·5	4·8
	d		+ ·1	+ ·8	7·5
AY Sct	A		+ ·7	+ 1·0	·0
	a		+ ·4	− ·8	2·8
	b		+ ·2	+ ·8	5·7
	c		− ·2	− ·1	7·9
	d		− ·4	+ ·0	9·3
TT Sct	a		− 4·7	+ 4·2	·0
	b		− 1·4	+ 3·4	4·1
	c		− 5·2	− 3·5	5·9
	d		+ 1·7	− ·9	8·7
	e		− 3·4	+ ·0	11·6
BN Sct	a	B.D. − 8° 4791	+ 4·0	−13·7	·0
	b		−10·2	+ 6·4	2·4
	c		− 4·4	+ 4·1	4·6
	d		+ 4·9	− 3·6	7·8
	e		− ·9	− 2·4	12·3
	f		+ ·6	− ·0	17·1
	g		− 1·3	+ ·6	19·9
VZ Aql	a		− 3·9	− ·0	·0
	b		+ 1·2	+ ·5	5·2
	c		+ 1·3	− 2·6	6·2
	d		+ 3·4	+ ·2	9·8
IM Aql	a		+ 4·2	− 1·5	·0
	b		− 2·4	− 4·3	4·9
	c		− 3·6	− 2·7	5·9
	d		− 4·0	− 2·8	8·9
	e		+ ·6	− ·0	12·4

stars used. Their position relative to the variable and their brightness in steps have been tabulated.

The following remarks refer to the individual variables.

UZ Sct: Because of its position this δ Cephei-type variable could only be estimated on the Cook 10-inch plates. The observations confirm the period of 14·749 days, which was derived by the writer from a number of Harvard maxima [1]). The variable is near maximum on Franklin-Adams Chart 86. An improved value of the period has been computed by least squares from 9 epochs of maximum. The oldest corresponds with the Franklin-Adams Chart, the following three were selected from the Harvard maxima and the remaining five epochs have been observed on the Cook plates. The elements of maximum are:

$$\text{J.D. } 2425440^{d}\cdot 01 + 14^{d}\cdot 7442\ (E - 446)$$
$$\pm\ 19 \qquad \pm\ 10 \qquad \text{(m.e.)}$$

The epochs and their residuals are shown in the table. Phases have been computed with formula (A). The mean light curve is shown in the figure. As the

[1]) *H. B.* No. 900, 12, 1935.

normal points contain less than 9 observations each, they have been indicated by open circles. The number of observations, the mean phase and the mean brightness of each normal point is given in the accompanying table. Although the light curve has only small weight, it shows the characteristic rising branch. It consists of two parts, the second of which is considerably steeper than the first.

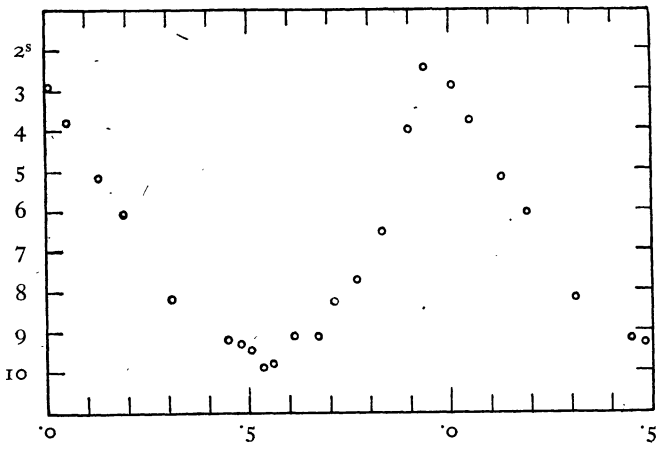
maxima: UZ Scuti

J.D.	E	O−C
d		d
2418864·4	0	+ ·3
2423935·3	344	− ·8
4732·6	398	+ ·3
5439·9	446	− ·1
7902·0	613	− ·3
60·9	617	− ·4
75·7	618	− ·3
91·8	619	+1·0
8064·7	624	+ ·2

mean light curve: UZ Scuti

n	mean phase	mean brightness
	P	s
5	·0092	2·92
6	·0543	3·78
6	·1293	5·17
2	·1955	6·05
1	·3100	8·20
7	·4486	9·21
6	·4807	9·32
7	·5043	9·44
6	·5368	9·87
7	·5583	9·79
6	·6133	9·13
7	·6729	9·14
6	·7185	8·25
4	·7640	7·75
5	·8330	6·54
2	·8985	4·00
4	·9380	2·45

FIGURE: UZ Sct



VX Sct: This variable has been discovered by Miss CANNON, who classified it as an eclipsing variable [1]). The star was found to be faint on the dates 1923 June 17 and 1924 July 26 and no period could be derived. From the observations by the writer a period of 33·6 days was readily found. On account of this long period the fractions of the Julian Day for the two minima observed by Miss CANNON are of little significance. They were assumed to be ·6 and from a combination of these two epochs with five epochs from the Leiden plates, the period has been determined by least squares, the elements being:

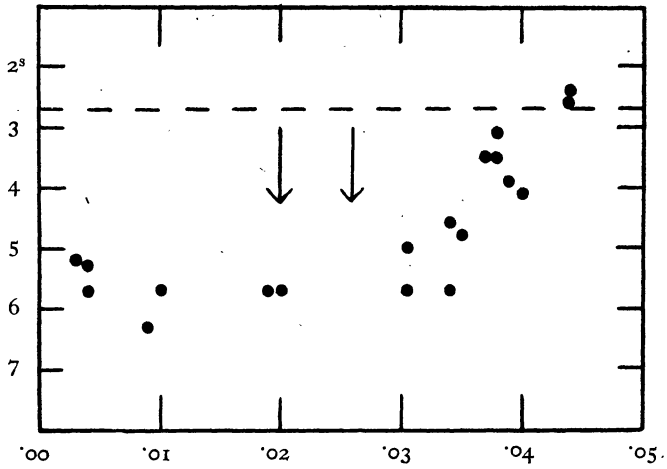
J.D. $2427926^{d}\cdot8 + 33^{d}\cdot623\ (E - 129)$
$\pm 3 \quad \pm 4$ (m.e.)

These epochs and their residuals are given in the table. Phases have been computed with formula (A)

minima: VX Scuti

J.D.	E	O−C
d		d
2423588·6	0	−·8
3993·6	12	+·7
7926·9	129	+·1
60·9	130	+·5
9104·4	164	+·8
36·4	165	−·9
9439·5	174	−·4

FIGURE: VX Sct



and the phase of minimum, which is rather uncertain, was taken as ·762. As the number of observations near minimum is small, phases have been counted from the phase of minimum without regard to sign. The individual observations of this reflected light curve near minimum are shown in the figure. The arrows indicate the phase of Miss CANNON's minima. The brightness in minimum is constant for a considerable time, but the shape of the descending and rising branches is very uncertain. The duration of the minimum and of the constant part may be provisionally put at $D = {}^{P}\cdot086$ or $2^{d}\cdot9$ and $d = {}^{P}\cdot064$ or $2^{d}\cdot2$. The system must consist of a large red and a small white component, the mean densities of which, expressed in the mean solar density, will be of the order of $4\cdot5.10^{-4}$ and ·15 respectively.

Y Sct: The period and the mean light curve of this δ Cephei-type variable have been determined with considerable accuracy by H. SHAPLEY, who has published in detail the observations on which his

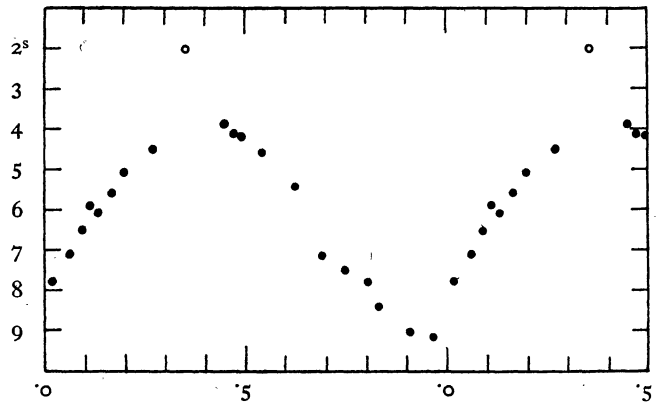
[1]) *H. C.* No. 265, 1924.

work is based [1]). For the Leiden observations phases have been computed with the reciprocal period, which corresponds with SHAPLEY's period, by means of formula (A). The mean light curve thus obtained is shown in the figure and the number of observations, the mean phase and the mean brightness of each normal point are given in the table. As compared with SHAPLEY's light curve this new curve is sharper

mean light curve:
Y Scuti

n	mean phase	mean brightness	m_{pg}
	P	s	m
14	·0176	7·77	11·58
14	·0601	7·11	11·47
14	·0922	6·54	11·38
15	·1135	5·92	11·28
14	·1398	6·07	11·30
14	·1646	5·59	11·22
14	·1985	5·06	11·13
14	·2721	4·54	11·05
6	·3555	2·03	10·63
14	·4501	3·88	10·94
14	·4739	4·14	10·98
14	·4950	4·19	10·99
14	·5406	4·62	11·06
14	·6234	5·44	11·20
14	·6903	7·14	11·48
14	·7449	7·49	11·53
14	·8021	7·79	11·58
14	·8304	8·43	11·69
14	·9071	9·01	11·79
14	·9645	9·16	11·81

FIGURE: Y Sct



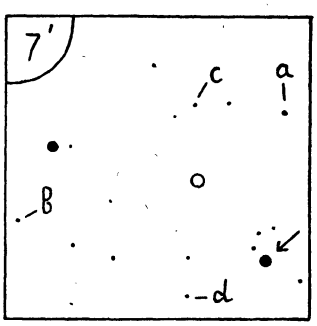
near maximum as well as near minimum. The number of observations near maximum however is small and the normal point of greatest brightness contains six observations only. The brightness in steps of the normal points has been reduced to SHAPLEY's magnitude system by the equation: $m = 10{\cdot}299 + {\cdot}165\,s$. The reduced values are given in the fourth column of the table. A correction to SHAPLEY's period has been derived in the following manner. The observations by SHAPLEY have been divided in two groups from J.D. 2414876 to J.D. 2420398 and from J.D. 2420444 to J.D. 2425889. For both groups a mean light curve has been formed, the phases being calculated with the formula: phase $= P^{-1}$ (J.D. -2400000). Again the reciprocal period from Table 1 has been used. The normal points, 18 in number for each light curve, contain 5 or 6 observations. Plotted on transparent paper these light curves, indicated by Sh I and Sh II, were in turn put on top of the mean light curve from the Leiden observations, through which a smooth curve had been drawn, and the deviations of SHAPLEY's normal points from this curve were read off. When the upper curve had been shifted along the phase axis in such a way that the sum of the squares of these deviations became a minimum, the old and new curve were supposed to coincide. In this way it was found that $P_{Sh\,I} - P_{Oo} = -{\cdot}0336$ and $P_{Sh\,II} - P_{Oo} = -{\cdot}0282$. As the phases have been computed with different formulae, a correction of $+{\cdot}0240$ must be added to these values and the true differences in phase are therefore: $P_{Sh\,I} - P_{Oo} = -{\cdot}0096$ and $P_{Sh\,II} - P_{Oo} = -{\cdot}0042$. These together with the mean Julian Days of the three light curves

Sh I	2417775
Sh II	2422948
Oo	2428375

give the improved reciprocal period $^{d-1}{\cdot}09669790$, which corresponds with the period given in Table 1. Its mean error given there is an estimate.

XY Sct: Miss HARWOOD has classified this star as a cluster-type variable with a period of ·2103 days [1]). These results are not confirmed by the present observations. There is however a discrepancy in the star's position, because in „Katalog und Ephemeriden veränderlicher Sterne für 1942" the declination is given as $-6°11'{\cdot}5$ (1855), whereas the writer finds $-6°12'{\cdot}4$ for the same equinox. For this reason a chart of this region is given here. The star indicated by an open circle is the variable treated in this note.

CHART: XY Sct



[1]) *Proc. Am. Acad. Arts and Sci.* **64**, 347, 1930.

[1]) *H. B.* No. 880, 14, 1930.

The bright star marked with an arrow is B.D.−6°4830, which is a variable of the δ Cephei-type [1]). Comparison star c is situated in the position of XY Sct, but as no variability has been detected in this star and as it is of the same apparent magnitude as the variable of this article, it has been assumed that the latter is identical with XY Sct.

The star is a W Ursae Majoris-type variable. As the two minima appear to be of equal depth, all computations were made with the apparent period. The period has been derived from 45 observations on the descending and rising branches of the light curve. They were first reduced to brightness $4^s.0$ by means of the adopted slope: $^s.1 \mathrel{\widehat{=}} {}^d.00094$. A least squares solution, which includes as third unknown the half width of the minimum, gives the elements:

$$\text{J.D.} + {}^d.0094\,(s - 4^s.0)\,X = 2428729^d.5293 \pm {}^d.0015 + {}^d.3926282\,(E - 2039) \pm {}^d.0009 + {}^d.0389\,X \pm {}^d.0014$$

where X equals −1 for the descending and +1 for the rising branch. The details of this solution are given in the table. From the mean light curve which is shown in the figure, the phase of minimum was found to be .534 and with this value a reflected mean light curve has been derived, which has been plotted in the right hand part of the figure. Information about the normal points will be found in the two remaining tables.

descending and rising branch: XY Scuti

J.D. −2420000	brightness	X	E	O−C
d	s			d
7928.913	3.4	−1	0	−.003
57.958	4.0	−1	74	−.018
63.878	4.6	−1	89	+.006
.955	3.4	+1	89	+.006
75.726	3.0	+1	119	−.005
83.901	5.2	−1	140	.000
.960	3.5	+1	140	−.012
84.270	3.0	−1	141	−.003
.292	4.0	−1	141	+.010
.356	4.0	+1	141	−.004
.378	2.9	+1	141	+.008
.747	4.0	+1	142	−.006
.774	2.1	+1	142	+.003
85.452	2.9	−1	144	+.002
.474	4.6	−1	144	+.008
.524	3.6	+1	144	−.018
.546	4.0	+1	144	+.008
88.290	3.2	+1	151	−.004
.592	3.6	−1	152	−.005
.615	5.2	−1	152	+.003
8013.717	2.7	−1	216	.000
.741	3.4	−1	216	+.018
15.698	2.1	−1	221	+.024
.786	2.1	+1	221	−.002
42.764	3.0	−1	290	−.011
8729.493	3.0	−1	2039	+.012
74.328	4.0	+1	2153	.000
.349	2.1	+1	2153	+.003
79.335	3.4	−1	2166	−.013
9020.498	5.2	+1	2780	+.003
.520	3.0	+1	2780	+.005
82.469	5.7	−1	2938	−.010
84.495	4.4	+1	2943	−.005
.517	3.6	+1	2943	+.009
9104.435	3.0	−1	2994	−.006
06.494	3.0	+1	2999	−.006
.515	1.0	+1	2999	−.004
08.462	3.2	+1	3004	.000
41.341	4.0	−1	3088	−.016
9430.434	3.0	+1	3824	+.015
.434	2.1	+1	3824	+.006
31.498	3.6	−1	3827	−.008
.528	5.7	−1	3827	+.002
.528	5.2	−1	3827	+.007
39.451	2.7	+1	3847	−.001

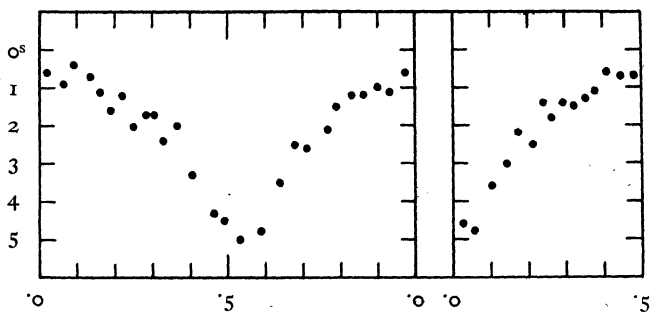
mean light curve: XY Scuti

n	mean phase	mean brightness
	P	s
10	.022	+ .6
10	.065	.9
10	.094	.4
10	.136	.7
10	.162	1.1
10	.188	1.6
10	.220	1.2
10	.251	2.0
10	.282	1.7
10	.304	1.7
10	.327	2.4
10	.365	2.0
10	.404	3.3
10	.465	4.3
10	.491	4.5
10	.533	5.0
10	.587	4.8
10	.641	3.5
10	.682	2.5
10	.712	2.6
10	.765	2.1
10	.792	1.5
10	.834	1.2
10	.861	1.2
10	.898	1.0
10	.931	1.1
9	.974	+ .6

reflected light curve: XY Scuti

n	mean phase	mean brightness
	P	s
17	.024	+4.6
18	.056	4.8
18	.102	3.6
18	.143	3.0
18	.174	2.2
18	.211	2.5
18	.238	1.4
18	.261	1.8
18	.295	1.4
18	.320	1.5
18	.350	1.3
18	.377	1.1
18	.406	.6
18	.444	.7
18	.481	+ .7

FIGURE: XY Sct



[1]) Var. 1: *B. A. N.* No. 355, 385.

RU Sct: For this variable of the δ Cephei-type SHAPLEY has published 199 observations from which he derived a period of $19^d.69647 \pm ^d.00033$ (m.e.) [1]. The light curve, which has a range of $1^m.4$, shows a steep rising branch, whereas the descending branch is characterized by a slight hump or retardation. First a period has been determined for the Leiden material alone from 22 observations on the rising branch. Observations of the same night have been combined into means and these were reduced to brightness $7^s.0$ with the adopted slope: $^s.1 \mathrel{\widehat{=}} ^d.015$. A least squares solution with weights proportional to the number of observations yields the elements:

$$\text{J.D.} +\cdot15\,(s-7\cdot0) = 2428671\cdot39 + 19^d\cdot7006\,(E-39)$$
$$\pm\ 4 \qquad \pm\ 13 \quad \text{(m.e.)}$$

The data of this solution are given in the table. Phases have been computed with formula (A) and the resulting mean light curve is shown in the figure. It is in satisfactory agreement with SHAPLEY's light curve, but the difference between the two periods, which amounts to three times its mean error, suggests that RU Sct has an increasing period. In order to make a solution of the period from the combined material of Harvard and Leiden, the step values have been reduced to SHAPLEY's magnitude system by the equation: $m = +10\cdot408 + \cdot119\,s$. Then 33 observations on the rising branch, 14 from Harvard and 19 from Leiden, were reduced to brightness $11^m.20$ by means of the adopted slope: $^m.01 \mathrel{\widehat{=}} ^d.013$ and a least squares solution, including a quadratic term for the period, has been made. The elements thus found are:

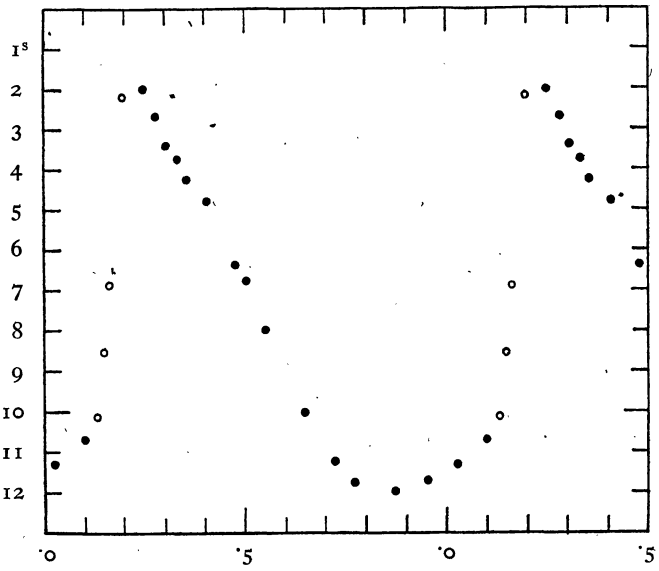
rising branch (Oo.): RU Scuti

J.D. −2420000	brightness	p	E	O−C
d	s			d
7902·97	7·1	3	0	−·08
62·90	2·0	4	3	−·02
8041·72	2·6	2	7	+·09
8671·55	6·4	2	39	+·07
8750·35	7·2	1	43	+·19
9045·48	8·8	2	58	+·05
84·50	10·5	2	60	−·08
9104·42	10·6	2	61	+·16
63·34	8·5	1	64	−·34
9439·47	8·4	3	78	−·03

mean light curve: RU Scuti

n	mean phase	mean brightness	
	P	s	m
15	·0264	11·29	11·75
12	·1003	10·72	11·68
5	·1342	10·14	11·61
5	·1482	8·56	11·43
6	·1613	6·90	11·23
6	·1972	2·20	10·67
15	·2483	2·01	10·65
16	·2799	2·68	10·73
16	·3033	3·41	10·81
16	·3321	3·75	10·85
16	·3549	4·24	10·91
16	·4063	4·80	10·98
16	·4777	6·37	11·17
16	·5024	6·78	11·21
16	·5539	7·99	11·36
16	·6493	10·03	11·60
16	·7209	11·23	11·74
16	·7751	11·76	11·81
16	·8716	11·98	11·83
16	·9532	11·70	11·80

FIGURE: RU Sct

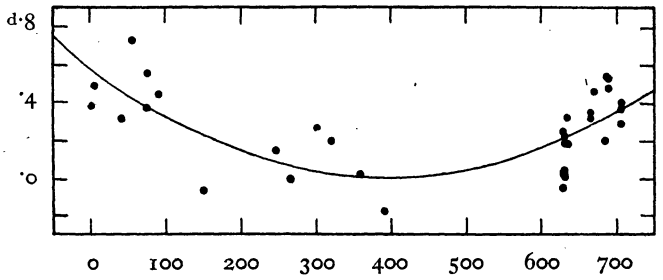


$$\text{J.D.} +1\cdot3\,(m-11\cdot20) = 2423234^d\cdot92 + 19^d\cdot69781\,(E-391) + ^d\cdot0000037\,(E-391)^2$$
$$\pm\ 6 \qquad \pm\ 11 \qquad \pm\ 7 \quad \text{(m.e.)}$$

The variability of the period seems to be well established, as the coefficient of the quadratic term is five times its mean error. According to these elements the values of the period during the time of the Harvard and of the Leiden observations are $19^d.69673$ and $19^d.69988$ respectively, which is in very close agreement with the values actually derived. In the last table, which gives the data used for this solution, the column headed $(O-C_1)$ has been computed with omission of the quadratic term, whereas in the following column $(O-C_2)$ the residuals from the complete elements are given. The values $(O-C_1)$ have been plotted against the number of periods in the figure.

[1] *Proc. Am. Acad. Arts and Sci.* **64**, 347, 1930.

FIGURE: The quadratic term in the period of RU Scuti.



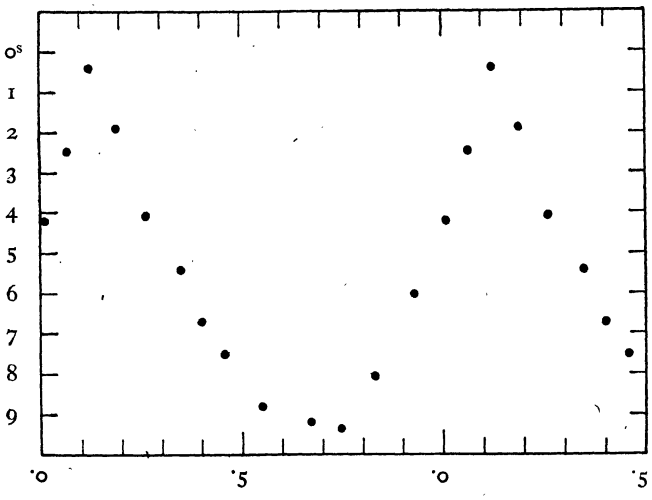
rising branch, Harvard and Leiden: RU Scuti

J.D. −2400000	m_{pg}	E	O−C$_1$	O−C$_2$
d	m		d	d
15533·74	10·72	0	+·38	−·19
5631·56	11·32	5	+·49	−·06
6340·65	11·21	41	+·31	−·15
6636·81	10·99	56	+·73	+·31
7010·69	11·01	75	+·37	−·01
49·67	11·47	77	+·55	+·18
7325·84	11·08	91	+·44	+·10
8467·80	11·08	149	−·07	−·29
20398·58	10·94	247	+·14	+·06
0752·49	11·32	265	−·01	−·07
1462·52	10·83	301	+·26	+·23
1836·53	10·97	320	+·19	+·17
2584·56	11·21	358	+·02	+·01
3234·74	10·94	391	−·18	−·18
7902·95	11·17	628	−·05	−·26
·98	11·20	628	+·02	−·19
·98	11·38	628	+·25	+·04
62·82	10·65	631	+·04	−·17
·90	10·72	631	+·22	+·01
·90	10·56	631	+·01	−·20
·96	10·65	631	+·18	−·03
8041·72	10·78	635	+·32	+·10
·72	10·67	635	+·18	−·04
8671·54	11·17	667	+·32	+·04
·56	11·18	667	+·35	+·07
8750·35	11·26	671	+·46	+·17
9045·46	11·34	686	+·20	−·12
·49	11·57	686	+·53	+·21
9104·41	11·66	689	+·48	+·15
·44	11·68	689	+·53	+·20
9439·45	11·38	706	+·29	−·08
·47	11·42	706	+·37	·00
·50	11·42	706	+·40	+·03

TY Sct: Observations of this variable of the δ Cephei-type have been published by LEINER [1]) and PARENAGO [2]). The number of observations by the last author is small and they have not been used here. The period derived by LEINER is 11·05289 days. The reciprocal of this period has been used for the computation of the phases for the Leiden observations according to formula (A). The resulting mean light curve is shown in the figure and information about the normal points is given in the table. The light curve has a considerable range and it is practically symmetrical with respect to the maximum, which is very sharp.

An improved period has been derived from a combination of the observations by LEINER and by the writer. For each set of observations by LEINER a separate mean light curve has been formed and the phase has been determined for a point on the rising branch which is separated by ·40 period from the corresponding point of the same brightness on the descending branch. As the writer's observations were treated in the same way four mean epochs have been obtained in this manner, from which the

FIGURE: TY Sct



mean light curve: TY Scuti

n	mean phase	mean brightness
	P	s
20	·0101	4·22
10	·0646	2·47
10	·1246	·42
12	·1912	1·89
21	·2612	4·07
21	·3483	5·43
21	·4009	6·74
21	·4579	7·53
21	·5518	8·83
20	·6726	9·18
20	·7456	9·36
20	·8332	8·06
20	·9323	6·03

rising branch: TY Scuti

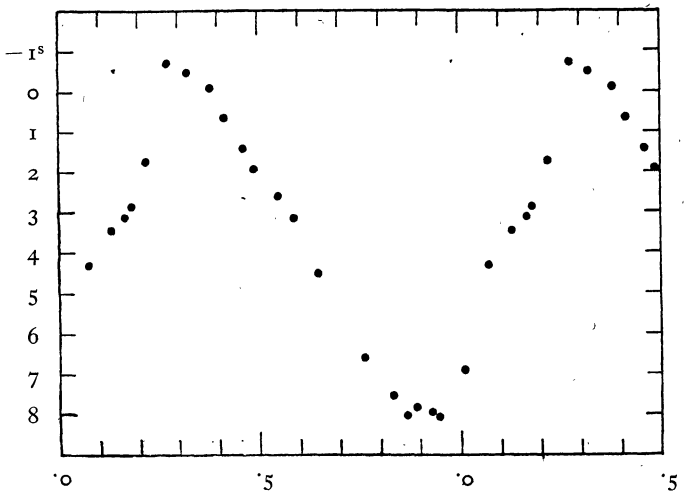
observer	J.D. −2420000	p	E	O−C
	d			d
LEINER	3260·086	16	0	+·055
,,	5138·979	17	170	−·066
OOSTERHOFF	8432·809	24	468	−·037
LEINER	9151·436	8	533	+·143

[1]) *A. N.* **218**, 71, 1923; **232**, 123, 1928 and **268**, 27, 1939.
[2]) *F. P. A. N. N.* **3**, 110, 1932.

period has been derived by least squares, after weights proportional to the number of observations in each light curve had been assigned to these epochs. This period is given in Table 1. The epochs and their residuals are given in the table.

Z Sct: This δ Cephei-type variable has been investigated by SHAPLEY, who published 196 observations from which he derived an improved value of the period and a mean light curve [1]). The reciprocal of SHAPLEY's period has been used in the reduction of the writer's observations. Phases were calculated by means of formula (A) and a mean light curve has been formed which is shown in the figure. Data about the normal points are tabulated below. The light curve, which is characteristic for variables with a period of 13 days, is very similar in shape to SHAPLEY's light curve, but the hump on the rising branch is more pronounced. The step values have been reduced to photographic magnitudes in SHAPLEY's system according to the relation:
$m = +10{\cdot}501 + {\cdot}199\,s$. The period finally adopted has been derived from 35 observations, 16 by SHAPLEY and 19 by the writer, on the steep upper part of the rising branch. They have been reduced to brightness $10^m{\cdot}60$ with the adopted slope: $^m{\cdot}01 \mathrel{\widehat{=}} {}^d{\cdot}0094$. A solution by least squares gives the elements:

FIGURE: Z Sct



$$\text{J.D. } +{\cdot}94\ (m - 10{\cdot}60) = 2427963^d{\cdot}535 + 12^d{\cdot}90165\ (E - 882)$$
$$\pm\ 31 \qquad \pm\ 7 \qquad \text{(m.e.)}$$

The epochs used, the magnitudes, the number of periods and the residuals from these elements are given in the table.

mean light curve: Z Scuti

n	mean phase	mean brightness	
	P	s	m
15	·0148	6·91	11·88
15	·0755	4·33	11·36
15	·1339	3·44	11·19
15	·1654	3·13	11·12
15	·1816	2·87	11·07
15	·2175	1·75	10·85
15	·2759	− ·73	10·36
16	·3224	− ·48	10·41
15	·3817	− ·07	10·49
15	·4162	·65	10·63
15	·4621	1·41	10·78
15	·4893	1·92	10·88
15	·5478	2·60	11·02
15	·5855	3·14	11·13
15	·6467	4·51	11·40
15	·7611	6·62	11·82
15	·8315	7·53	12·00
15	·8648	8·01	12·09
15	·8881	7·83	12·06
15	·9271	7·95	12·08
15	·9497	8·04	12·10

rising branch, Harvard and Leiden: Z Scuti

J.D. −2400000	brightness	E	O−C
d	m		d
16583·83	10·95	0	−·12
6635·72	10·77	4	−·01
8132·66	10·49	120	+·08
58·53	10·59	122	+·24
·58	10·31	122	+·03
8441·75	10·86	144	−·13
67·80	10·59	146	−·13
21047·76	11·12	346	·00
73·63	11·12	348	+·06
99·55	10·77	350	−·15
1460·60	11·29	378	+·15
3305·62	10·86	521	−·18
3641·68	10·68	547	+·28
4415·51	10·49	607	−·17
4699·69	10·31	629	·00
5808·72	10·68	715	−·16
7963·82	10·50	882	+·19
·88	10·20	882	−·04
·88	10·40	882	+·15
·96	10·40	882	+·23
89·73	10·40	884	+·20
·73	10·40	884	+·20
8014·85	11·04	886	+·12
·85	10·66	886	−·23
8750·35	10·86	943	+·05
76·35	10·50	945	−·08
8815·34	10·40	948	+·11
9021·42	10·60	964	−·05
9111·42	10·94	971	−·04
·44	10·80	971	−·15
63·36	10·64	975	+·01
9434·39	10·60	996	+·07
·39	10·30	996	−·21
·44	10·40	996	−·07
·46	10·20	996	−·24

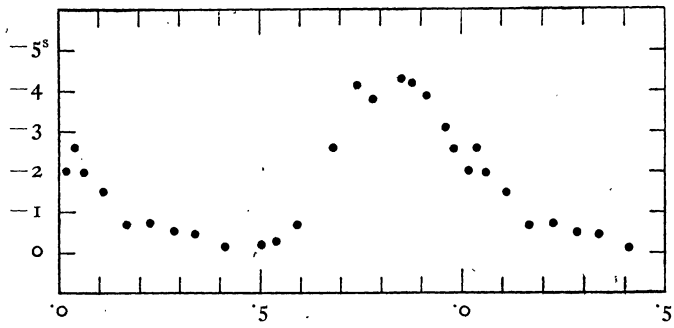
[1]) *Proc. Am. Acad. Arts and Sci.* **64**, 347, 1930.

SS Sct: This variable of the δ Cephei-type also has been investigated by SHAPLEY, who published an improved period and a mean light curve, which is based on 194 observations [1]). Because of its brightness the variable is very difficult to estimate on the present plates. Only one comparison star has been used, namely: B.D. −7°4688 or H.D. 173220, spectrum Fo. Near minimum the variable and the comparison star are about equally bright. Phases have been computed according to formula (A) with the reciprocal of SHAPLEY's period. The resulting mean light curve is shown in the figure, while the table gives information about the normal points. The maximum, which is rather broad, is less accurately determined than the minimum on account of the larger difference in brightness between variable and comparison star. The general shape is very similar to that of SHAPLEY's light curve.

mean light curve:
SS Scuti

n	mean phase	mean brightness
	P	s
16	·016	−2·03
16	·037	−2·59
16	·060	−1·97
16	·111	−1·50
16	·169	− ·66
16	·224	− ·72
16	·284	− ·50
16	·339	− ·44
16	·412	− ·12
16	·502	− ·16
16	·538	− ·25
15	·595	− ·67
15	·683	−2·57
15	·740	−4·13
16	·782	−3·78
16	·852	−4·28
16	·878	−4·19
16	·915	−3·88
16	·960	−3·09
16	·983	−2·56

FIGURE: SS Sct



The period given in Table 1 has been derived from a combination of the observations by SHAPLEY and by the writer. For the mean light curves computed for both groups separately with the formula: phase = P^{-1} (J.D. −2400000) the phase has been determined of a point on the rising branch of such brightness, that the difference in phase between this point and the corresponding point on the descending branch is ·40. This phase was found to be ·446 for Harvard and ·488 for Leiden, corresponding to the mean epochs 2420288·602 and 2428537·908. The interval comprises 2247 periods and the period is therefore $3^d·671253$ with an estimated mean error of $\pm^d·000016$. The probable error given by SHAPLEY for his period is nearly ten times smaller than the mean error given here, although the latter has been derived from a material of considerably more weight. A solution of the period from 13 individual observations on the rising branch yields a mean error of $\pm^d·000015$, which fully confirms the value given above.

AC Sct: This Algol variable has been discovered by Miss CANNON who found the star faint on three nights [1]). The period has been derived by KORDYLEWSKY who gave the elements [2]):

$$2424350^d·558 + 4^d·79765\ E.$$

Five years later he gave the improved period: $4^d·797645$ [3]). The variable has a very large range, which is estimated to be nearly three magnitudes.

It is very faint on four plates of the present material. A solution of the period from these epochs together with that given by KORDYLEWSKY yields the elements:

$$2424350^d·57 + 4^d·79759\ E$$
$$\pm 3 \quad \pm 7 \quad \text{(m.e.)}$$

The epochs used, the number of periods and the residuals are:

minima: AC Scuti

J.D. −2420000	E	O−C
d		d
4350·56	0	−·01
7991·91	759	−·03
8044·80	770	+·08
8788·34	925	−·00
8836·28	935	−·04

Phases have been computed according to formula (A) and a mean light curve was formed. The phase of minimum was found to be ·8167 and a reflected mean light curve, in which phase is counted from the phase of minimum without regard to sign, has then been computed. The interesting part of this curve is shown in the figure. Near the central part of the eclipse the individual observations have been plotted, as can be seen from the corresponding table.

[1]) *Proc. Am. Acad. Arts and Sci.* **64**, 347, 1930.

[1]) *H. C.* No. 265, 1924.
[2]) *Acta Astr. c*, **1**, 165, 1931.
[3]) *S. A. C.* **14**, 61, 1936.

The eclipse is total and the brightness of the variable in minimum is constant for nearly three hours. The duration of the minimum and of its constant part are provisionally determined as:

$$D = {}^{P}\cdot146 = {}^{d}\cdot70 = {}^{h}16\cdot8$$
$$d = {}^{P}\cdot024 = {}^{d}\cdot12 = {}^{h}2\cdot9$$

An improved value of the period has been derived from 9 observations on the descending and rising branches, which provide excellent epochs. The observations were reduced to brightness $14^{s}\cdot0$ with the adopted slope: ${}^{s}\cdot1 \mathrel{\widehat{=}} {}^{d}\cdot0009$ and the half width of the minimum has been included as a third unknown in the least squares solution, which gives the following elements:

$$\text{J.D.} + {}^{d}\cdot009\,(s - 14\cdot0)\,X = 2428817^{d}\cdot143 + 4^{d}\cdot797584\,(E - 167) + {}^{d}\cdot140\,X$$
$$\pm\ 3 \qquad \pm\ 33 \qquad \pm\ 4 \quad \text{(m.e.)}$$

This period, which is given in Table 1, is in satisfactory agreement with the period derived above. Details of the solution are given in the table.

reflected light curve: AC Scuti

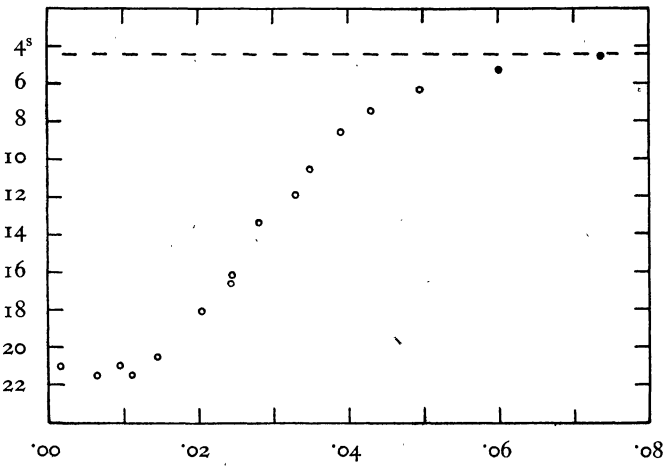
n	mean phase	mean brightness
	P	s
1	·0017	21·0
1	·0063	21·5
1	·0095	21·0
1	·0111	21·5
1	·0147	20·5
1	·0204	18·1
1	·0244	16·7
1	·0246	16·2
1	·0282	13·4
1	·0328	12·0
5	·0349	10·58
5	·0389	8·62
5	·0430	7·50
5	·0495	6·38
10	·0599	5·27
10	·0737	4·53
30	·1321	4·50
30	·2307	4·60
30	·2864	4·32
30	·3223	4·41
30	·3540	4·44
30	·4009	4·49
30	·4520	4·51
10	·4715	4·40
10	·4944	4·79

descending and rising branch: AC Scuti

J.D. −2420000	brightness	X	E	O−C
d	s			d
8015·786	12·0	−1	0	−·003
·825	16·2	−1	0	−·002
8668·555	13·4	+1	136	−·008
·577	12·7	+1	136	+·007
8817·318	11·7	+1	167	+·014
9100·303	18·1	+1	226	−·001
9397·540	16·7	−1	288	+·005
9407·416	10·9	+1	290	+·002
·416	9·2	+1	290	−·013

For the observations near minimum phases have been computed with formula (A) with the reciprocal period ·214388. A plot of these observations is shown in the figure.

FIGURE: AC Sct



AE Sct: This Algol variable resembles the preceding variable AC Sct very closely, the main difference being the smaller range, which is estimated to be about 1·5 magnitude. The star has been discovered by Miss CANNON, who found two minima [1]). A provisional period of 4·66444 days was easily derived from the present observations. Details of a mean light curve, which was computed with the aid of formula(A), are given in the table. During the central part of the minimum the variable is of constant brightness. The steep branches provide the means for a considerable improvement of the period. A least squares solution, including the half width of the minimum at brightness $6^{s}\cdot0$, has been made from 13 observations, 9 on the descending and 4 on the rising branch. They have first been reduced to brightness $6^{s}\cdot0$ with the adopted slope: ${}^{s}\cdot1 \mathrel{\widehat{=}} {}^{d}\cdot0014$.

The resulting elements are:

$$\text{J.D.} + {}^{d}\cdot014\,(s - 6\cdot0)\,X = 2427984^{d}\cdot521 + 4^{d}\cdot664435\,E + {}^{d}\cdot171\,X$$
$$\pm\ 6 \qquad \pm\ 39 \qquad \pm\ 5 \quad \text{(m.e.)}$$

Provisional values for the duration of the minimum and of totality are: $D = {}^{P}\cdot10 = {}^{d}\cdot47$ and $d = {}^{P}\cdot04 = {}^{d}\cdot19$.

[1]) *H. C.* No. 265, 1924.

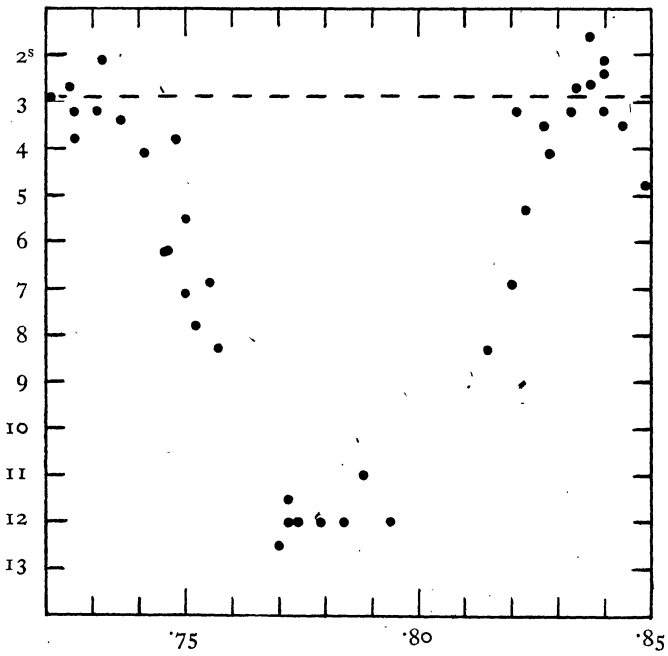
mean light curve:
AE Scuti

n	mean phase	mean brightness
	P	s
23	·0027	2·9
24	·0691	3·0
24	·1347	2·9
23	·2694	2·7
23	·3830	2·9
24	·4979	2·9
24	·5836	2·8
23	·6578	3·2
23	·7164	2·9
5	·7624	3·0
5	·7772	5·2
4	·7855	7·5
4	·8042	12·0
4	·8178	11·8
4	·8532	5·5
5	·8652	3·2
23	·9019	3·2

descending and rising branch: AE Scuti

J.D. −2420000	brightness	X	E	O−C
d	s			d
7984·313	4·1	−1	0	−·010
·335	6·2	−1	0	−·018
·356	5·5	−1	0	+·013
·378	6·9	−1	0	+·015
·697	5·3	+1	0	−·005
·721	4·1	+1	0	+·002
8777·322	7·8	−1	170	−·007
·344	8·3	−1	170	+·008
8996·531	3·8	−1	217	+·029
9043·486	8·3	+1	227	−·001
·509	6·9	+1	227	+·003
9108·462	6·2	−1	241	−·020
·484	7·1	−1	241	−·010

FIGURE: AE Sct

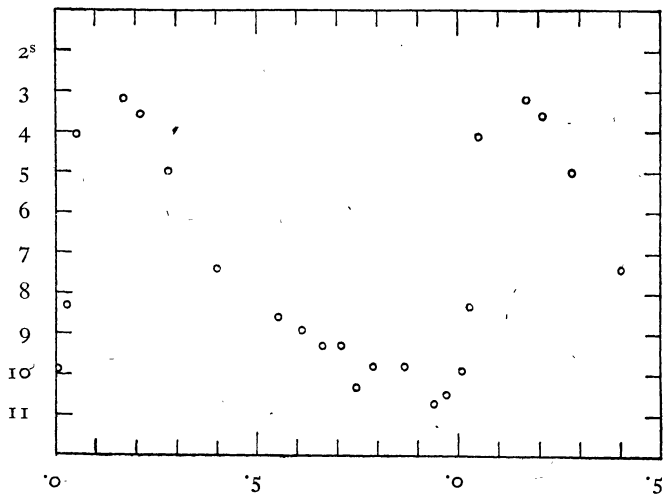


AF Sct: The variability of this star has been discovered by Miss CANNON [1]). It is situated near the edge of the Cook 10-inch plates and could be estimated on 59 plates only. The star is a RR Lyr-type variable of BAILEY's subclass *a*. The period given in Table 1 has been derived from the following three epochs for a point on the rising branch of brightness 6s·0: J.D. 2427926·985, 2427962·950, and 2428067·688. The mean light curve, of which the maximum has not been observed, is shown in the figure. The variable has been investigated by J. UITTERDIJK on more than 300 plates taken with the Franklin-Adams camera at Johannesburg of a region with the centre at 19h, −19°. His unpublished results are in full agreement with the data presented here.

mean light curve:
AF Scuti

n	mean phase	mean brightness
	P	s
2	·006	9·9
2	·028	8·3
1	·050	4·1
3	·170	3·2
3	·208	3·6
4	·278	5·0
5	·401	7·4
5	·553	8·6
5	·614	8·9
5	·663	9·3
5	·708	9·3
5	·746	10·3
5	·790	9·8
5	·864	9·8
4	·942	10·7

FIGURE: AF Sct



CF Sct: This variable has been discovered by Miss HARWOOD who classified it as an eclipsing variable with a period of 31·9415 days [2]). The

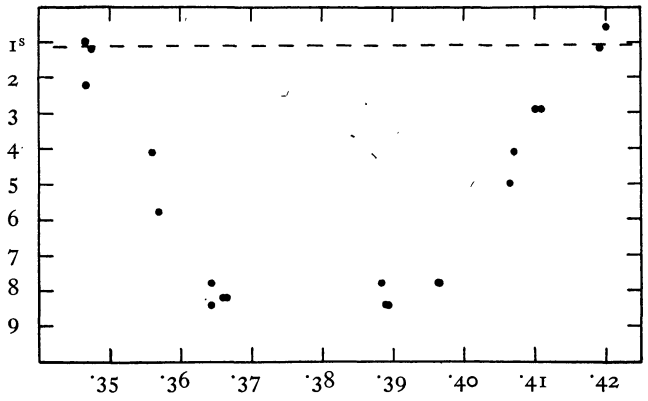
[1]) *H. C.* No. 265, 1924.
[2]) *H. B.* No. 893, 24, 1933.

present observations are well represented by this period, which is given unchanged in Table 1. Phases have been computed by means of formula (A) and the individual observations near minimum are shown plotted against phase in the figure. The mean brightness of the variable outside the minimum is $1^s.1$. Though the number of observations during minimum is small, it seems certain that the eclipse is total, the duration of the minimum and of totality being: $D = {}^P.07 = 2^d.2$ and $d = {}^P.035 = 1^d.1$. The J.D., the brightness and the phase of the observations near minimum are given in the table.

observations near minimum:
CF Scuti

J.D. −2420000	brightness	phase
d	s	P
7901.964	7.8	.3884
.996	8.4	.3894
02.948	1.2	.4192
.976	.6	.4201
32.871	4.1	.3560
.900	5.8	.3569
8668.577	8.4	.3889
9020.498	5.0	.4065
.520	4.1	.4072
50.500	.0	.3458
.521	1.0	.3465
82.469	2.2	.3467
.491	1.2	.3474
84.495	2.9	.4101
.517	2.9	.4108
9434.439	8.2	.3659
.462	8.2	.3666
.392	7.8	.3644
.392	8.4	.3644
35.414	7.8	.3964
.414	7.8	.3964

FIGURE: CF Sct



BS Sct: This eclipsing variable is the fifth of the present list with a considerable duration of totality. The new observations confirm the period derived by LANGE [1]). As the branches of the light curve are steep they provide valuable epochs for the derivation of the period. A least squares solution, which includes the half width of the minimum at brightness $6^s.0$, has been made from 10 observations on the descending and 4 on the rising branch. The reduction to brightness $6^s.0$ was performed with the adopted slope: $^s.1 \triangleq {}^d.0011$. The resulting elements are:

J.D. $+.011\,(s-6.0)\,X = 2428727^d.617 \pm 3 + 3^d.820994 \pm 16\,(E-209) + {}^d.107 \pm 3\,X$ (m.e.)

The observations used, the number of periods and the residuals are given in the table. The mean light curve computed by means of formula (A) is shown in the figure. The duration of the minimum and of totality are provisionally found to be: $D = {}^P.107 = {}^d.41$ and $d = {}^P.029 = {}^d.11$. The variable is faint on Franklin-Adams Chart 87. Further epochs of minimum have been given by TEN BRUGGENCATE [1]) and ZESSEWITSCH [2]). The last author gives two epochs of minimum from which he concludes that the period is varying. The period derived from all the epochs of minimum, with the exclusion of the second epoch by ZESSEWITSCH, is found to be: $3^d.821001 \pm {}^d.000006$ (m.e.). These epochs and their residuals are:

	d		d
Franklin-Adams	2418915.292	0	−.001
LANGE	2424788.180	1537	+.008
TEN BRUGGENCATE	5040.345	1603	−.013
ZESSEWITSCH	6557.305	2000	+.010
,,	(7665.275	2290	−.110)
OOSTERHOFF	8815.502	2591	−.005

mean light curve:
BS Scuti

n	mean phase	mean brightness
	P	s
25	.0298	.57
3	.0713	.00
3	.0817	1.13
3	.0900	3.07
3	.0980	5.43
3	.1037	7.63
3	.1057	7.93
3	.1167	10.20
3	.1267	10.53
3	.1313	10.37
3	.1373	10.07
3	.1407	10.03
3	.1527	6.87
3	.1640	3.17
2	.1795	.95
25	.2900	.48
25	.3585	.08
25	.4426	.38
25	.5369	.51
26	.6147	.49
26	.6642	.22
25	.7350	.25
25	.8217	.27
25	.8627	.51
25	.9348	.20

[1]) *Lembang Ann.* **2**, c 42, 1928.
[2]) *Tadjik Cir.* No. 1, 1934.

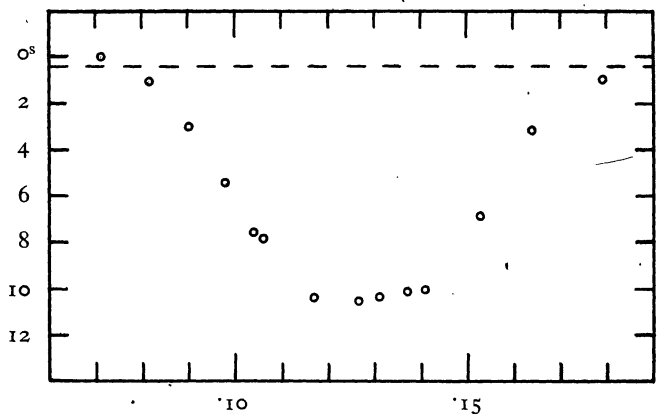
[1]) *A. N.* **229**, 451, 1927.

In Table 1 the weighted mean value has been given of this period and of the period derived from the Leiden observations alone.

descending and rising branch: BS Scuti

J.D. −2420000	brightness	X	E	O−C
d	s			d
7928·913	4·6	−1	0	+·005
·944	7·6	−1	0	+·003
·944	7·6	−1	0	+·003
8043·726	8·0	+1	30	−·018
8727·487	4·1	−1	209	−·002
9136·362	6·4	−1	316	+·001
·384	7·6	−1	316	+·009
63·336	5·6	+1	323	+·015
9434·392	5·1	−1	394	+·008
·392	6·6	−1	394	−·009
38·423	7·0	+1	395	+·006
·446	4·1	+1	395	−·003
57·341	8·6	−1	400	−·008
·341	8·9	−1	400	−·011

FIGURE: BS Sct



AN Sct: The period of this δ Cephei-type variable has been determined by Miss HARWOOD [1]). This period of 32·8543 days does not entirely satisfy the present observations. A least squares solution has been made from 10 observations on the steep rising branch. These were first reduced to brightness 5s·0 with the adopted slope: s·1 ≙ d·056. The elements thus derived are:

$$\text{J.D.} +\cdot 56\,(s - 5\cdot 0) = 2428725^{d}\cdot 68 + 32^{d}\cdot 733\,(E - 22)$$
$$\pm 11 \qquad \pm 7 \quad \text{(m.e.)}$$

The epochs, the number of periods and the residuals are given below. The maximum comes about 2·3 days later than the time given by the elements. The epoch of maximum given by Miss HARWOOD does not agree with these elements; it deviates by 5 days from the predicted time. Whether this should be attributed to a rapidly changing period, cannot be decided from the present material. A mean light curve, computed according to formula (A), is shown in the figure. It has the usual asymmetry without further special features. Information about the normal points is given in the table.

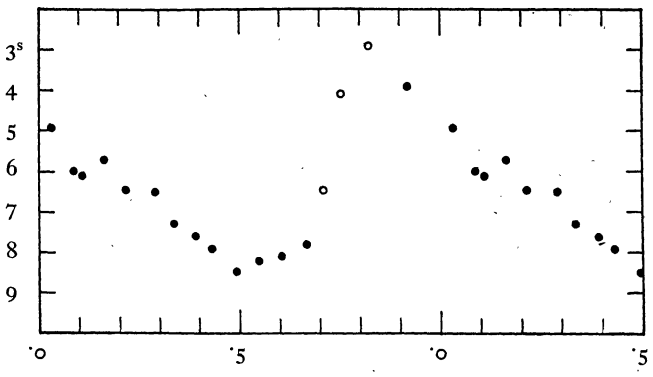
mean light curve: AN Scuti

n	mean phase	mean brightness
	P	s
18	·0336	4·94
18	·0854	5·99
18	·1081	6·10
18	·1618	5·73
18	·2153	6·46
18	·2885	6·51
18	·3360	7·28
18	·3937	7·60
18	·4301	7·92
18	·4972	8·47
18	·5486	8·22
18	·6040	8·11
18	·6671	7·81
3	·7103	6·47
4	·7562	4·08
5	·8224	2·90
18	·9177	3·90

rising branch: AN Scuti

J.D. −2420000	brightness	E	O−C
d	s		d
8004·7	5·6	0	−·5
6·8	2·8	0	+·0
38·7	4·1	1	−·1
69·6	8·4	2	+·5
8727·5	1·8	22	+·0
·5	2·3	22	+·3
9020·5	5·2	31	+·3
·5	4·2	31	−·2
84·5	6·8	33	−·2
·5	7·0	33	−·1

FIGURE: AN Sct



AP Sct: The variability of this star has been discovered by Miss CANNON [1]) and it has been classified as an RR Lyrae-type variable with a period of ·248 days by Miss HARWOOD [2]). The variable discussed here is probably identical with AP Scuti,

[1]) *H. B.* No. 893, 22, 1933.

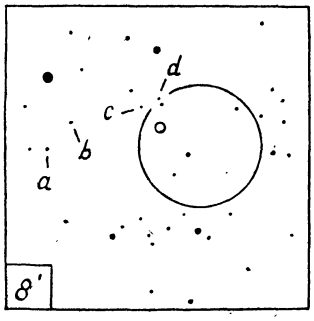
[1]) *H. C.* No. 265, 1924.
[2]) *H. B.* No. 880; 14, 1930.

although it appears to be a semi-regular variable. The star is situated near N.G.C. 6712 and its equatorial co-ordinates are:

$$\left.\begin{aligned}\alpha &= 18^h47^m41^s.3\\ \delta &= -8°49'13''\end{aligned}\right\}\ (1900.0)$$

and its position relative to the centre of the cluster is: $\Delta\alpha\cos\delta = +68''$, $\Delta\delta = +29''$. The latter co-ordinates are uncertain, as the centre of the cluster is rather ill defined. The variable and four comparison stars have been marked on the accompanying chart.

CHART: AP Sct



The large circle indicates N.G.C. 6712

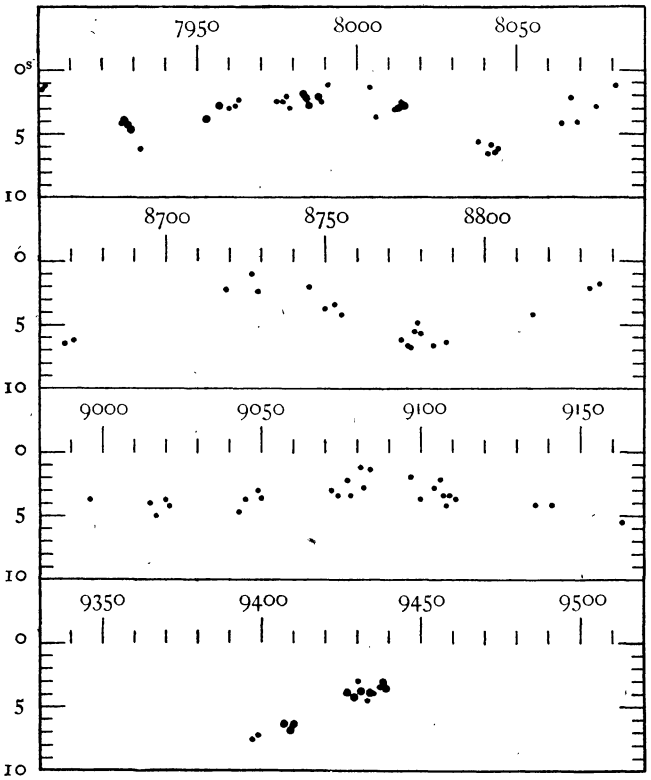
light variation: AP Scuti

J.D. −2420000	mean brightness	n	J.D. −2420000	mean brightness	n	J.D. −2420000	mean brightness	n
	s			s			s	
7901	1·5	2	8067	2·2	1	9074	3·4	3
02	1·2	2	69	4·1	1	77	2·2	2
26	4·1	3	75	2·8	1	78	3·4	2
27	3·9	5	81	1·2	1	81	1·2	1
28	4·3	4	8668	6·5	2	82	2·8	2
29	4·7	5	71	6·2	2	84	1·4	2
32	6·2	2	8719	2·2	2	97	2·0	2
53	3·8	4	27	1·0	2	9100	3·7	1
57	2·8	4	29	2·4	2	04	2·8	2
60	3·0	1	45	2·0	2	06	2·2	2
62	2·8	3	50	3·7	1	07	3·4	2
63	2·4	3	53	3·4	2	08	4·2	2
75	2·5	1	55	4·2	1	09	3·4	2
77	2·5	1	74	6·2	2	11	3·7	2
78	2·1	3	76	6·6	1	36	4·2	2
79	3·0	2	77	6·8	2	41	4·2	2
83	1·9	8	78	5·5	2	63	5·5	2
84	2·2	20	79	4·8	1	9397	7·5	1
85	2·8	16	80	5·7	1	99	7·2	1
88	2·1	18	84	6·6	1	9407	6·3	4
89	2·5	1	88	6·4	2	09	6·8	4
91	1·2	2	8815	4·2	1	10	6·3	6
8004	1·4	1	33	2·1	1	27	3·8	4
06	3·7	1	36	1·8	1	29	4·2	4
12	3·1	3	8996	3·7	1	30	2·9	2
13	3·0	6	9015	4·0	2	31	3·7	6
14	2·5	1	17	5·0	2	33	4·5	2
15	2·8	4	20	3·7	2	34	3·9	4
38	5·7	1	21	4·2	1	35	3·9	2
41	6·6	1	43	4·7	2	37	3·4	2
42	5·9	2	45	3·7	2	38	3·0	7
43	6·5	2	49	3·0	2	39	3·5	7
44	6·2	1	50	3·6	2			
64	4·2	1	72	3·0	1			

The long series of observations during a number of nights exclude a rapid change in brightness. Therefore night means have been computed, which are given in the following table.

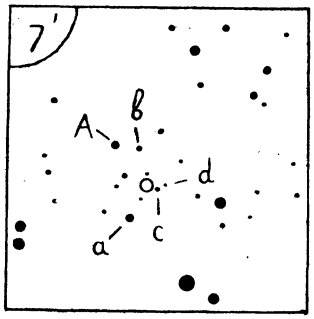
They are graphically represented for the separate oppositions in the figure. The first two oppositions show a light variation, which resembles that of the β Lyrae-type, but with the very long apparent period of 105 days. The observations of the fourth opposition are also satisfactorily represented by this period, but those of the third opposition do not fit in and it seems therefore certain that this variable is semi-regular. The total range of the light variation is estimated to be rather less than a magnitude.

FIGURE: AP Sct



AY Sct: The variable discussed here is probably identical with AY Scuti, notwithstanding the small difference in the star's position. The variable and its comparison stars have been marked on the chart.

CHART: AY Sct



The star is a cluster-type variable and the period has been derived from 23 observations on the rising branch, which were first reduced to brightness $5^{s}.0$ by means of the adopted slope: $^{s}.1 \mathrel{\widehat{=}} {}^{d}.000517$. The elements resulting from a least squares solution are:

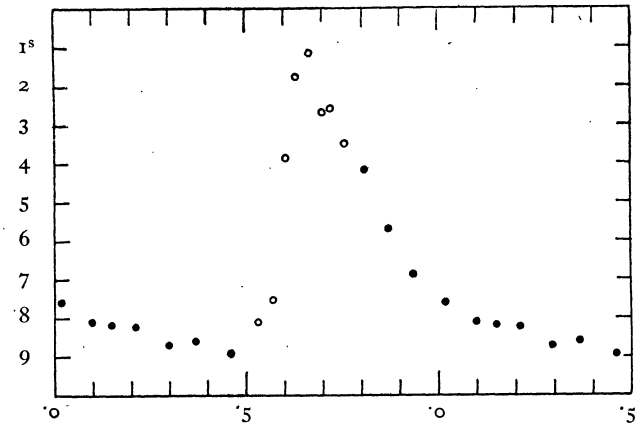
$$\text{J.D.} + {}^{d}.00517\,(s - 5^{s}.0) = 2428745^{d}.4412 \pm 14 + {}^{d}.5446323 \pm 8\,(E - 1501)\ \text{(m.e.)}$$

The epochs, the number of periods and the residuals from these elements are tabulated below. A mean light curve computed according to formula (A) is shown in the figure. It belongs to BAILEY's subclass *a*.

mean light curve: AY Scuti

n	mean phase	mean brightness	*n*	mean phase	mean brightness
	P	s		P	s
16	·0188	7·58	8	·6016	3·88
16	·0999	8·11	8	·6269	1·78
16	·1524	8·18	8	·6636	1·15
16	·2144	8·24	8	·6985	2·70
16	·2984	8·72	8	·7202	2·60
17	·3671	8·61	8	·7568	3·48
17	·4606	8·95	16	·8044	4·17
8	·5349	8·10	16	·8689	5·70
8	·5729	7·55	16	·9369	6·87

FIGURE: AY Sct



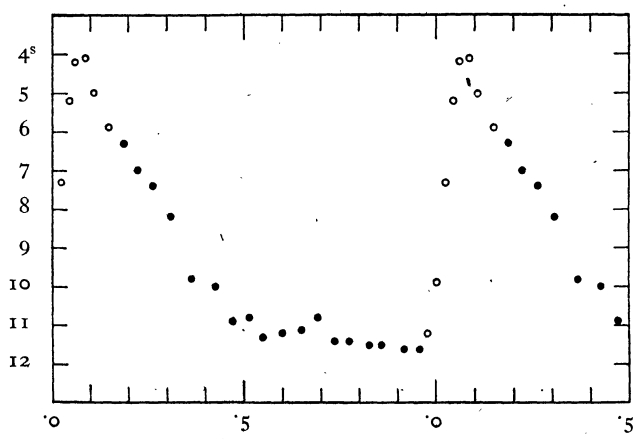
rising branch: AY Scuti

J.D. −2420000	brightness	E	O−C
d	s		d
7927·954	3·8	0	·000
32·871	2·8	9	+·010
62·816	1·9	64	−·004
63·878	5·7	66	−·012
88·398	7·2	111	+·007
·419	1·9	111	+·001
8727·465	5·7	1468	+·001
·487	2·5	1468	+·006
45·432	8·4	1501	+·008
·453	·0	1501	−·014
8996·531	3·4	1962	+·006
9020·498	2·2	2006	+·003
97·281	4·5	2147	+·005
9106·515	9·3	2164	+·005
11·415	7·9	2173	−·004
·437	5·7	2173	+·006
9399·546	4·2	2702	−·002
9410·443	2·8	2722	−·006
·443	2·4	2722	−·008
29·485	7·2	2757	−·003
·485	7·9	2757	+·001
34·392	5·7	2766	−·005
·392	6·8	2766	+·000

TT Sct: Like the preceding star TT Sct is a faint RR Lyrae-type variable. It has been investigated by Miss HARWOOD, who gives a period of ·452936 days [1]). The present observations confirm this period. From 20 observations on the rising branch, which were first reduced to brightness $8^{s}.0$ with the adopted slope: $^{s}.1 \mathrel{\widehat{=}} {}^{d}.00037$, the elements derived by least squares are found to be:

$$\text{J.D.} + {}^{d}.0037\,(s - 8^{s}.0) = 2428671^{d}.5246 \pm 8 + {}^{d}.4529390 \pm 8\,(E - 1699)\ \text{(m.e.)}$$

FIGURE: TT Sct



Details of this solution are given below. A mean light curve has been formed according to formula (A). It is shown in the figure and it belongs to BAILEY's subclass *a*. Near minimum the observations have little weight as the variable is then very faint and near the limit of the plate.

BN Sct: The period of this Algol variable has been determined by KORDYLEWSKY [2]) and PARENAGO [3]). The present observations confirm the period of 14·6118 days, which could be slightly improved by means of the observations on the steep branches of the minimum. The period finally adopted is: 14·61155

[1]) *H. B.* No. 893, 22, 1933.
[2]) *Circ. Obs. Cracovie* No. 19, 1925; No. 22, 1926.
[3]) *F. P. A. N. N.* 3, 118, 1931.

mean light curve: TT Scuti

n	mean phase	mean brightness
	P	s
5	·0004	9·9
5	·0238	7·3
5	·0440	5·2
5	·0606	4·2
5	·0856	4·1
5	·1084	5·0
7	·1477	5·9
10	·1870	6·3
10	·2237	7·0
10	·2634	7·4
10	·3085	8·2
10	·3639	9·8
10	·4271	10·0
10	·4745	10·9
10	·5160	10·8
10	·5492	11·3
10	·5992	11·2
10	·6522	11·1
10	·6937	10·8
10	·7378	11·4
10	·7743	11·4
10	·8277	11·5
10	·8579	11·5
10	·9176	11·6
5	·9576	11·6
5	·9786	11·2

rising branch: TT Scuti

J.D. −2420000	brightness	E	O−C
d	s		d
7901·9964	4·1	0	+·0008
26·9007	5·3	55	−·0021
83·9605	9·9	181	+·0044
85·3174	8·4	184	−·0030
·3389	4·1	184	+·0026
88·4844	8·0	191	−·0081
·5059	5·0	191	+·0023
8671·5390	4·1	1699	·0000
8719·5305	10·2	1805	+·0025
29·4931	11·6	1827	+·0056
·5153	3·3	1827	−·0029
50·3475	5·9	1873	+·0037
74·3275	11·2	1926	−·0025
·3494	6·3	1926	+·9013
78·4233	6·8	1935	+·0007
79·3346	5·9	1937	+·0027
9017·5575	10·9	2463	−·0018
·5796	5·0	2463	−·0015
97·2809	8·7	2639	−·0038
9109·5026	11·6	2666	−·0008

days with an estimated mean error of ±·00015 days. A mean light curve has been formed with the aid of formula (A). Information about the normal points is given in the table and the light curve is shown in the figure. Only the beginning of the descending and of the rising branch has been observed. The phase of minimum, which is found to be ·5110, is therefore somewhat uncertain. A reflected light curve is shown in the right hand part of the figure. The eclipse is total and the duration of minimum and of totality is: $D = {}^{P}\cdot09 = 1^{d}\cdot3$ and $d = {}^{P}\cdot02 = {}^{d}\cdot29$ respectively.

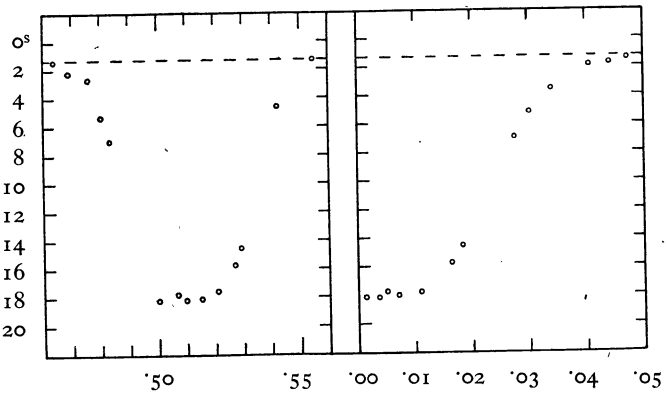
mean light curve: BN Scuti

n	mean phase	mean brightness
	P	s
27	·0129	1·51
26	·1085	1·44
26	·2785	1·19
26	·3779	1·19
26	·4402	1·20
4	·4642	1·45
4	·4688	2·25
4	·4758	2·70
4	·4805	5·32
4	·4835	6·98
4	·5032	18·25
4	·5068	17·80
4	·5098	18·15
4	·5152	18·12
5	·5212	17·66
3	·5273	15·73
3	·5293	14·53
1	·5420	4·60
2	·5545	1·30
26	·6023	1·53
26	·7010	·99
26	·7664	1·25
26	·9129	1·28

reflected light curve: BN Scuti

n	mean phase	mean brightness
	P	s
4	·0012	18·15
4	·0035	18·18
4	·0050	17·75
4	·0070	18·02
5	·0108	17·78
3	·0163	15·73
3	·0183	14·53
4	·0275	6·92
4	·0302	5·20
4	·0338	3·58
4	·0405	1·95
4	·0442	1·80
3	·0473	1·40

FIGURE: BN Sct



VZ Aql: Miss HARWOOD has classified this star as a δ Cephei-type variable with a period of 1·66825 days [1]). The new observations are in full accordance with these results. The mean light curve, which is shown in the figure, is however very remarkable. Directly after minimum at $10^{s}\cdot9$ the variable reaches a sharp maximum of brightness $8^{s}\cdot1$. Then the brightness drops again to $9^{s}\cdot8$ after which a very steep rise brings the variable to its maximum at $2^{s}\cdot7$. The irregularities on the descending branch are not believed to be real. The secondary maximum however is very pronounced and is real beyond doubt. Accurate photometric observations of this variable seem to be required. The brightness at different phases is estimated to be:

[1]) *H. B.* No. 893, 22, 1933.

	s	m
primary maximum:	2·8	13·0
secondary maximum:	8·1	13·9
primary minimum:	10·9	14·4
secondary minimum:	9·8	14·2

The observations on the very steep ascending branch between secondary minimum and primary maximum have been used for a least squares solution of the period. They were first reduced to brightness $6^{s}\cdot0$ by means of the adopted slope: $^{s}\cdot1 \mathrel{\widehat{=}} {}^{d}\cdot0016$. The resulting elements are:

$$\text{J.D. } +\cdot016\ (s - 6\cdot0) = 2428727^{d}\cdot522 + 1^{d}\cdot668226\ (E - 443)$$
$$\pm\ 4 \quad \pm\ 13 \quad \text{(m.e.)}$$

The epochs used, the number of periods and the residuals from these elements are tabulated below.

rising branch: VZ Aquilae

J.D. −2420000	brightness	E	O−C
d	s		d
7988·463	7·4	0	−·013
·484	5·5	0	−·022
·506	5·2	0	−·005
·527	3·5	0	−·011
·549	3·0	0	+·003
·570	3·5	0	+·032
91·909	2·6	·2	+·021
8727·465	10·8	443	+·020
·487	7·4	443	−·013
9049·434	8·6	636	−·013
74·524	6·2	651	+·014
·549	3·5	651	−·004
84·495	8·6	657	+·015
·517	5·2	657	−·018
9109·481	8·9	672	−·019
·503	8·0	672	−·011
9431·476	9·8	865	+·024

mean light curve: VZ Aquilae

n	mean phase	mean brightness	n	mean phase	mean brightness
	P	s		P	s
10	·0560	7·5	5	·5820	9·8
10	·1094	8·4	5	·5954	8·2
10	·1725	9·1	5	·6206	5·1
10	·2275	9·9	5	·6540	2·7
10	·2611	10·4	5	·6742	2·8
10	·2869	10·8	5	·6884	3·2
10	·3273	10·9	5	·6998	4·4
10	·3666	10·9	10	·7302	4·7
10	·4080	10·6	10	·7594	4·9
5	·4766	8·7	10	·7908	4·8
5	·4924	8·0	10	·8194	5·0
5	·5122	8·4	10	·8582	5·6
5	·5320	8·7	10	·8970	6·4
5	·5588	9·8	10	·9745	7·4

FIGURE: IM Aql

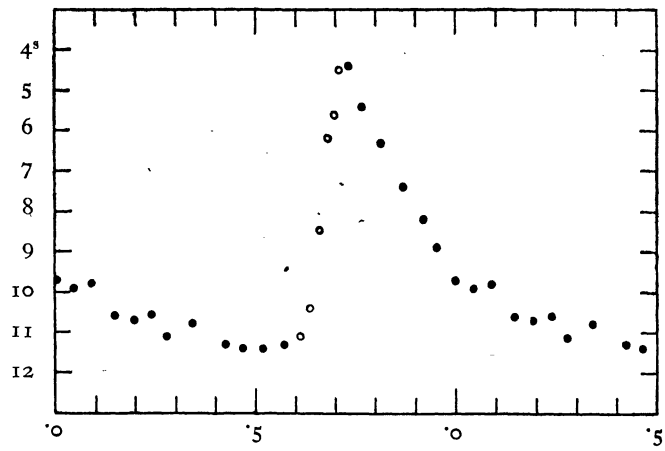
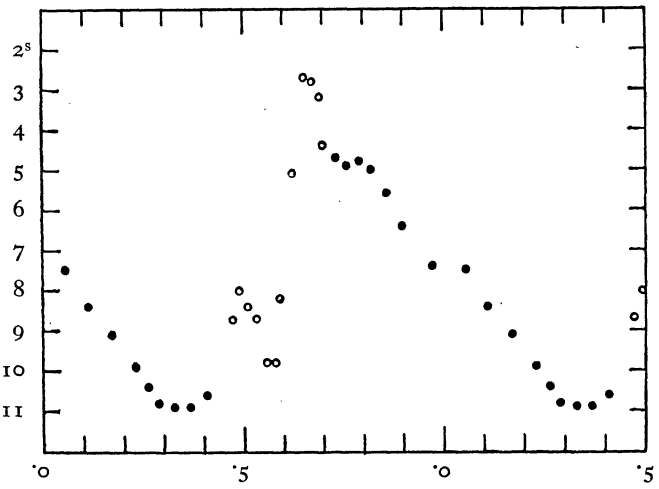


FIGURE: VZ Aql



IM Aql: This RR Lyrae-type variable is H.V. 4942 and has been investigated by Miss HARWOOD. At first she derived a period of ·264190 days and classified the star as a cluster-type variable of BAILEY's subclass *a* [1]). According to a second note by the same author [2]) the star belongs to BAILEY's subclass *c* and has a period of ·313368 days. Both periods are erroneous, the true period being ·4569 days. The reciprocal values of the spurious periods, 3·79 and 3·19 respectively, are related in a simple manner with the true reciprocal period 2·19. The period has been computed from 20 observations on the steep rising branch, which were first reduced to brightness $8^{s}\cdot0$ by means of the adopted slope: $^{s}\cdot1 \mathrel{\widehat{=}} {}^{d}\cdot00047$. The elements derived by least squares are:

$$\text{J.D. } +\cdot0047\ (s - 8\cdot0) =$$
$$2428064^{d}\cdot6720 + {}^{d}\cdot4569565\ (E - 356)$$
$$\pm\ 14 \quad \pm\ 13 \quad \text{(m.e.)}$$

The epochs used, the number of periods and the residuals from these elements are given in the table. The mean light curve computed with formula (A) is shown in the figure. It is typical for BAILEY's subclass *a*.

[1]) *H. B.* No. 880, 12, 1930.
[2]) *H. B.* No. 893, 22, 1933.