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PERIODS AND MEAN LIGHT CURVES OF 22 LONG PERIOD  
VARIABLES IN A FIELD CENTERED AT  $\alpha = 13^{\text{h}}$ ,  $\delta = -70^{\circ}$

This report gives the results of a study of 22 new long period variable stars in a galactic field centered at  $\alpha = 13^{\text{h}}$ ,  $\delta = -70^{\circ}$ . The results of a search for short and intermediate period variables in the same field have been reported by Deurinck and Vissenberg (1973). The variable stars were discovered with a blink microscope, and their light variability measured on 551 photographic plates that were taken with the 10-inch telescope of the Boyden Observatory. The observations span 11 years. The apparent magnitudes of the variables were estimated on each plate with Pogson's method using six comparison stars for each variable star. When a variable star becomes fainter than the limiting magnitude of the photographic plates, which is about  $16^{\text{m}}.1$ , it is assigned an apparent magnitude of  $16^{\text{m}}.1$ . For each comparison star the number of stars brighter than this comparison star were counted in one square degree around each variable star. The apparent magnitudes of the comparison stars were then derived by interpolation in the Tables of the Groningen Publication Nr. 43. The periods and the mean light curves were determined by means of computer analysis using the Phase Dispersion Minimization method (PDM) (Stellingwerf, 1978), the program of which was kindly put at our disposal by R. Stellingwerf. The PDM method can be applied successfully to variables for which there are only a few observations of maximum or minimum light, which makes the usual least squares treatment of the observed moments of maximum or minimum light impossible. In the case of long period variables there are very few observations of maximum light even if the observations span several years. The PDM method has been used with a bin structure  $N_b = 20$ ,  $N_c = 2$  (the notation is Stellingwerf's 1978).

The variables are indicated on identification charts 1-22, which cover a field of about 30 minutes of arc squares with North on top. On Table I we have listed for each variable star the program number, the provisional coordinates, the period with an accuracy of about  $0.5^d$ , the apparent magnitude of maximum light of the mean light curve, the total variation of the mean light curve, the number of estimates, the number of observed moments of maximum light, and the Julian date of the observed moment of maximum light that is closest to the midpoint of the observations. No amplitude is given for stars that become fainter than the limiting magnitude of the photographic plates. Because of the finite width of the bins, the maximum and total variation of the mean light curve underestimate the true maximum and total variation. The difference between the true maximum and the maximum of the mean light curve is of the order of  $A/N_b \approx 0.2^m$  which is about the accuracy of the magnitude determination of the comparison stars. On Table II we have summarized the basic quantities of the PDM analysis of the light curves. The notation  $\sigma^2$ ,  $\sigma_0^2$ ,  $\sigma_N^2$ ,  $\theta_{\min}$ , and  $\epsilon$  is Stellingwerf's.  $\theta_{\min}$  is typically 0.1 and in all cases smaller than 0.2 so that generally 90% and always more than 80% of the initial variance of the data has been removed by the mean light curve at the indicated period. The signal-to-noise ratio is typically 3 to 4. Table II is followed by a list of remarks on individual variables. Here we have also indicated the stars that are invisible (fainter than the limiting magnitude of the photographic plates) during a considerable portion of the total phase interval.

Light curves are presented by Figures 1-22. Individual observations (estimated magnitudes) are indicated by an asterisk \*, bin means by +, the spline fit to the bin means, which is used to remove the oscillation from the data and to calculate the residuals, by x. The symbol Q is used whenever at least two out of the three symbols, \*, + and x, coincide.

Acknowledgement. The authors are grateful to R.J. Stellingwerf.

Table I

Nr	$\alpha$	$\delta$	P	$V_{\max}$	A	NE	Nm	JD 2 437 000 +
1	12 <sup>h</sup> 21 <sup>m</sup> 25 <sup>s</sup>	- 67° 58.6	248 <sup>d</sup> .6	13.1		477	2	1915
2	12 33 02	- 69 30.7	155.3	12.5	3.4	502	6	1472
3	12 40 40	- 69 28.5	220.4	12.75		410	4	1504
4	12 42 28	- 69 50.1	408.7	14.1	1.7	389	6	1812
5	12 42 39	- 70 05	279.4	14.6		446	4	1911
6	12 44 09	- 69 20.1	349.0	12.75		408	1	368
7	12 46 00	- 71 31.9	131.5	14.0		456	6	1474
8	12 49 08	- 67 25.3	347.8	14.5		416	2	757
9	12 49 59	- 73 35.6	202.9	12.1		508	7	1178
10	12 51 13	- 70 40.8	297.6	13.8		495	4	1530
11	12 51 35	- 67 32.4	253.3	14.1		412	4	1910
12	12 51 57	- 72 23.9	329.3	12.9		457	5	1490
13	12 52 11	- 70 39.4	341.7	13.55		331	2	3044
14	12 55 13	- 67 16.7	199.5	12.0		483	4	1202
15	13 02 15	- 72 58.0	209.9	13.35		458	2	1468
16	13 03 02	- 67 53.7	317.7	11.45	4.55	496	5	3008
17	13 08 38	- 67 18.6	203.3	12.15	3.65	479	6	1511
18	13 10 12	- 67 13.1	352.7	13.45		469	1	1213
19	13 10 20	- 65 34.3	189.2	12.8		415	6	1502
20	13 21 04	- 72 12.4	275.15	13.75		391	2	403
21	13 22 38	- 67 09.2	241.75	13.4		383	2	1461
22	13 22 45	- 72 39.4	316.05	12.55		454	5	1407

Nr : program number which refers to the identification chart

$\alpha, \delta$  : provisional coordinates for 1900

P : period in days

$V_{\max}$  : apparent magnitude of maximum light of the mean light curve

A : total variation of the mean light curve

NE : number of estimates

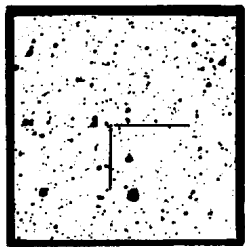
Nm : number of observed moments of maximum light

JD : mean epoch

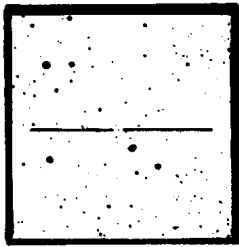
Table II

Characteristic quantities of the PDM analysis of the light curves

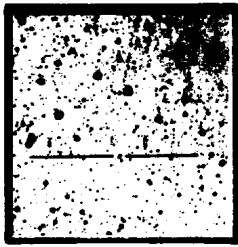
Nr	$\sigma^2$	$\sigma_N^2$	$\sigma_0^2$	$\theta_{\min}$	$\epsilon$
1	1.156	0.101	1.055	0.102	3.2
2	1.626	0.096	1.530	0.069	4.0
3	2.016	0.116	1.900	0.064	4.0
4	0.350	0.034	0.316	0.108	3.0
5	0.404	0.021	0.382	0.090	4.2
6	1.079	0.079	1.000	0.087	3.4
7	0.761	0.040	0.721	0.061	4.3
8	0.391	0.051	0.340	0.159	2.6
9	2.245	0.125	2.120	0.065	4.1
10	0.685	0.087	0.598	0.139	2.6
11	0.499	0.038	0.461	0.089	3.5
12	1.026	0.059	0.967	0.070	4.0
13	0.572	0.040	0.532	0.079	3.6
14	1.723	0.029	1.594	0.092	3.5
15	1.124	0.068	1.056	0.076	3.9
16	1.836	0.082	1.754	0.058	4.6
17	1.855	0.147	1.708	0.090	3.4
18	1.416	0.198	1.218	0.153	2.5
19	1.042	0.156	0.886	0.170	2.4
20	0.958	0.025	0.933	0.036	6.2
21	1.355	0.078	1.277	0.076	4.0
22	1.740	0.124	1.616	0.097	3.6



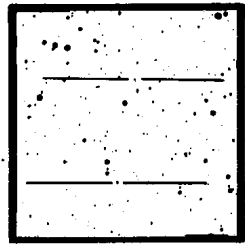
Var. 1



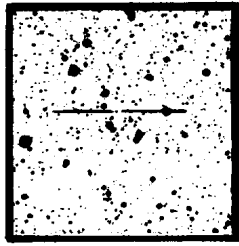
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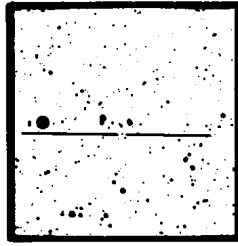
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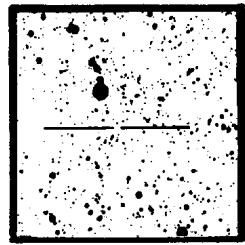
Var. 4 and 5



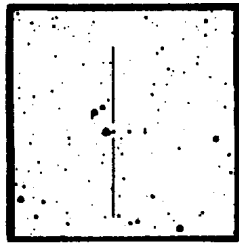
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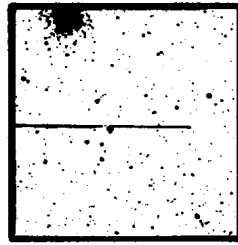
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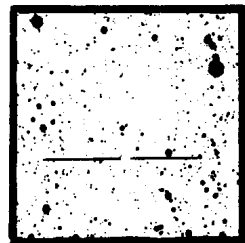
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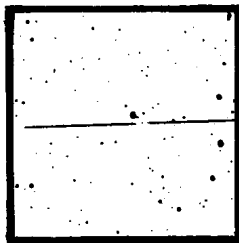
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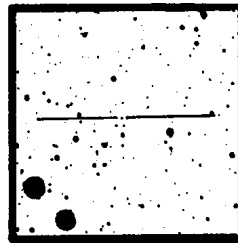
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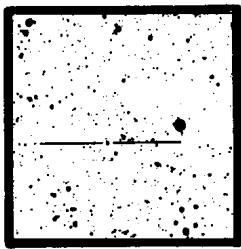
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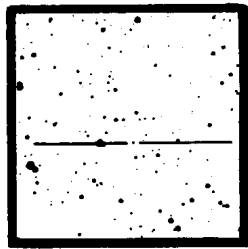
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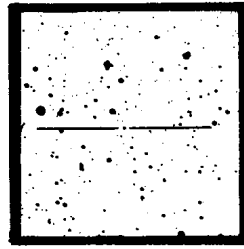
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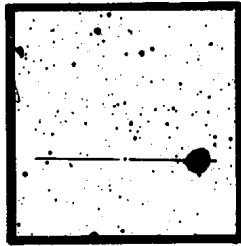
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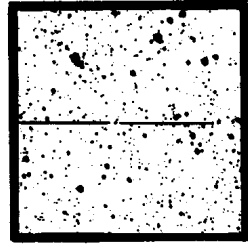
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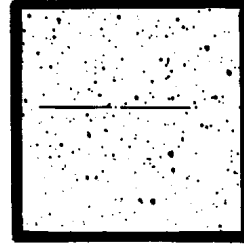
Var. 16



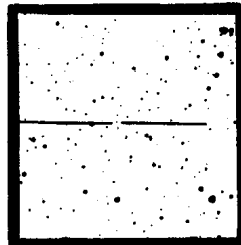
Var. 17



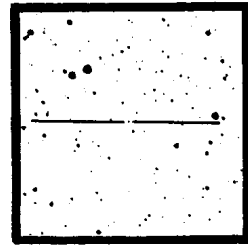
Var. 18



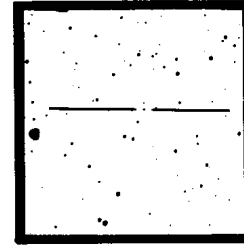
Var. 19



Var. 20



Var. 21



Var. 22

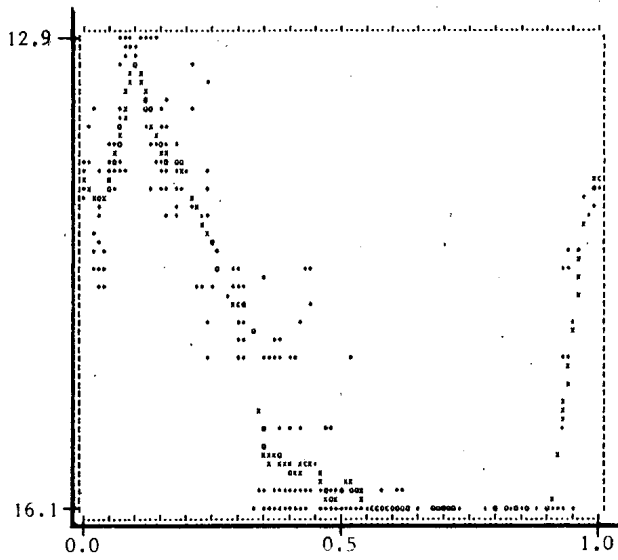


FIG. 1. Variable 1

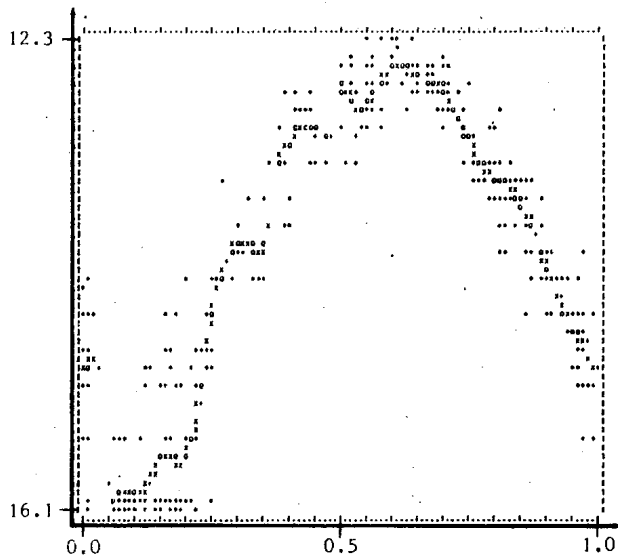


FIG. 2. Variable 2

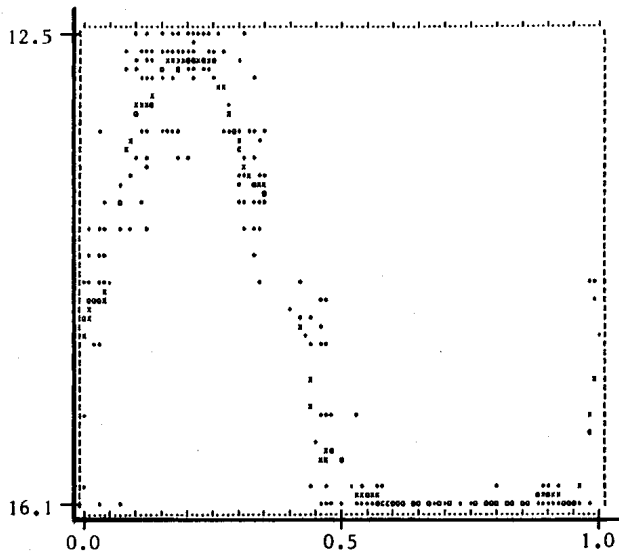


FIG. 3. Variable 3

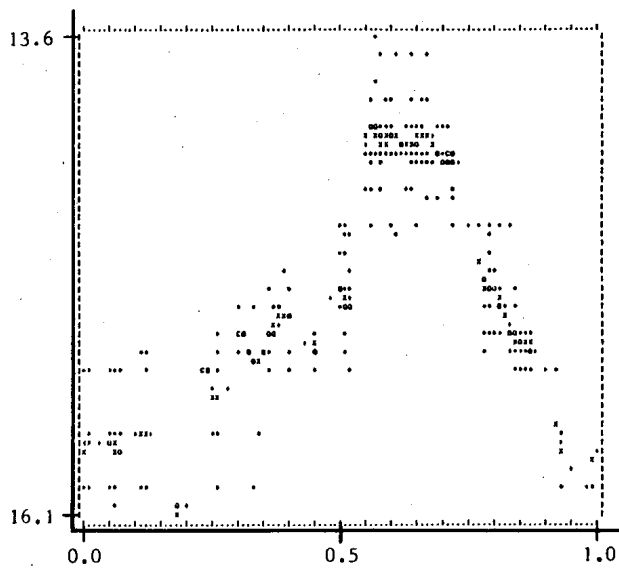


FIG. 4. Variable 4



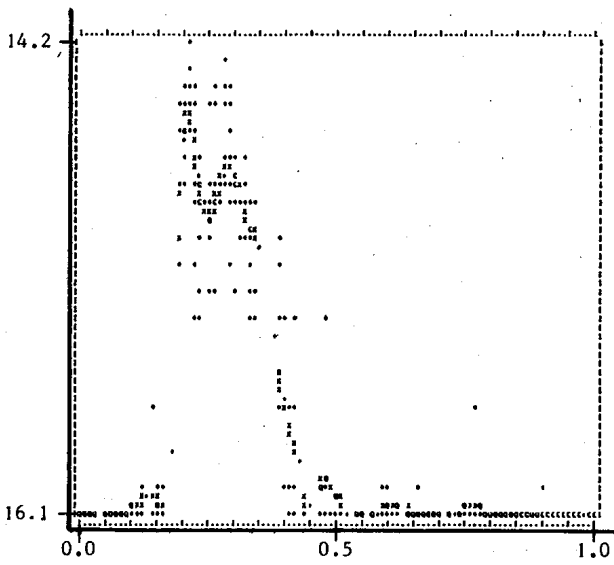


FIG. 5. Variable 5

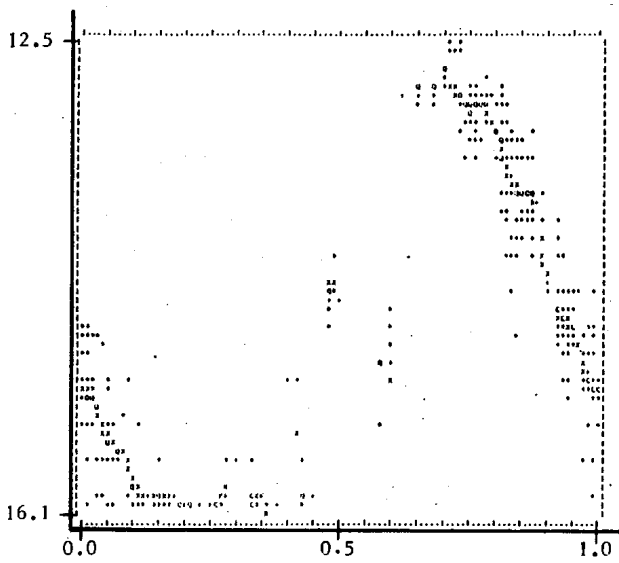


FIG. 6. Variable 6

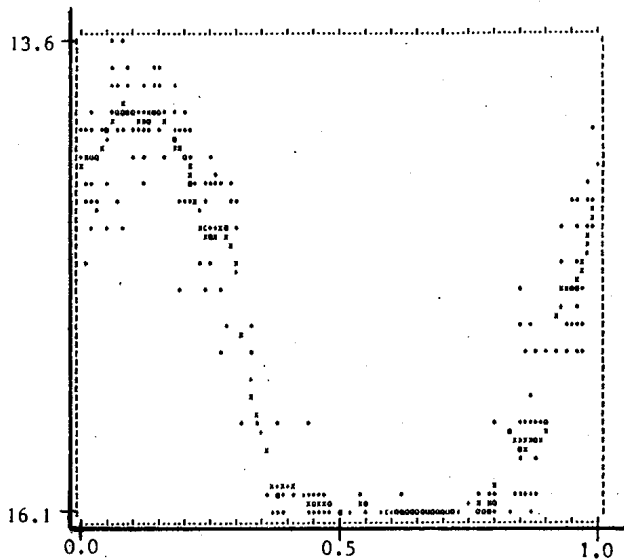


FIG. 7. Variable 7

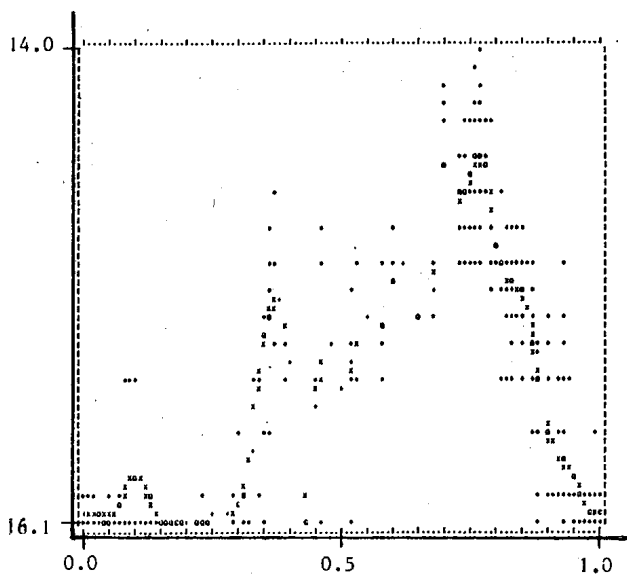


FIG. 8. Variable 8

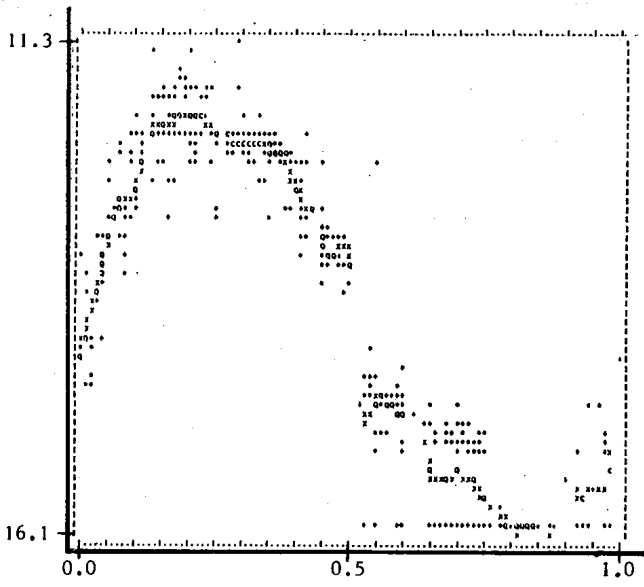


FIG. 9. Variable 9

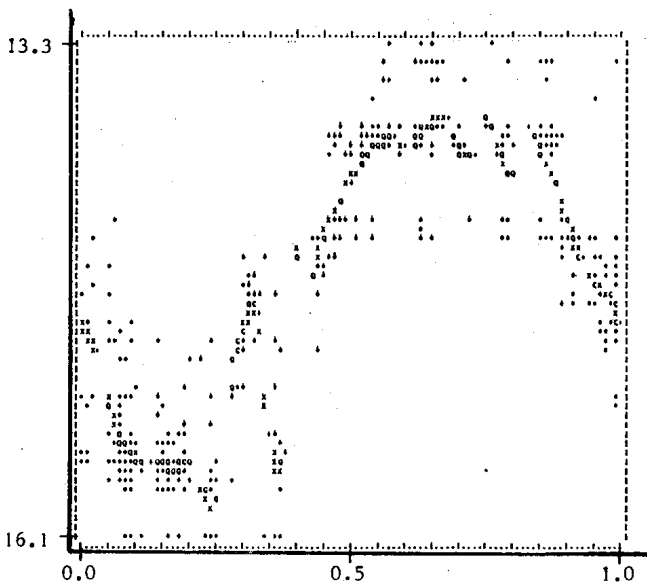


FIG. 10. Variable 10

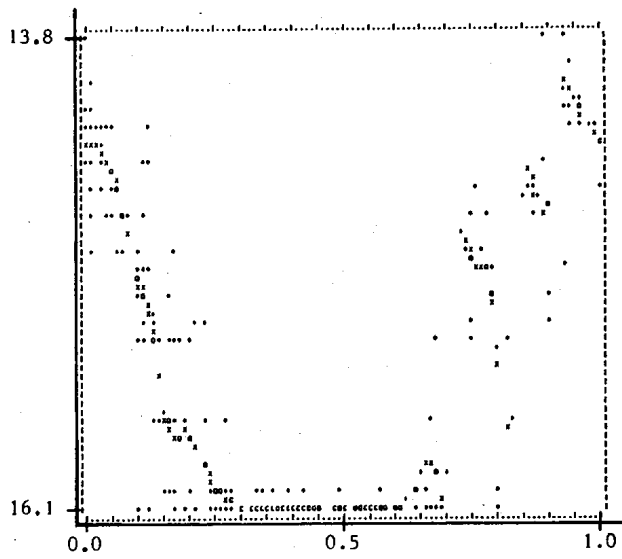


FIG. 11. Variable 11

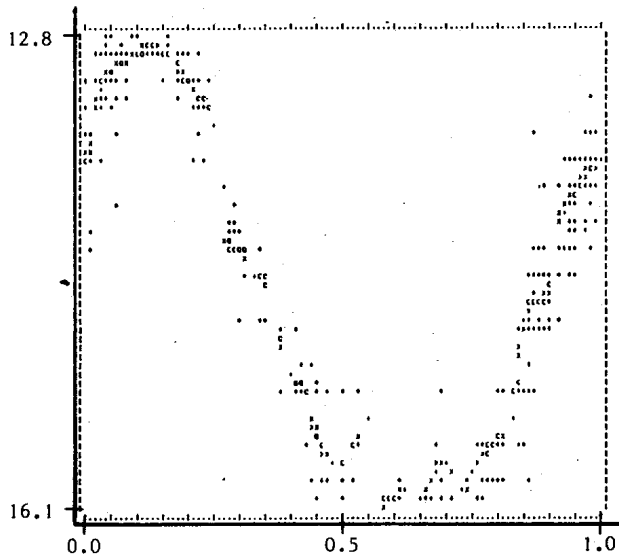


FIG. 12. Variable 12

13

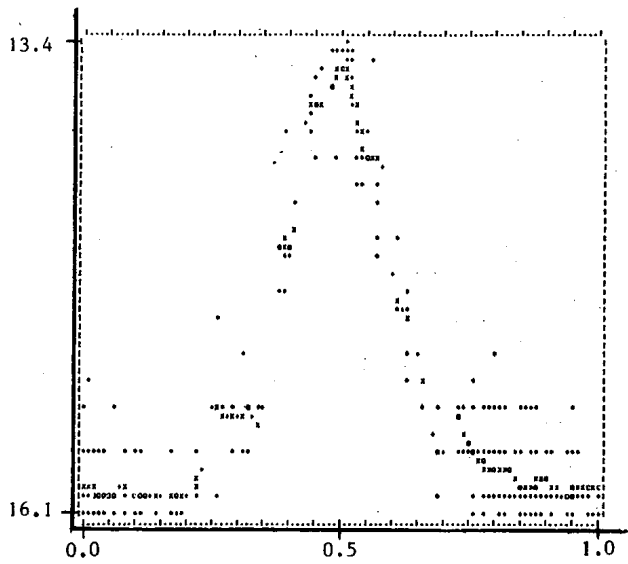


FIG. 13. Variable 13

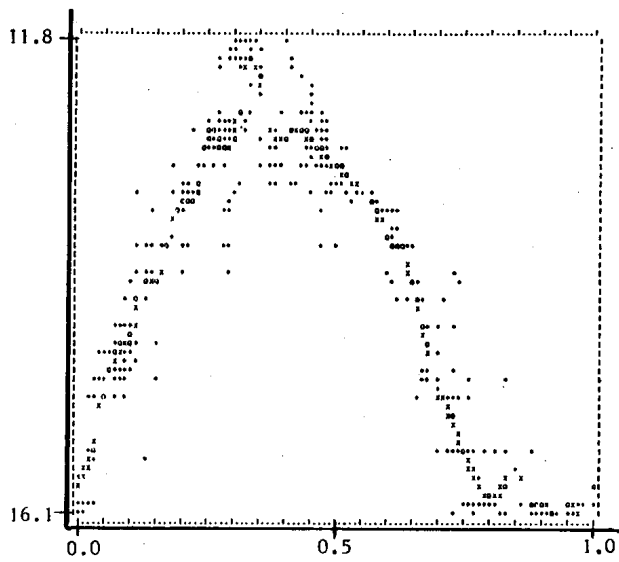


FIG. 14. Variable 14

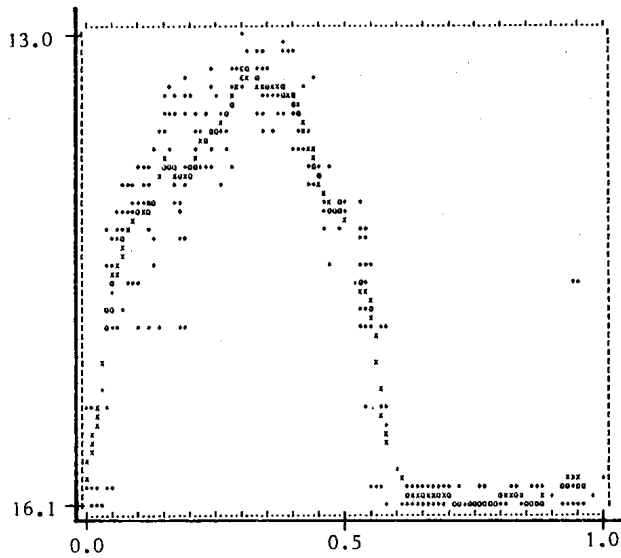


FIG. 15. Variable 15

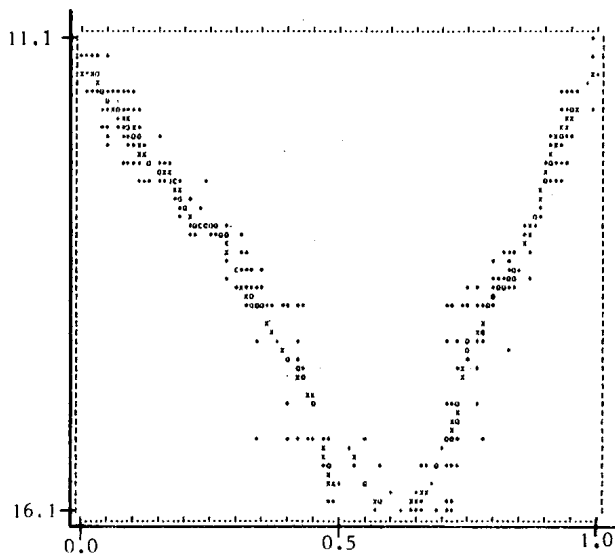


FIG. 16. Variable 16

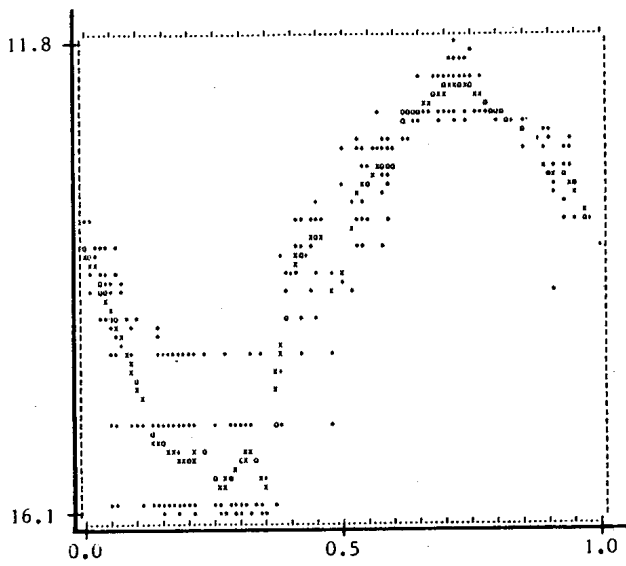


FIG. 17 Variable 17

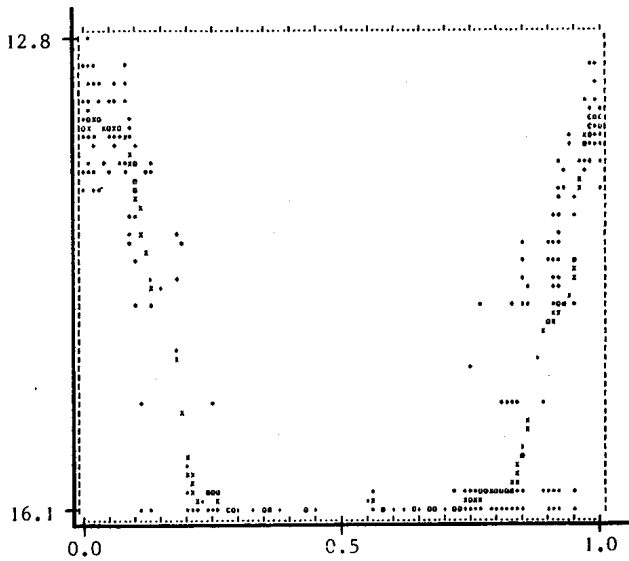


FIG. 18 Variable 18

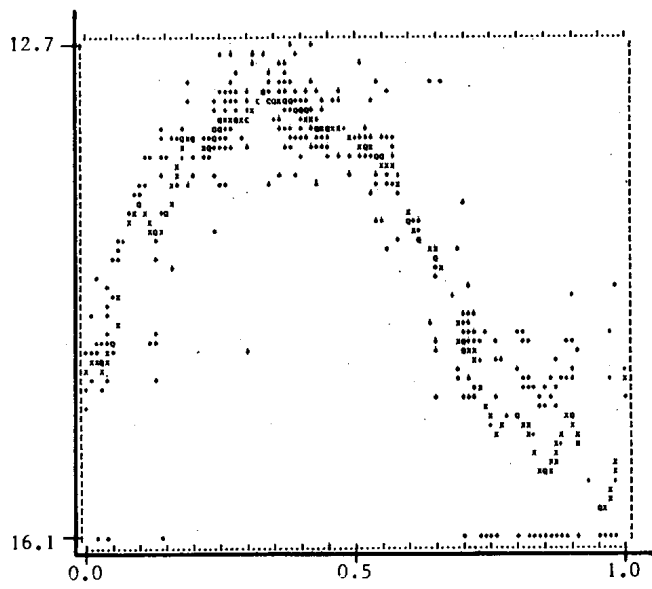


FIG. 19. Variable 19

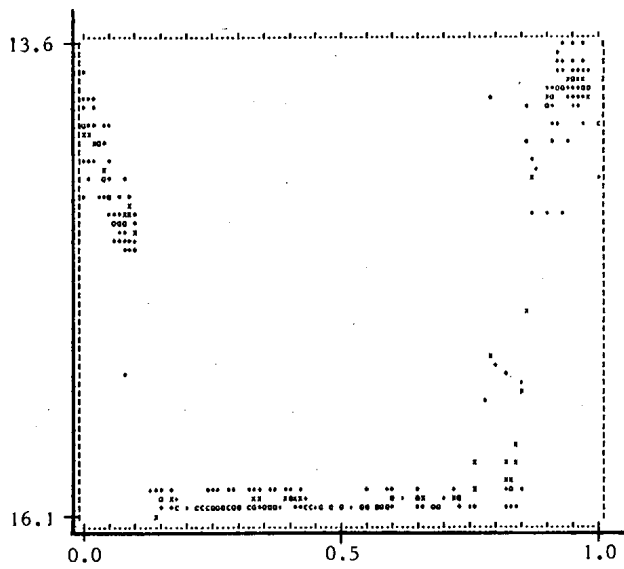


FIG. 20. Variable 20



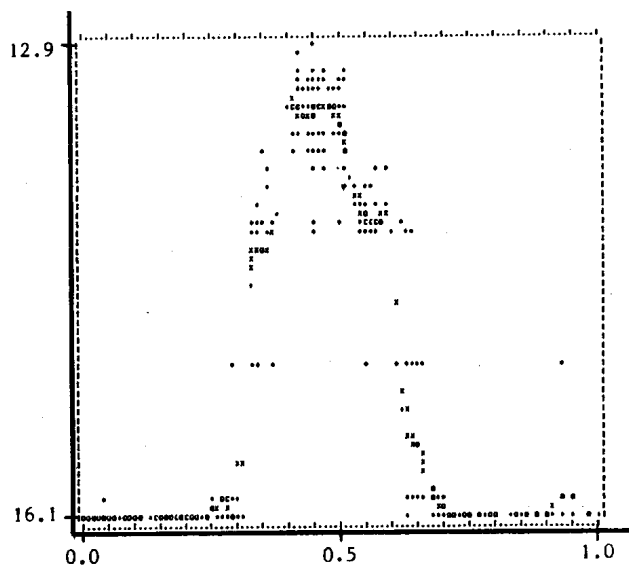


FIG. 21. Variable 21

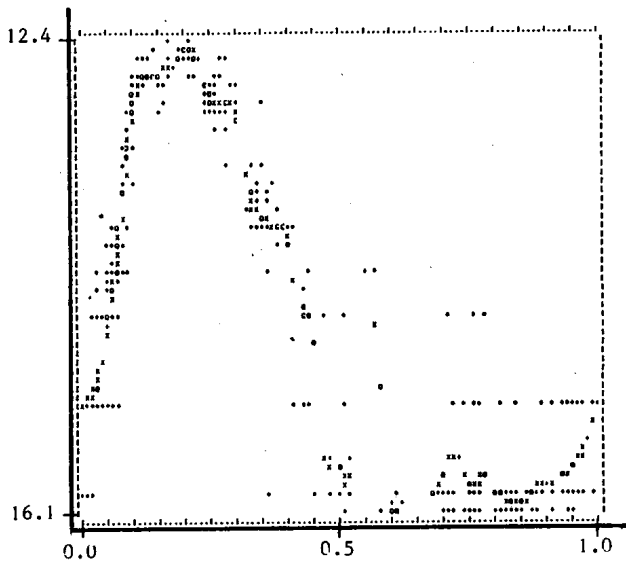


FIG. 22 Variable 22

## Individual remarks

- Var. 1. Invisible during about  $2/5$  of the total phase interval.
- Var. 3. Invisible during about  $1/4$  of the total phase interval.
- Var. 4. Bump on the ascending branch.
- Var. 5. Invisible during about  $7/10$  of the total phase interval, the light curve has probably a double maximum.
- Var. 7. Invisible during about  $1/3$  of the total phase interval.
- Var. 11. Invisible during about  $1/2$  of the total phase interval.
- Var. 14. Intensity of maximum light decreases in time.
- Var. 15. Invisible during about  $1/4$  of the total phase interval.
- Var. 18. Invisible during about  $1/3$  of the total phase interval.
- Var. 20. Invisible during about  $7/10$  of the total phase interval.
- Var. 21. Invisible during about  $3/5$  of the total phase interval.

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- Deurinck, R. and Vissenberg, B. : 1973, I.B.V.S. No. 793.
- Stellingwerf, R.J. : 1978, Ap. J. 224, 953.