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PUBLICATIONS OF THE

VARIABLE STAR SECTION

ROYAL ASTRONOMICAL SOCIETY OF NEW ZEALAND

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2002 May 20th

HDE 331015 - A NEW LARGE AMPLITUDE ECLIPSING BINARY

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SUMMARY: The suspected variable star HDE 331015 Arae has been investigated visually by members of the VSS, RASNZ. The available data indicates HDE 331015 is an Algol type eclipsing binary of period near 9.4169895 days, a mean magnitude range of 11.0 to 13.4v with a flat bottom eclipse light curve. No information regarding the secondary minimum is available as this has not been detected in the visual data. A preliminary ephemeris is provided to allow for a thorough investigation by more accurate methods.

INTRODUCTION

HDE 331015 is located RA 16h 37m 23.4s Dec -48deg 42' 11" (epoch 2000). Alternative designations include Cod -48 10986 and GSC 8329-3364. It has a GSC magnitude of 11.14 and spectral class shown as type A.

Variability of HDE 331015 was first noted by Paul Camilleri (1) on films exposed on 1991 Feb 18UT as part of his photographic nova search program. Inspection by Camilleri of his earlier photographs revealed an earlier event had also been recorded on 1990 July 26UT. In both cases the star was invisible and fainter than the 12th magnitude limit of the photographs.

A summary of Camilleri's photographic observations is given in Table 1.

It is interesting to note HDE 331015 was included in a 1991 hand written list of variables discovered by Camilleri (2) as PC5 but later (3) was omitted from his list of stars as he believed he had made an error. HDE 331015 was subsequently missing from his official 1993 discovery list published in IBVS3923 (4).

OBSERVATIONS

A chart showing HDE 331015 in relation to nearby field stars was prepared by Mati Morel (5) to which a small scale finder chart was added. Preliminary GSC magnitudes were then assigned to a sequence of lettered comparison stars. While the GSC magnitudes are recognised as not necessarily accurate, they are sufficient to allow for reduction of the visual data.

This chart was later distributed to a number of observers and is reproduced here as Figure 1. All observations discussed here have been made visually by members of the VSS, RASNZ using the GSC magnitudes shown. Some observers have, however, used a magnitude of 10.3 for comparison star marked 'A' but which has a GSC magnitude 10.0. This appears to have introduced some scatter into the results at maximum light but has not effected the eclipse timings.

Regular observation on a nightly basis was commenced by the author in 1991 June after notification by Camilleri of his discovery. Only two partially observed events were recorded during the following 1600 days. In 1996 January a Circular (6) was sent to other potential observers which resulted in a much improved coverage of HDE 331015.

HDE 331015 – A NEW LARGE AMPLITUDE ECLIPSING BINARY Cont.

By the end of 1997 observing season a total of 20 events, including Camilleri's two photographic discovery observations, had been recorded.

DISCUSSION

The first eclipse of HDE 331015 for which sufficient observations were obtained, thus allowing for a reasonably accurate representation of the eclipse curve, was that recorded on JD 2450311/312. A total of 19 magnitude estimates covered the final stage of decline, minimum light and the recovery to maximum brightness.

These observations were plotted using the 'mirror image' method, assuming a symmetrical shape for the curve. This is shown in Figure 2 wherein large dots represent original observations and small dots are points generated by the mirror image plot.

The date of mid eclipse determined by this is GJD 2450311.9775. This value has been used as the primary epoch from which the period of this system has been calculated. This mean light curve was then superimposed on other less well observed eclipse curves to allow for better measuring the mid point of these events.

Of the 20 eclipses observed through to the end of the 1997 observing season, the dates of 6 additional events were thus measured. Light curves of these are shown as Figures 3a to 3f.

Figure 4 is a mean light curve which clearly shows what is believed to be the true character of the eclipse curve.

This mean light curve indicates a gradual onset of eclipse after which the rate of decline increases towards minimum light.

At minimum the curve appears to be flat bottomed, suggesting eclipses of HDE 331015 are total (or annular) with this phase lasting some 1.2 hours. Total duration of eclipse is approximately 7.73 hours.

Dates of mid eclipse determined are listed in Table 2. Column 1 notes the Figure (2, 3a to 3f) for the relevant eclipse, column 2 the GJD of mid eclipse, column 3 indicates the probable accuracy of the eclipse timing with 1 indicating those considered most reliable. Column 4 shows the phase according to the deduced epoch and period. No heliocentric corrections have been applied to this data.

The 7 measured eclipses cover an interval of 452 days, from which a mean period of 9.4169895 days has been derived. An alternative period of 4.7081089 days, about half the above value, has been ruled out when no eclipse events were observed at times predicted by this shorter period.

Figure 5 is a phase plotted light curve for HDE 331015. The observations used here are those by the author only so as to reduce the scatter in the observations at maximum light which, as mentioned above, appears to be the result of observers using different comparison stars.

There is no clear evidence for secondary eclipse within the entire data base and this appears to be beyond the capability of visual detection. The question of secondary eclipse therefore remains unanswered.

HDE 331015 – A NEW LARGE AMPLITUDE ECLIPSING BINARY Cont.

CONCLUSION

The available visual data indicate the following elements for HDE 331015 :

GJD 2450 311.9775 +/- 9.4169895E
mean maximum magnitude : 11.0v
mean magnitude at minimum : 13.4v
amplitude of variation : 2.4v
duration of eclipse : 7.73 hours (0.32 d)
duration of total eclipse : 1.2 hrs

Based on the visual data, HDE 331015 appears to be an Algol type eclipsing system of somewhat larger than usual amplitude. The lack of firm evidence for secondary eclipse and the large amplitude of variation suggest the stellar components of HDE 331015 are of vastly differing luminosities and character.

HDE 331015 would therefore appear to be a potentially interesting binary system for detailed investigation by more accurate and multi coloured methods.

ACKNOWLEDGEMENTS

All observers are thanked for their persistent efforts without which this paper could not have been written.

Researchers are advised the complete visual data set is available from the VSS, RASNZ by request through the Director.

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(1) Camilleri P. 1991.
Private communication, 1991 March 19.
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(3) Camilleri P. 1992.
Private communication, 1992 Sept. 15.
(4) Morel M & Camilleri P. 1993.
International Bulletin on Variable Stars, No.3923, 1993 August 13.
(5) Morel M. 1991. Morel Astrographics, preliminary chart dated 15 Sept, 1991.
(6) Williams P. 1996 Circular letter.

HDE 331015 - A NEW LARGE AMPLITUDE ECLIPSING BINARY Contd.

TABLE 1

PHOTOGRAPHIC OBSERVATIONS OF HDE 331015
by Paul Camilleri.

Date	Mag
1990 May 18	~10
1990 July 26	<12
1990 Sept 09	~10
1990 Oct 12	~10
1990 Oct 16	~10
1991 Jan 24	~10
1991 Feb 08	~10
1991 Feb 18	<12
1991 Feb 20	~10
1991 Feb 21	~10
1991 Mar 13	~10

TABLE 2

TIMED MINIMA OF HDE 331015
No heliocentric corrections have been applied to this data.

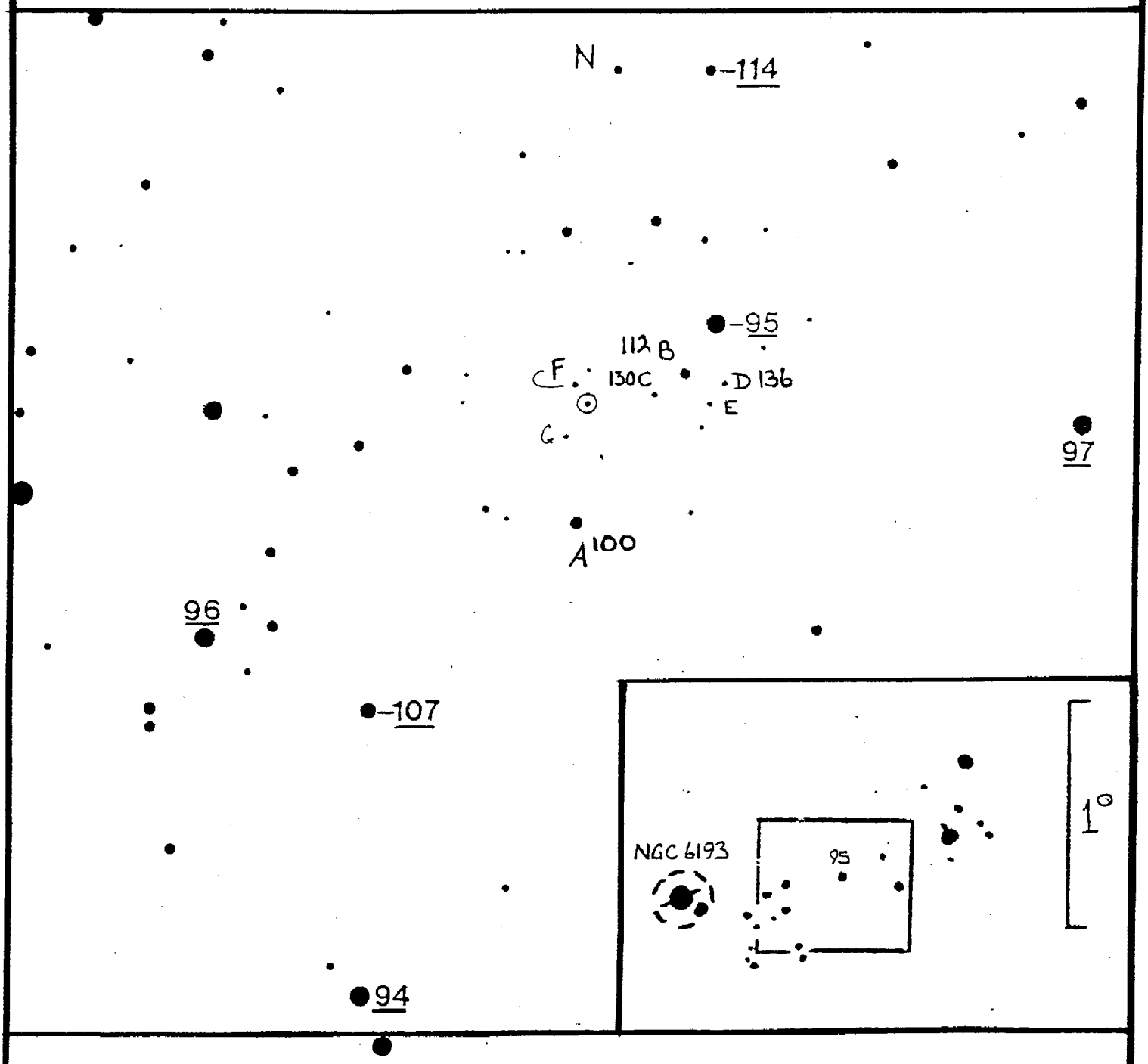
Fig.	GJD2450	Wt	Phase
3a	198.9665	1	0.0008
3b	246.0350	2	0.0025
2	311.9775	1	E
3c	603.9165	2	0.0013
3d	632.1100	1	0.9952
3e	650.9880	1	0.9999
3f	716.8865	3	0.9997

New Variable. HDE 331015 = CoD -48°10986 = GSC 8329-3364

(2000) 16h 37m 23.4s -48°42'11"

GSC Mag. = 11.14. Spectrum = A.

Scale: 10" = 1mm



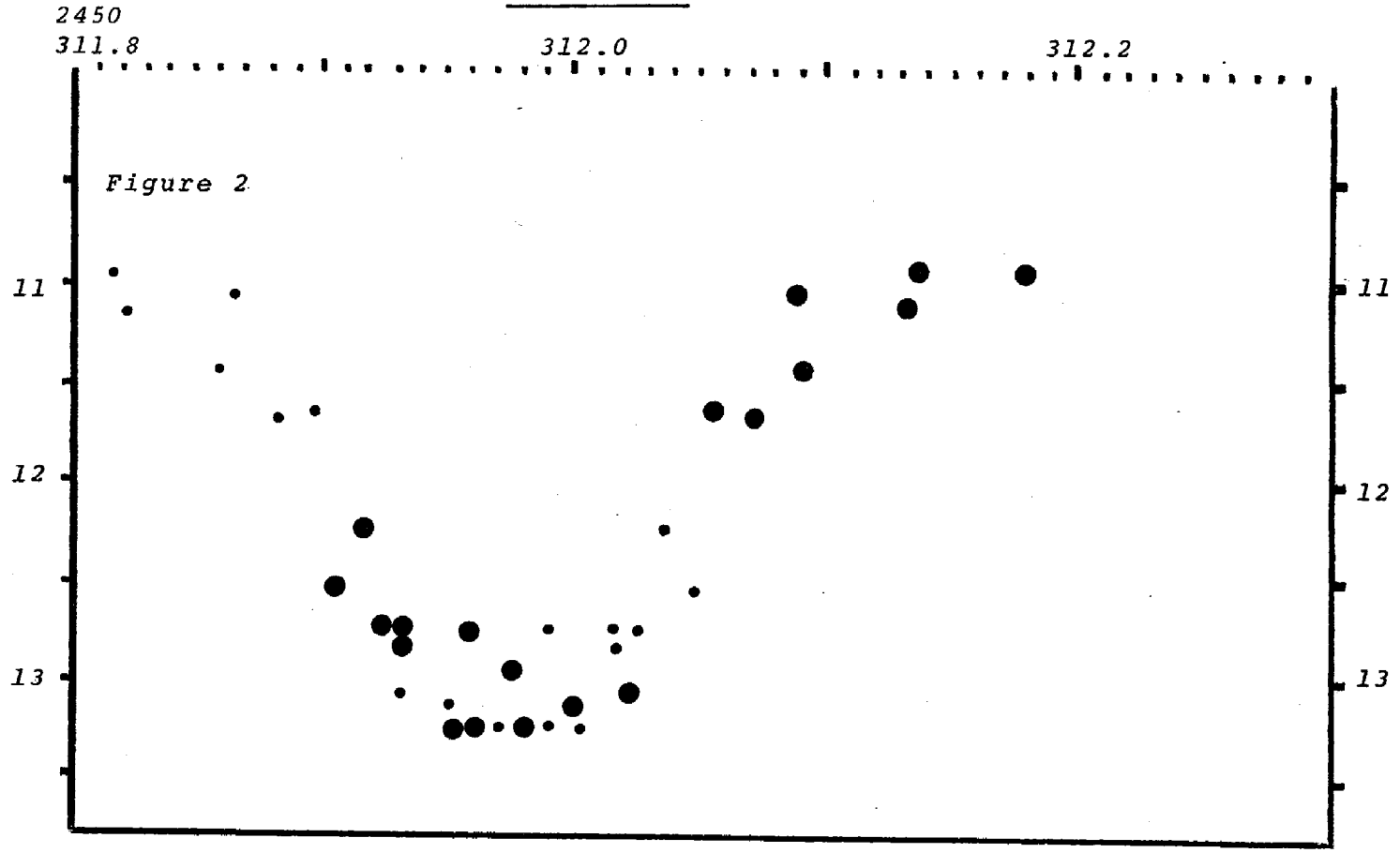
Plotted from CoD, CPD and GSC.

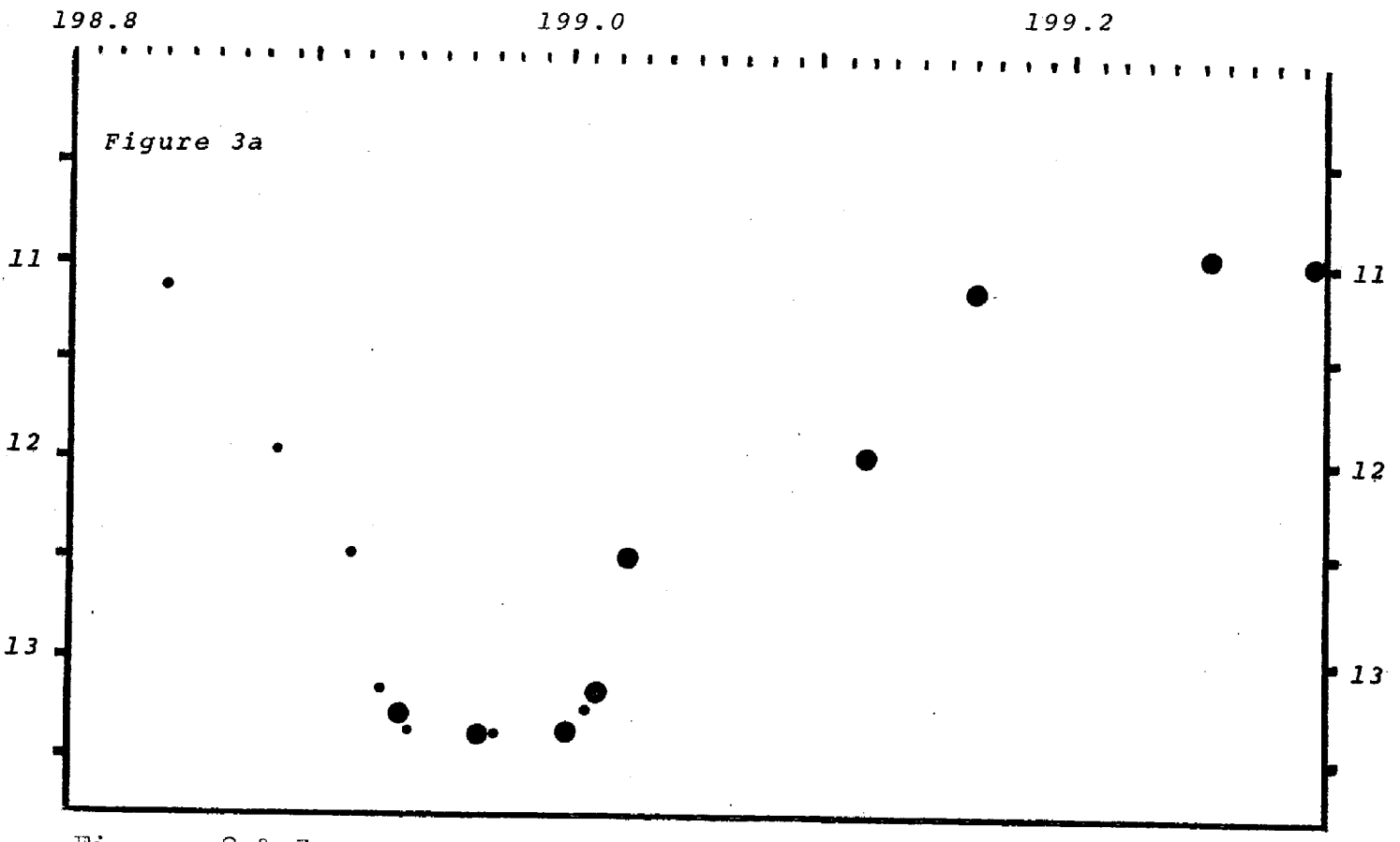
Mags. V. *OTHERS PRELIMINARY GSC MAGNITUDES*
ADDITIONAL LETTERED STARS BY PFW

MM 15.09.91

FIGURE 1.

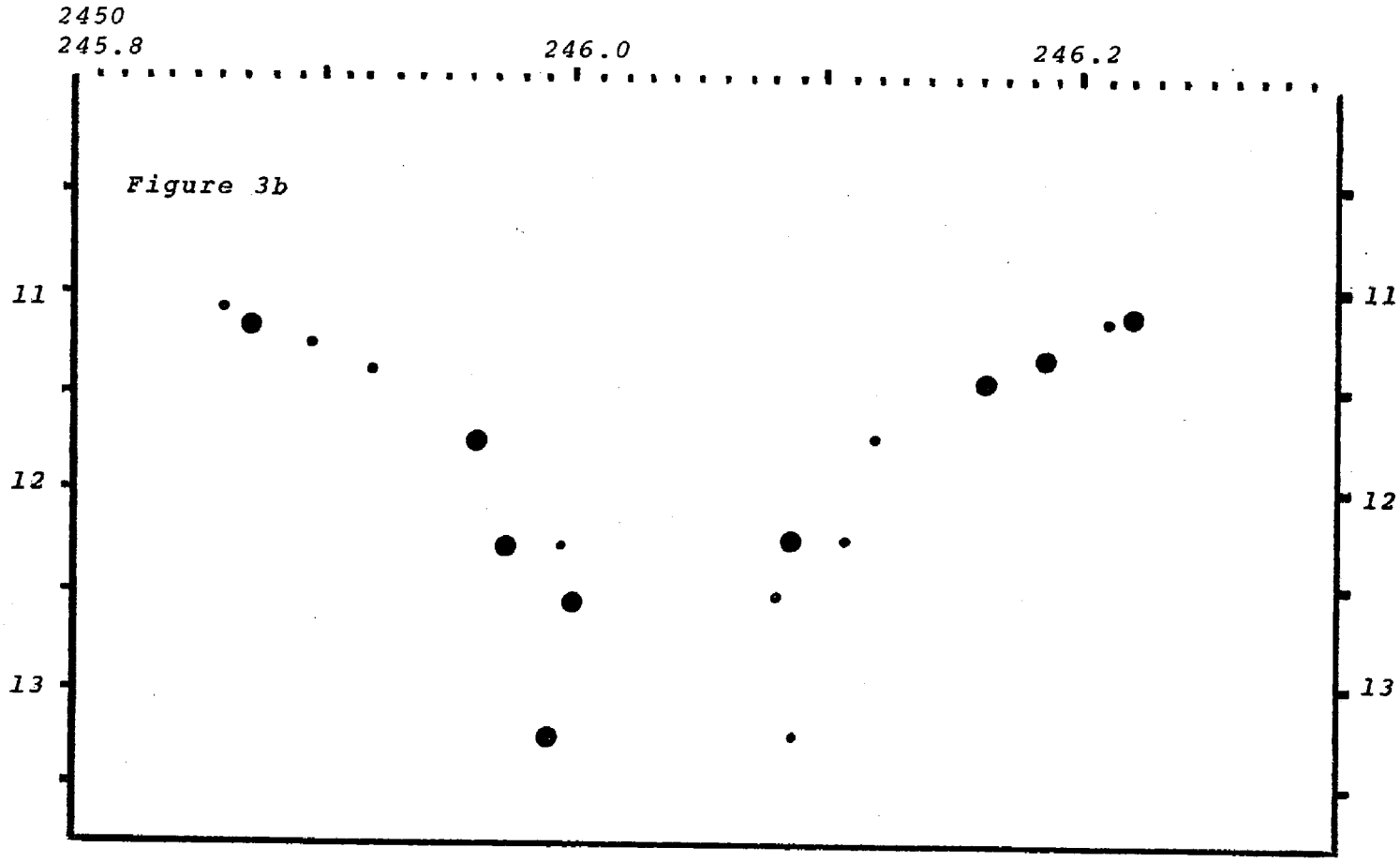
HDE 331015

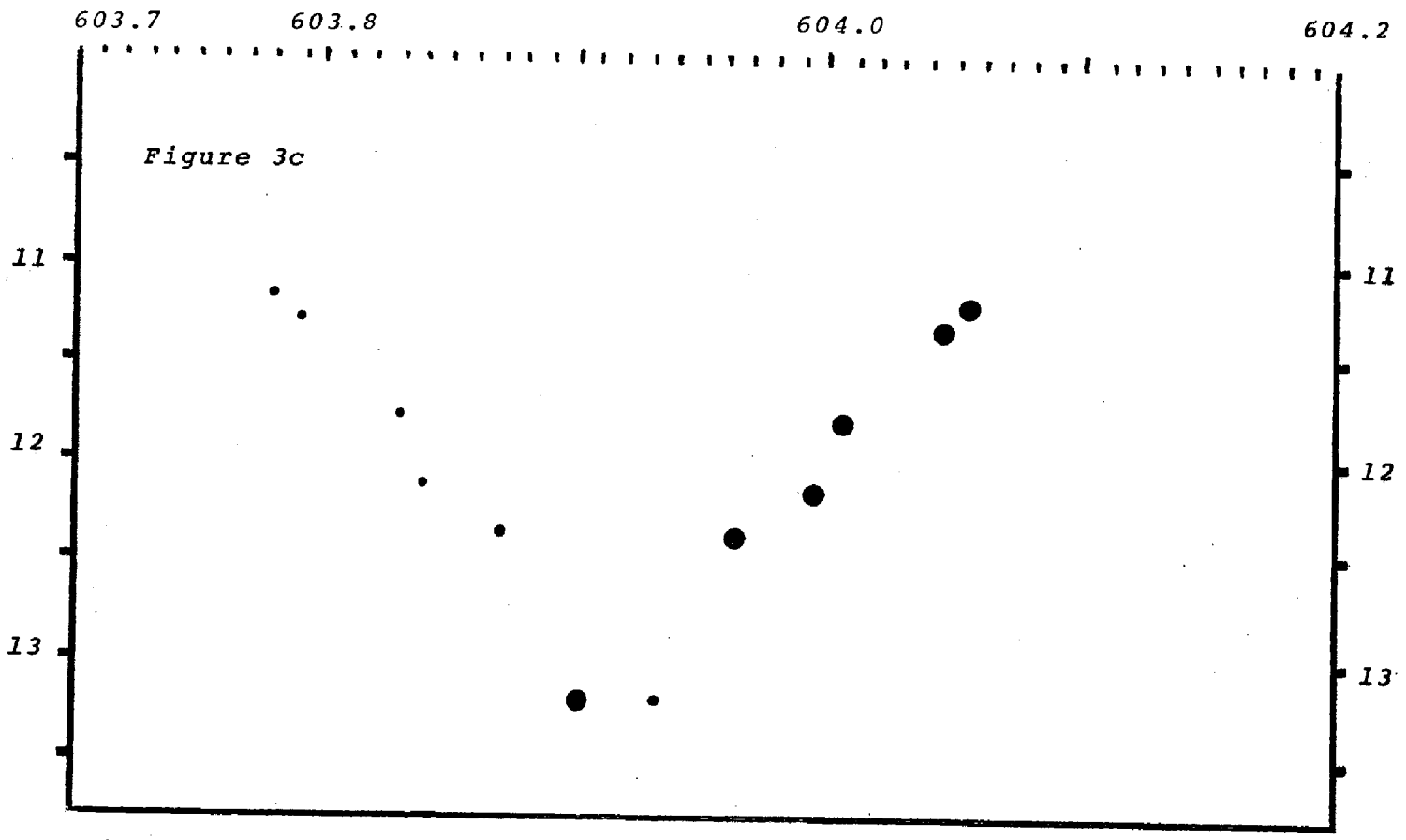




Figures 2 & 3a

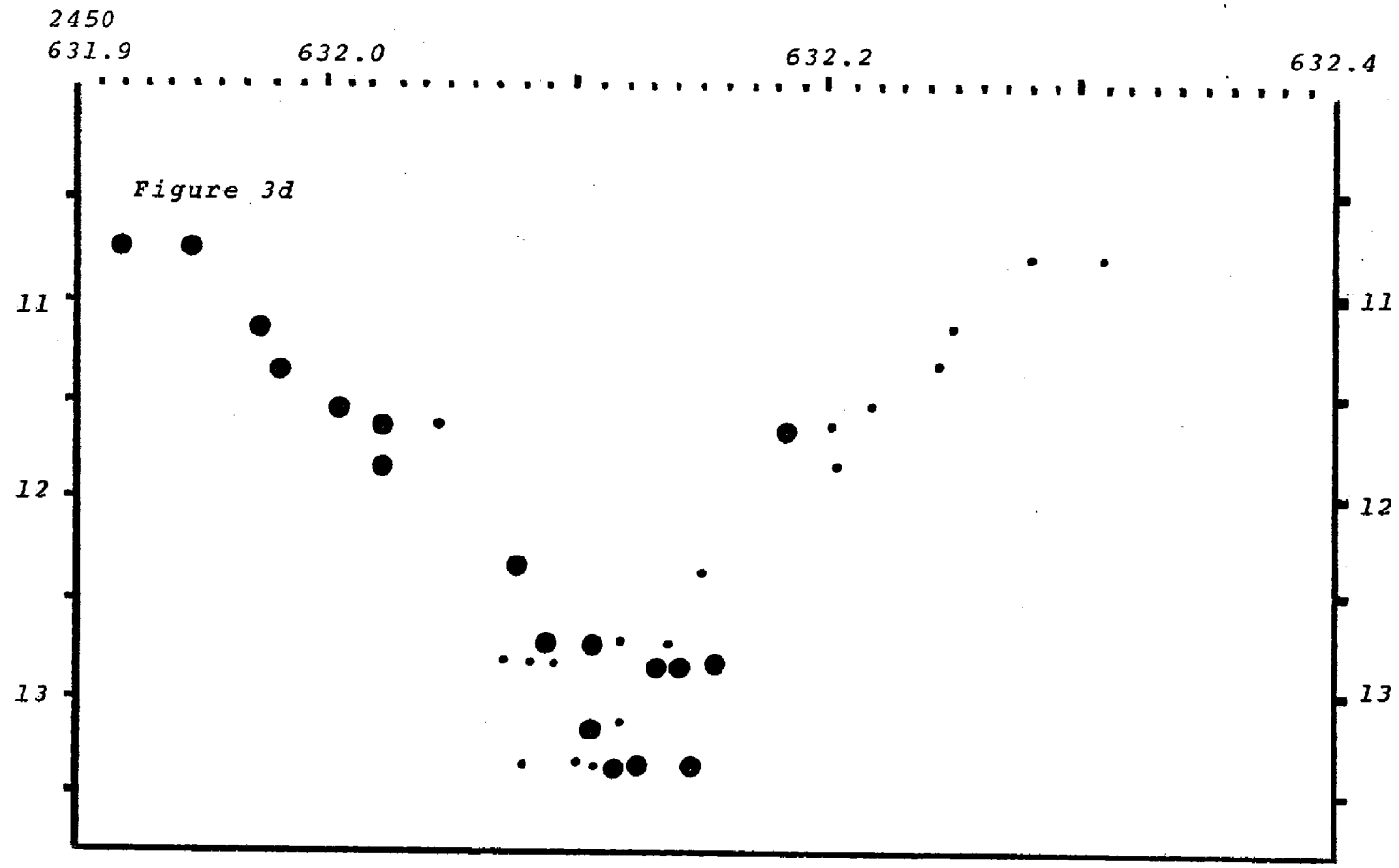
HDE 331015

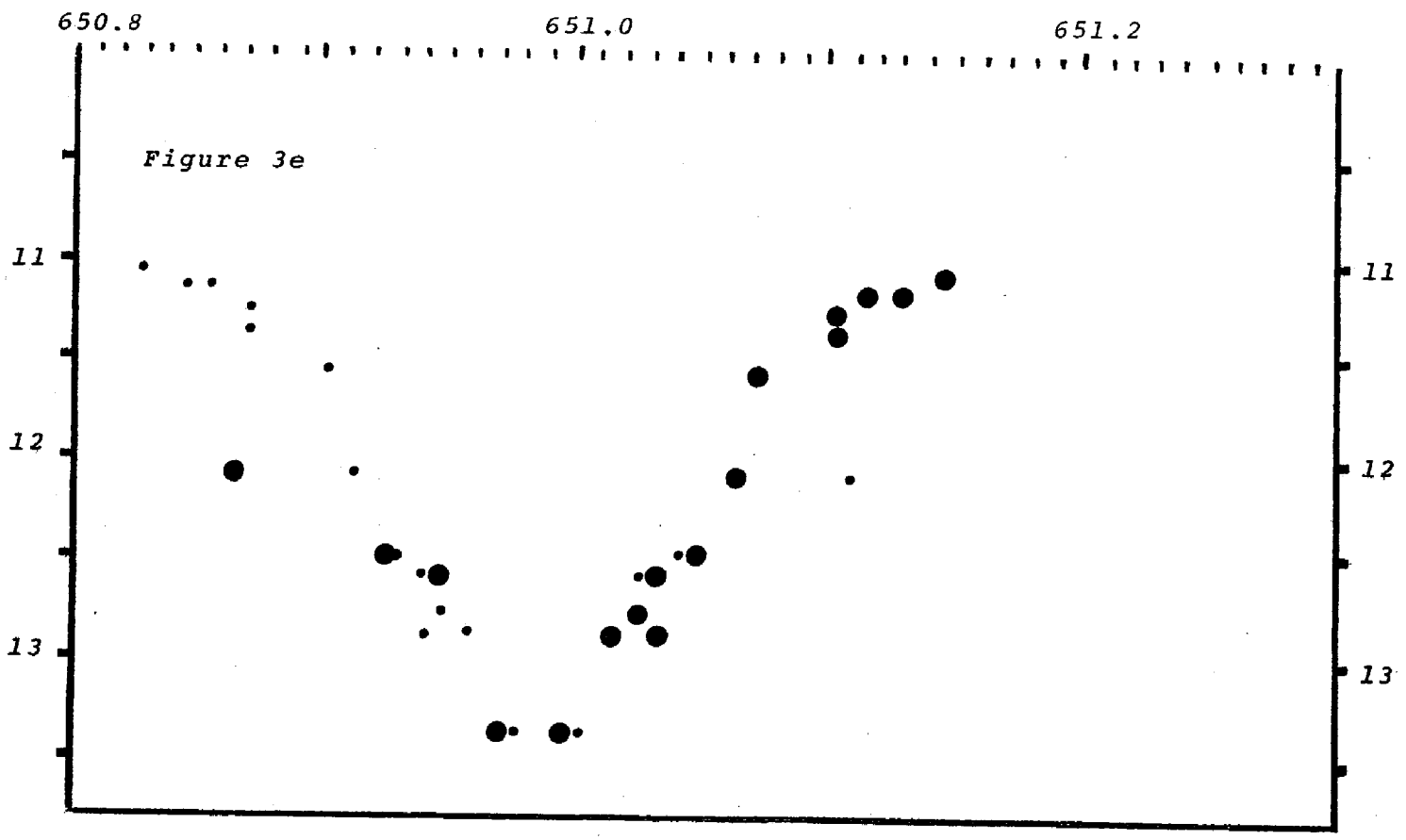




Figures 3b & 3c

HDE 331015





Figures 3d & 3e

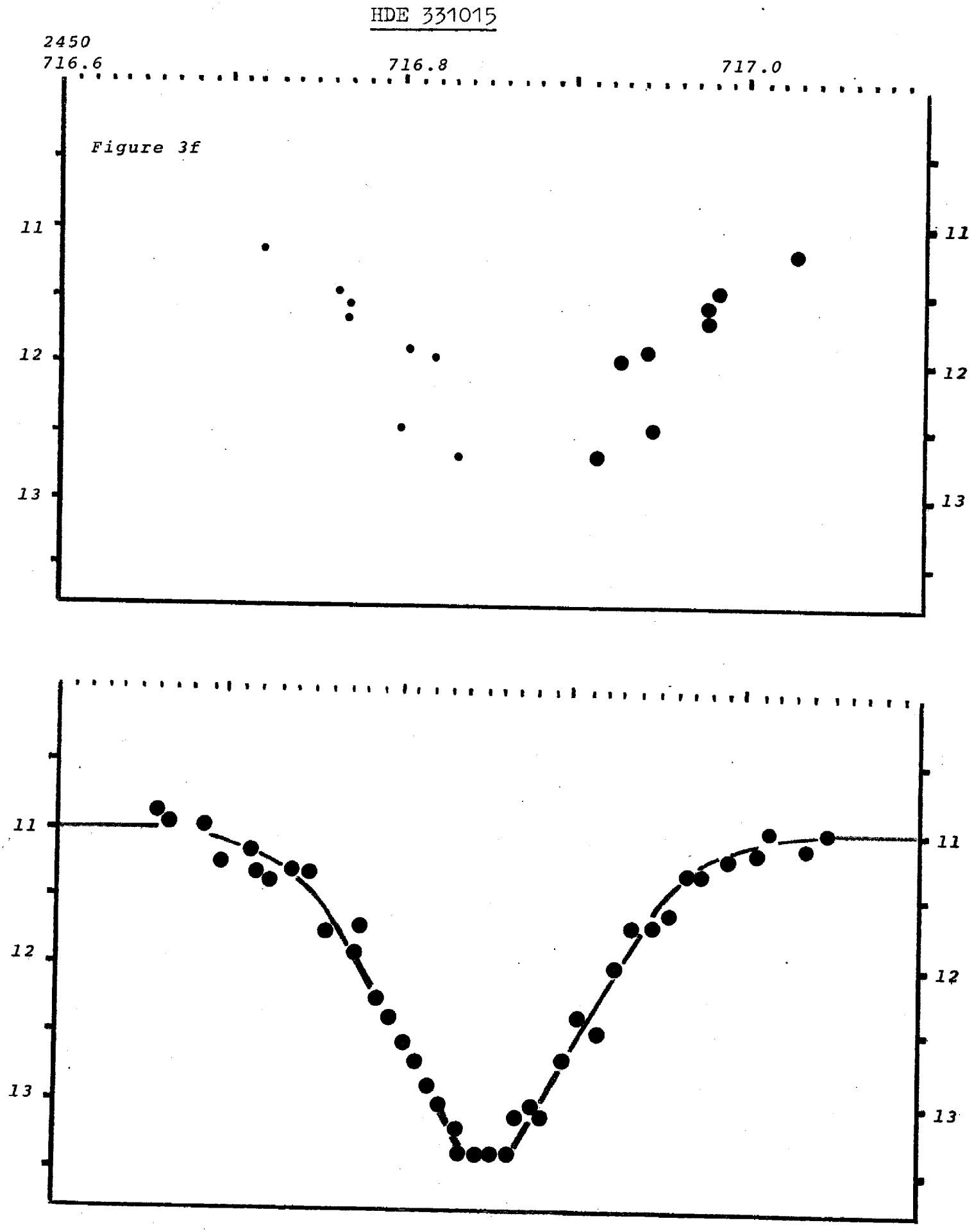


Figure 4. Mean light curve of HDE 331015.

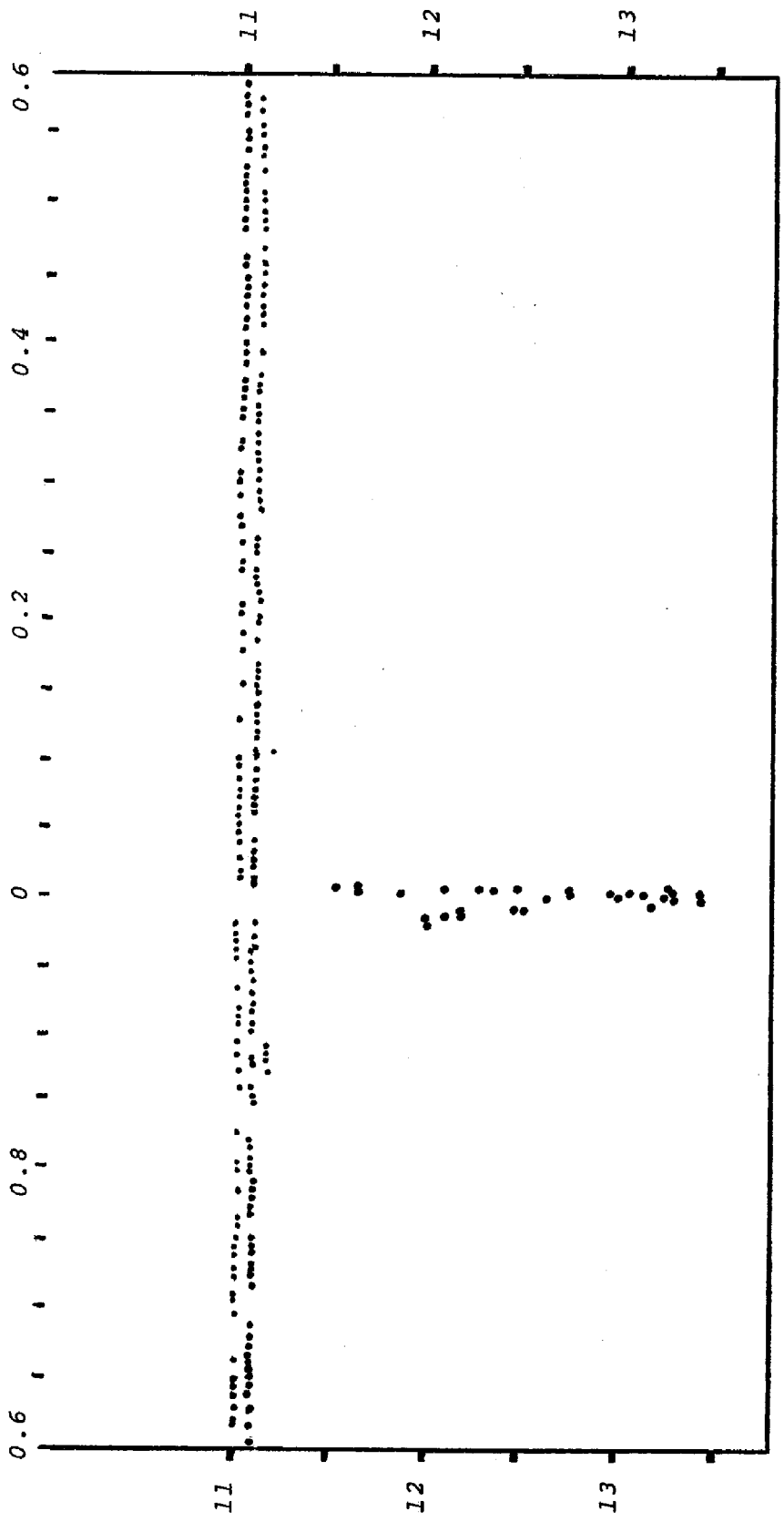


Figure 5. Phase plot of HDE 331015 using period 9.4169895 days.

BL TELESCOPII - VISUAL OBSERVATIONS OF THE YEAR 2000 ECLIPSE

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(VSS RASNZ and Sutherland Astronomical Society, Sydney)

SUMMARY: Visual observations of the 2000 eclipse of BL Telescopii are discussed. These indicate mid eclipse occurred on 2000 September 25.0UT (GJD2451812.5), an interval of 778.0 days since the previous eclipse.

1. INTRODUCTION

Eclipses of BL Tel have been the subject of a long term study by members of the VSS RASNZ since 1983. Results of these eclipses, except the 1990 eclipse which was not observed, have been reported progressively by Williams (1) and other references therein.

The 2000 eclipse of BL Tel is the 8th successfully observed event since commencement of this program.

2. DISCUSSION

A total of 225 visual observations were obtained by 11 observers during this eclipse. These are given as daily means in Table 1 which lists the Julian Date, the daily mean magnitude and the number of observations comprising the mean value.

There is, unfortunately, considerable scatter within the raw data and which, at times, amounts to near 1 full magnitude. Where a star such as BL Tel has an amplitude of just over two magnitudes, this level of scatter can have a significant effect on the resultant light curve. Consequently, a number of observations have been rejected during preparation of the mean light curve.

This serves to stress the importance for observers to exercise great care and the use of correct observing techniques as described by Bateson (2) during eclipses of BL Tel and variable star observing in general. This will maximise the value of each observation.

The daily mean magnitudes have been plotted as the light curve shown in Figure 1. Here, means of 2 or more observations are shown as solid circles and single observations are shown as open circles.

The mean light curve indicates this eclipse commenced with a gradual decline on August 20.0UT (GJD 2451776.5), falling 0.6 magnitudes in 16.5 days (0.04 mag/day). This was followed by a steeper decline of 1.9 magnitude in a further 16.5 days (0.12 mag/day), reaching minimum magnitude on September 22.0UT (GJD 2451809.5).

A period of constant light is then evident for 6 days through to September 28.0UT (GJD 2451815.5). This flat bottom light curve indicates a total eclipse occurred.

The recovery to maximum initially occurred at a slightly quicker rate, rising 1.1 magnitudes in 10 days (0.11 mag/day) before a more gradual brightening of 1.4 magnitude in 19 days (0.07 mag/day), reaching maximum on October 27.0UT (GJD 2451844.5). A total duration of 68.0 days is thus indicated for this eclipse. No heliocentric corrections have been applied due to the nature of the visual observations.

BL TELESCOPII - VISUAL OBSERVATIONS OF THE YEAR 2000 ECLIPSE (cont.)

Overall daily mean rates of change for the 2.5 magnitude amplitude of this eclipse are 0.076 mag/day in 33.0 days during decline and 0.086 mag/day in 29 days during recovery.

A minimum magnitude of 9.6v was attained during this event.

Several observers independently reported a brief decline and recovery immediately prior to the onset of this eclipse. This is, however, not well shown in the mean light curve and as variations such as this have not been noted during earlier eclipses it is not clear if this is in fact real.

Because of the clearly non-symmetrical character of this eclipse, no mirror image plot has been applied to the light curve as has been done for previous eclipse curves.

Based on the available visual data mid eclipse occurred on 2000 September 25.0UT (GJD 2451812.5). This is an interval of 778.0 days since the date of previous mid eclipse.

Details of this eclipse are included in Table 2. This Table is a cumulative summary of the visual results for eclipses of BL Tel since commencement of this long term program in 1983, relative to the elements given by Kholopov (3).

Based on the date of mid eclipse for 2000, the next eclipse of BL Tel is expected to be centered on 2002 November 11 (JD 2452590.6). At this time BL Tel will be a difficult object near conjunction with the sun.

3. CONCLUSION

Visual observations of the 2000 eclipse of BL Tel indicate mid eclipse occurred on 2000 September 25.0UT (GJD 2451812.0), an interval of 778.0 days since the time of previous mid eclipse. This indicates the next eclipse will be centered around 2002 November 11 (GJD 2452590.6).

ACKNOWLEDGEMENTS

All observers are thanked for their observations and ongoing interest in this long term program to monitor eclipses of BL Tel.

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(2) Bateson, F.M., 1982. "The Observations of Variable Stars", Tauranga, N.Z.

(3) Kholopov P.N. Ed 1987. Gen.Cat.Var. Stars, 4th ed Vol III, Nauka, Moscow.

BL TELESCOPII - VISUAL OBSERVATIONS OF THE YEAR 2000 ECLIPSE (cont.)

TABLE 1
DAILY MEAN MAGNITUDES

GJD 2451000+	MEAN	No.	GJD 2451000+	MEAN	No.
748	7.2	1	805	8.86	3
749	6.9	1	806	9.10	4
750	7.2	1	807	9.0	1
753	7.15	2	808	8.95	2
755	7.20	2	809	9.25	4
759	7.0	1	810	9.6	1
760	7.10	2	811	9.6	1
762	7.10	1	812	9.46	3
765	7.1	1	814	9.3	1
766	7.05	2	816	9.45	3
767	7.2	1	817	9.46	3
770	7.0	1	818	9.42	4
772	7.5	1	820	9.55	2
773	7.23	3	821	9.43	3
774	7.10	2	822	9.36	3
776	7.2	1	823	9.1	1
777	7.2	1	824	8.90	3
778	7.20	4	825	8.70	2
779	7.30	4	826	8.50	3
780	7.30	3	827	8.6	1
781	7.46	6	828	8.50	3
782	7.30	5	829	8.35	2
783	7.36	5	831	8.1	1
784	7.40	3	832	8.35	2
785	7.43	3	833	8.00	3
786	7.60	2	834	7.97	4
787	7.40	3	835	7.6	1
788	7.62	4	836	7.7	1
789	7.4	1	837	7.7	1
790	7.70	2	838	7.60	3
791	7.63	3	839	7.50	3
792	7.6	1	840	7.6	1
793	7.74	5	841	7.5	1
794	8.0	1	842	7.30	3
795	7.93	3	843	7.3	1
796	8.26	3	844	7.20	2
797	8.4	1	845	7.15	4
798	8.27	4	846	7.2	1
800	8.6	1	847	7.15	2
801	8.43	3	848	7.15	2
802	8.70	2	849	7.2	1
803	8.60	2	857	7.1	1
804	8.66	3			

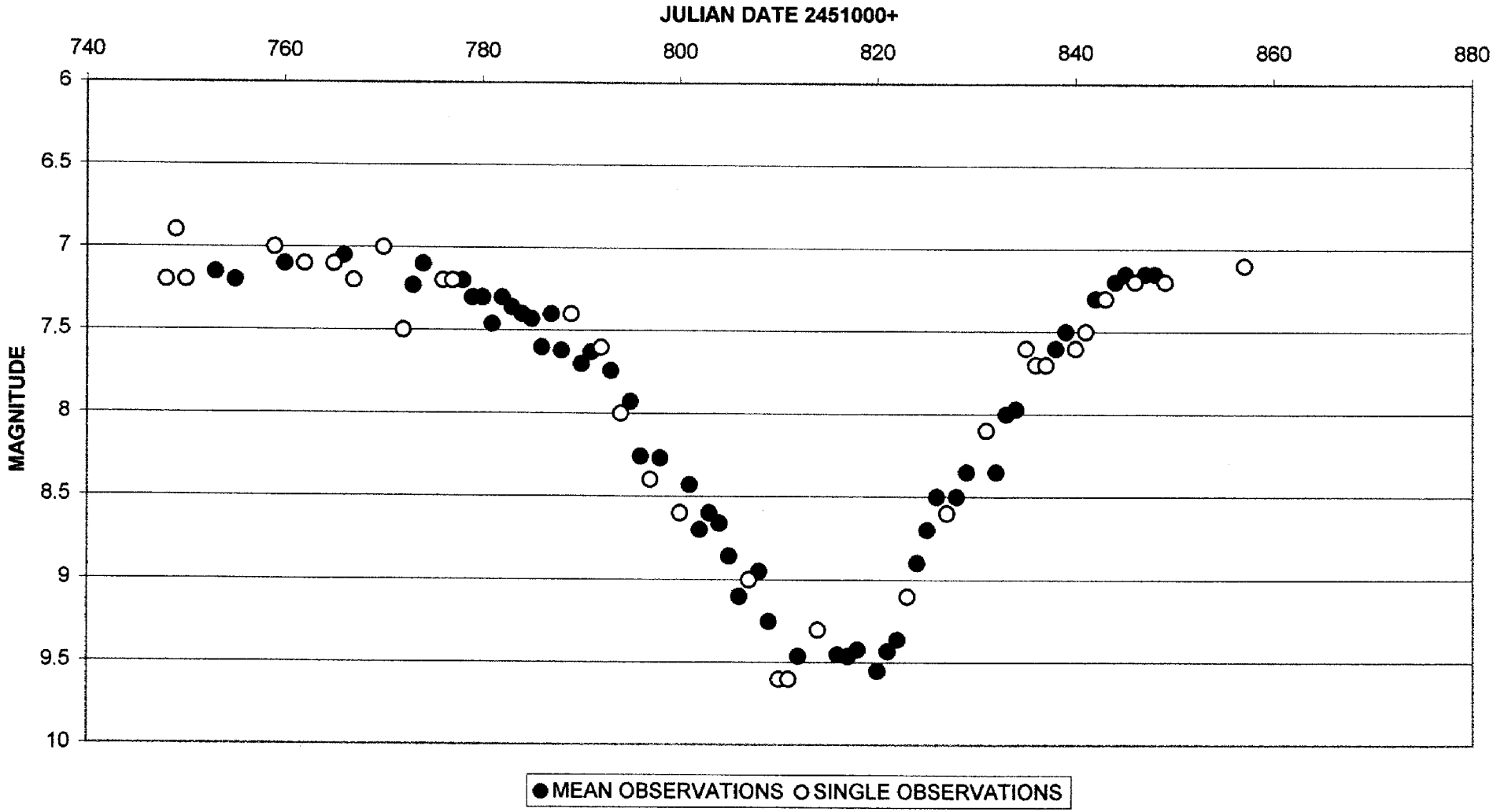
BL TELESCOPII - VISUAL OBSERVATIONS OF THE YEAR 2000 ECLIPSE (cont.)

TABLE 2

O-C and Summary of BL Tel eclipses 1983-2000
from visual data by VSS, RASNZ according to elements JD 2434692 +778.1 days

Year	Observed	Calculated	O-C	Mag. (v)	Duration days	Interval days
1983	2445591.5	2445586.0	+4.5	8.60	57.0	-
1985	2446369.5	2446364.1	+5.4	9.60	65.0	778.0
1987	2447144.5	2447142.2	+2.3	9.30	63.0	775.0
1992	2448703.0	2448698.4	+4.6	9.20	58.0	(1558.5)
1994	2449481.0	2449476.5	+4.5	10.10	62.0	778.0
1996	2450256.0	2450254.6	+1.4	8.90	65.0	775.0
1998	2451034.5	2451032.1	+2.4	8.96	56.0	778.5
2000	2451812.5	2451810.2	+2.3	9.60	68.0	778.0

BL TELESCOPII 2000 MEAN VISUAL LIGHT CURVE



A LIGHT CURVE FOR THE MIRA VARIABLE RU SCORPII - Paper 1

Wes Taylor
Member, Variable Star Section, RASNZ

SUMMARY: A graph constructed from observations by members of the Variable Star Section of The Royal Astronomical Society of New Zealand show the behaviour of the Mira variable RU Scorpii over a period of 27 years.

1. INTRODUCTION

The variable star RU Scorpii, Harvard Designation – 173543, is featured in Chart 37. Observations of its visual magnitude have been made by members of the VSS RASNZ since 1953 June.

2. OBSERVATIONS

For the first eight or nine years (from JD 2434540 to about 2438000) a very consistent set of observations was made mainly by one member (A F Jones). Since then, the star was monitored by a number of observers, resulting in a scatter in the estimates of magnitude. After obvious inconsistent values were eliminated, averages of the remainder were taken over periods of ten days, or less, depending on where convenient breaks could be made. In the accompanying graphs, single observations are represented by small squares and averages by crosses.

3. DISCUSSION

From about JD 2438700 until 24900 there is a paucity of observations when the brightness is at minimum. The period stated in the chart is 368.21 days, approximately one year, so that the star would be ill-placed for observation at the same stage of its cycle every year, and this happened to be near the minimum. In recent years, observations around the minimum have been more frequent, the scarcity of observations occurring at a different phase, at present closer to maximum brightness.

Due to the averaging process, it is inevitable that much detail in the light curve will be masked. However, some features will be noticed. For example, there is a cluster of four peaks around the maximum at JD 2447700 followed by two clearly separated dips around the subsequent minimum. It is as if a secondary oscillation is superimposed on the main one.

As stated earlier, some records had to be rejected. There appear to be two main sources of error:

(i) the star a little to the east is mistaken for RU Sco, and

(ii) no allowance is made for the relative positions of RU Sco and comparison stars. If a comparison star is above or below the target star, an error of about 1/2 magnitude can be introduced, so that two observations taken at the same time, but with different orientations can differ by a whole magnitude. The instructions in the Manual (2) should be carefully followed.

ACKNOWLEDGEMENTS

All observers are thanked for their data, and particularly headquarters of the Section for presenting these data in a clearly readable and easily usable manner.

A LIGHT CURVE FOR THE MIRA VARIABLE RU SCORPII (cont.)

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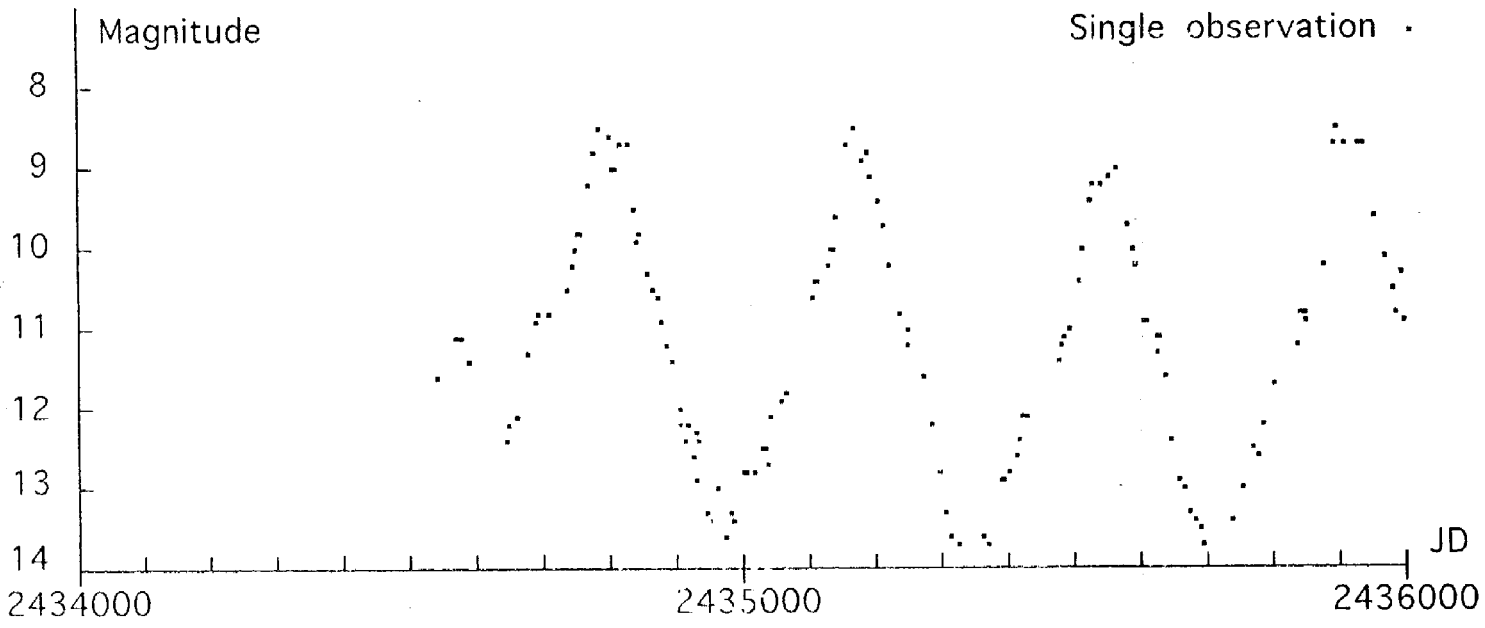
Charts for Southern Variables. Series II.
Pub by F M Bateson, Tauranga, N.Z.

(2) 1997. Bateson, F M. The Observation
of Variable Stars. Pub by Astronomical
Research Ltd., Tauranga, N.Z.

Graph of the Visual Magnitude of RU Scorpii HD –1735 43
The square dots show single observations and the crosses show averages of a number of observations



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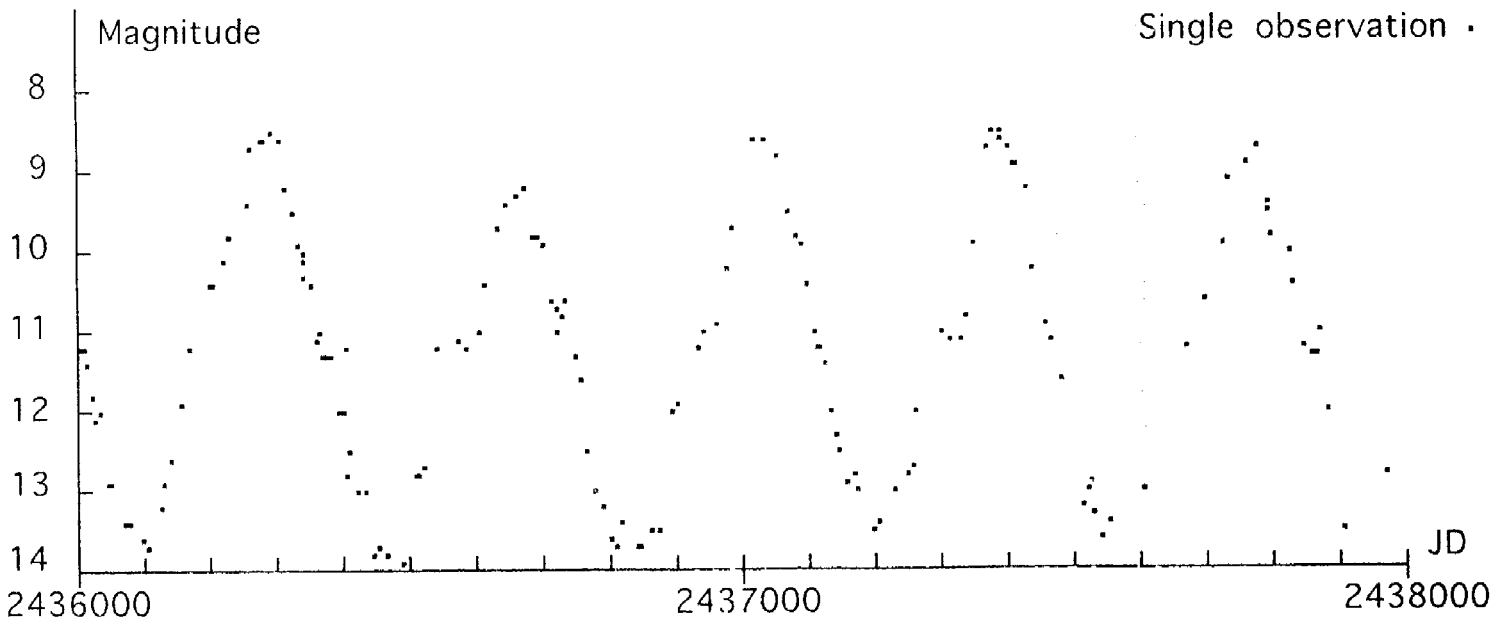
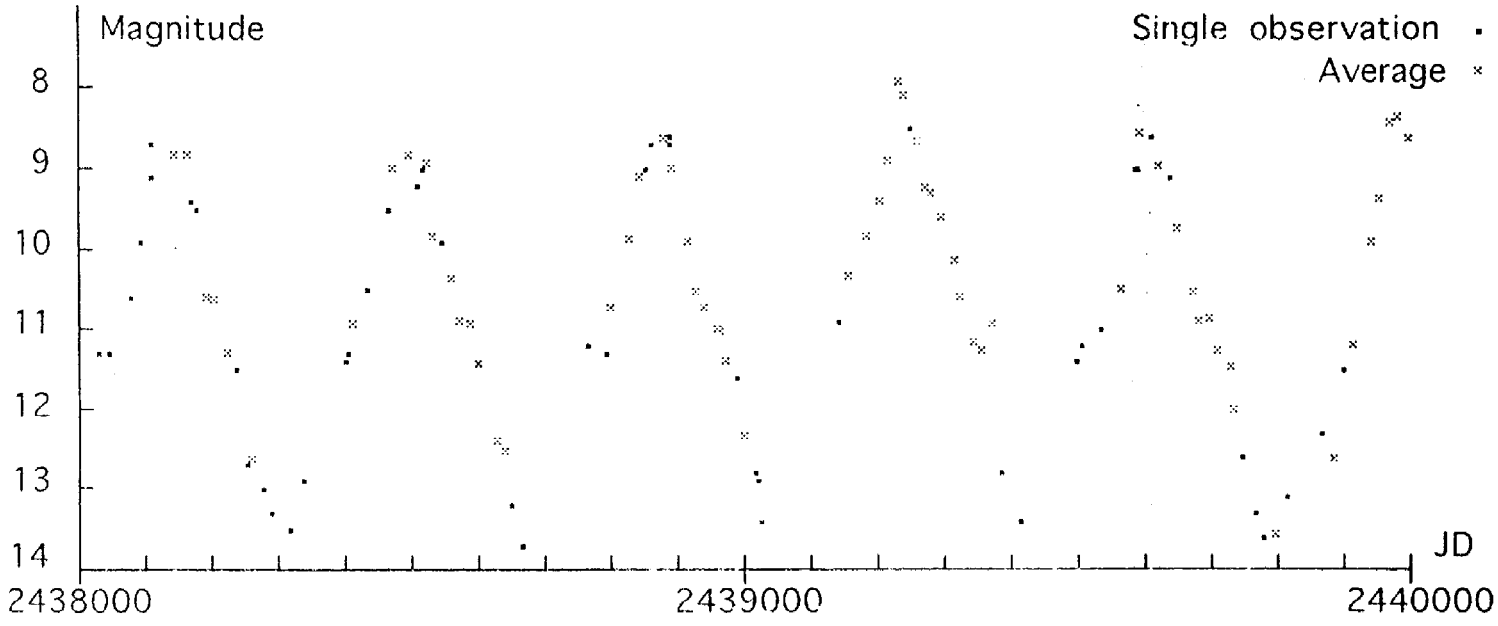


Part 2

Graph of the Visual Magnitude of RU Scorpii HD –1735 43

The square dots show single observations and the crosses show averages of a number of observations



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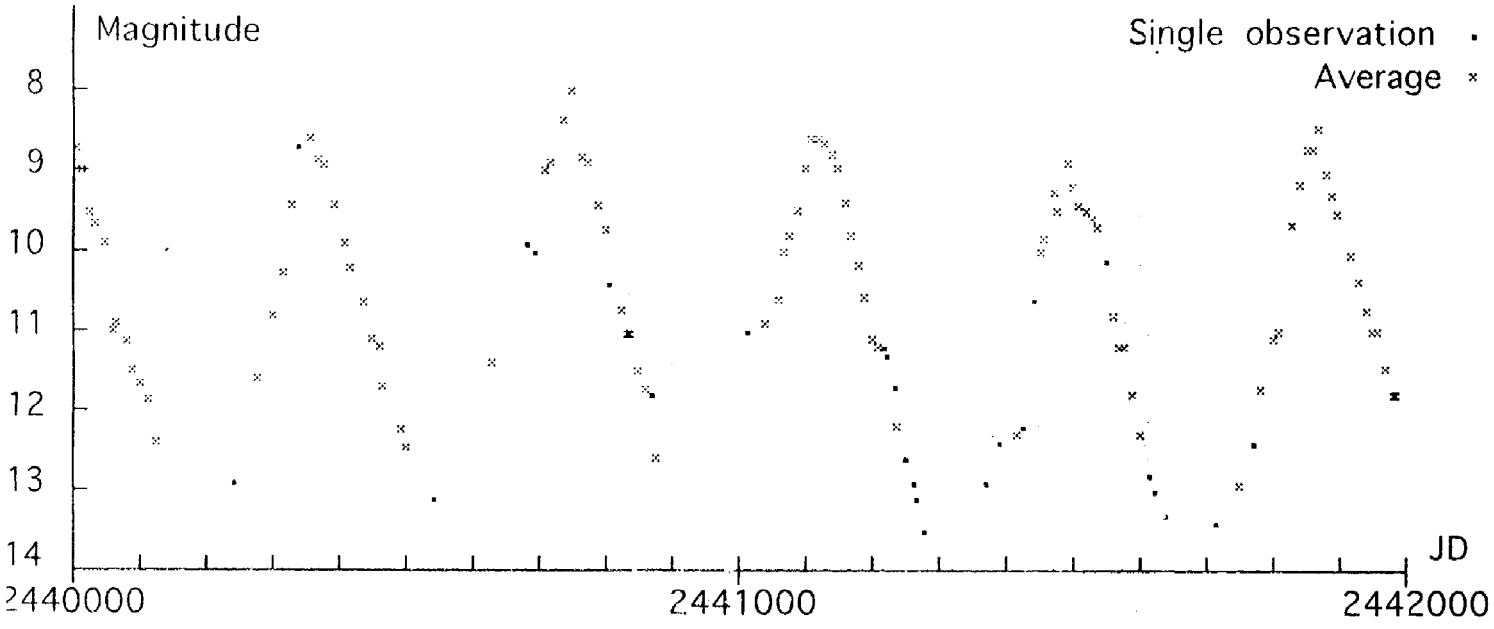

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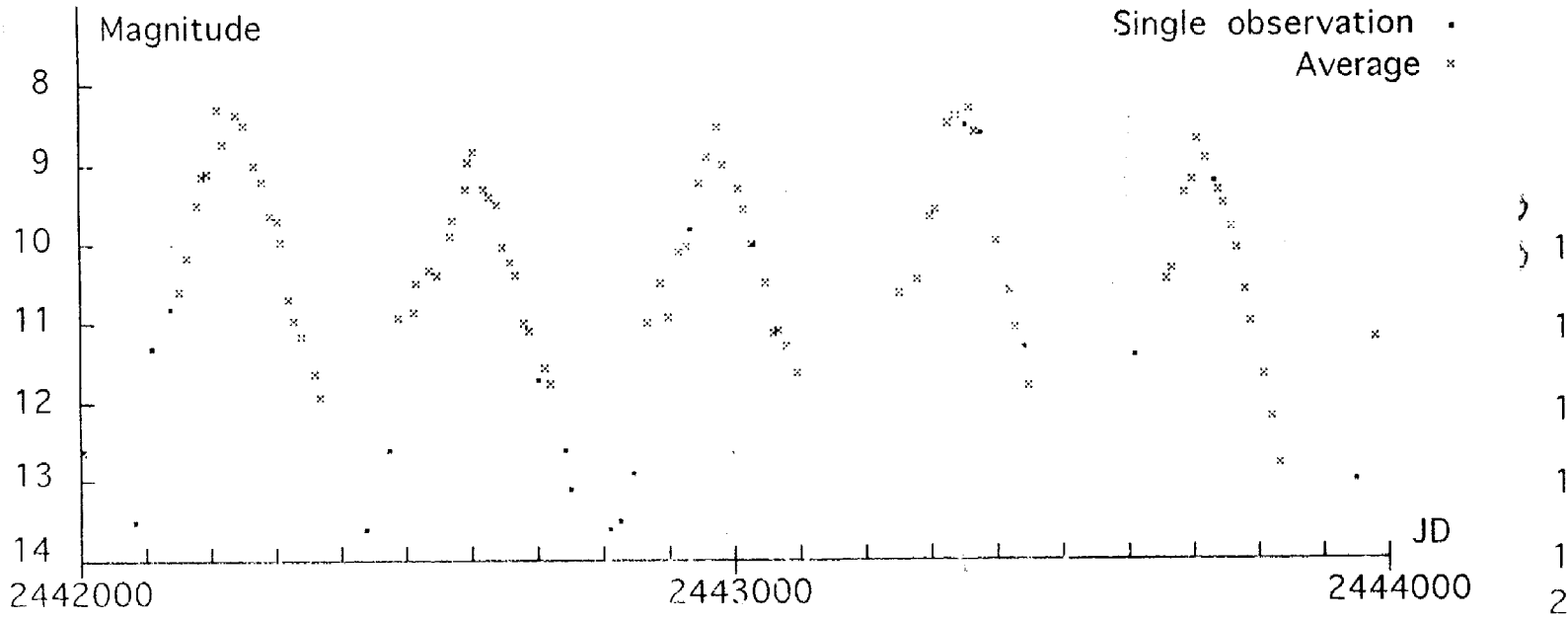
The square dots show single observations and the crosses show averages of a number of observations



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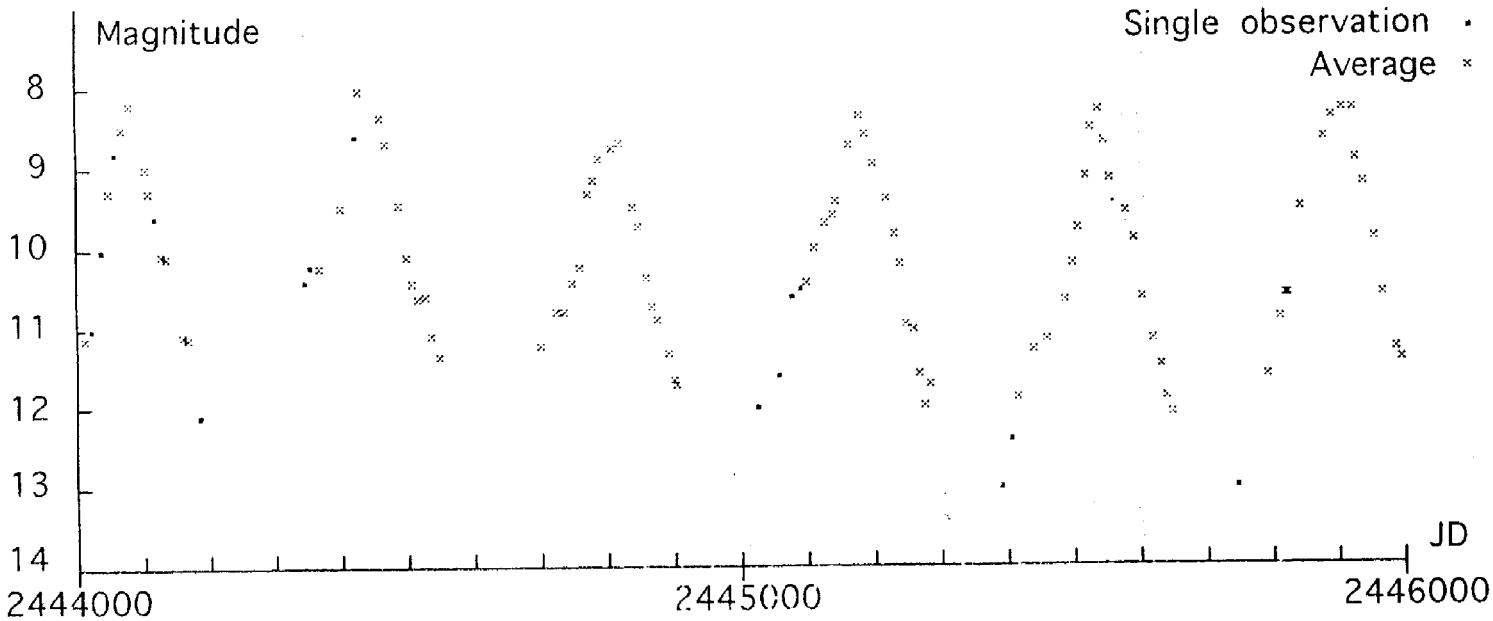
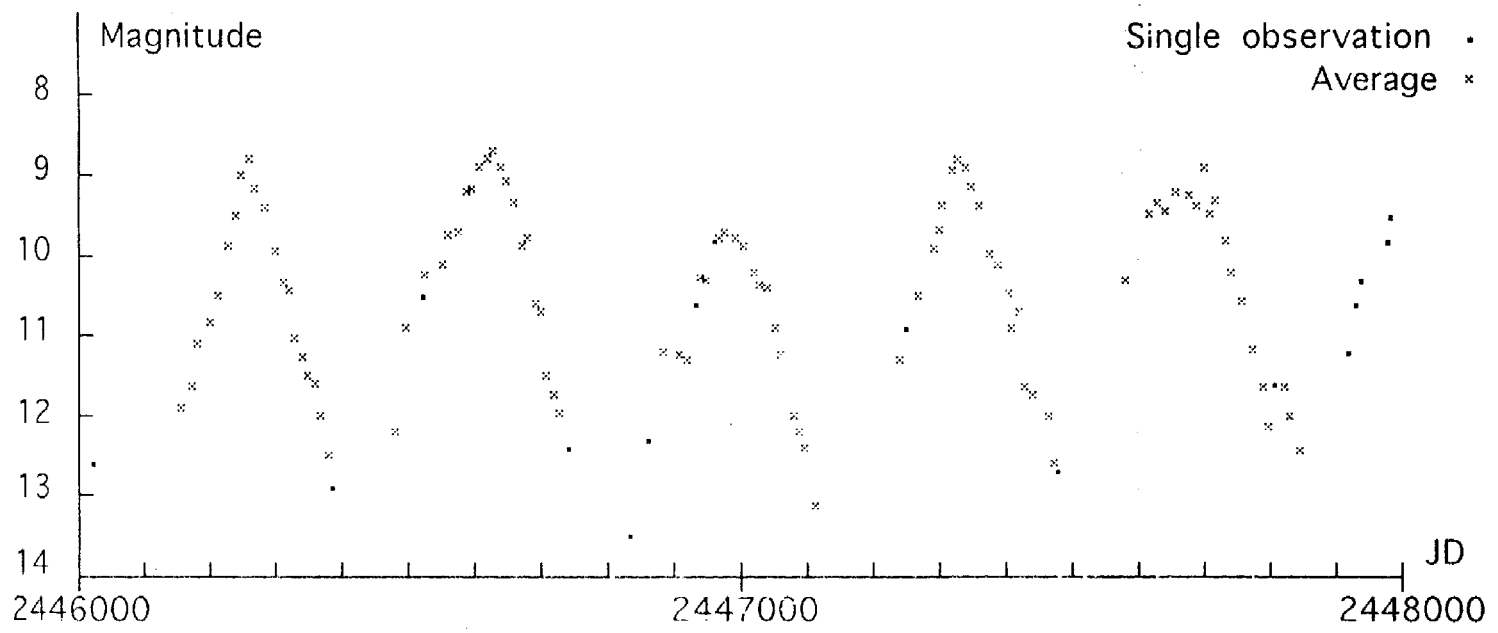


Part 6

Graph of the Visual Magnitude of RU Scorpii HD –1735 43

The square dots show single observations and the crosses show averages of a number of observations



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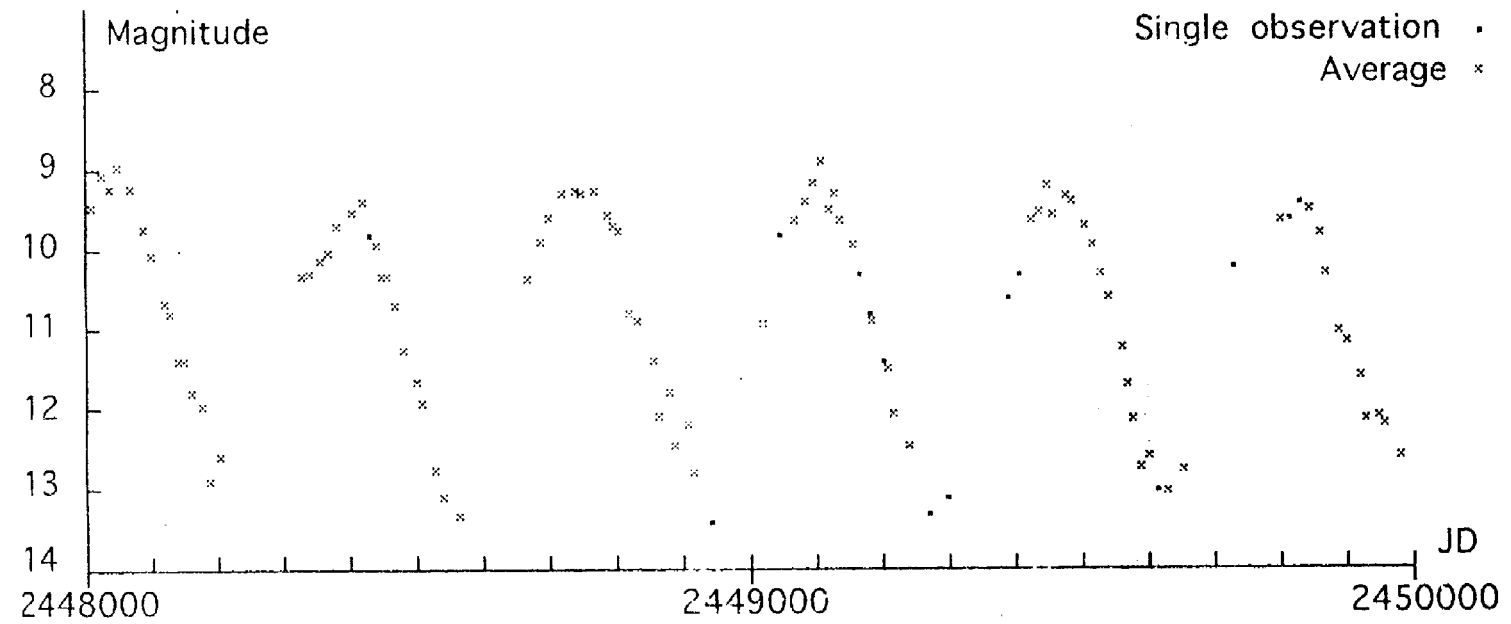
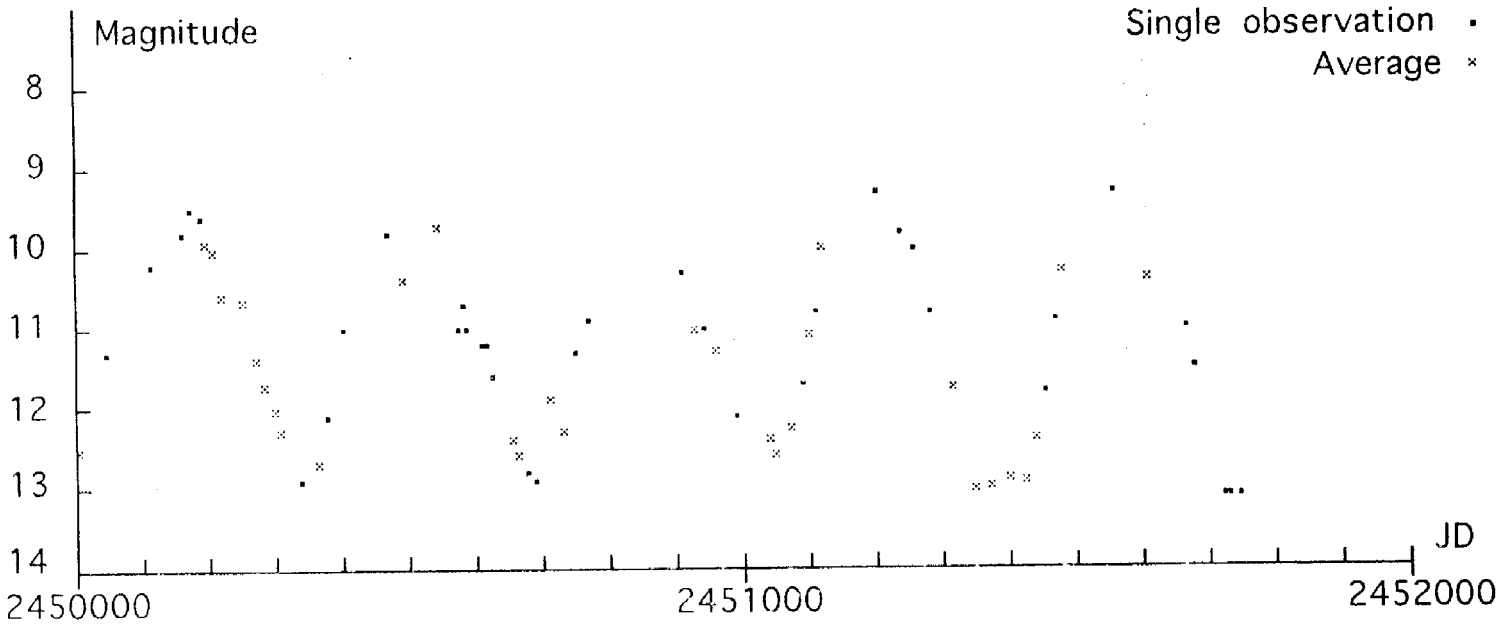


Part 8

Graph of the Visual Magnitude of RU Scorpii HD –1735 43
The square dots show single observations and the crosses show averages of a number of observations



Part 9

CHANGE IN THE PERIOD OF RU SCORPII - Paper 2

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SUMMARY: In recent years, the Mira variable RU Scorpii has undergone a decrease in mean period and in mean brightness at maximum.

1. INTRODUCTION

The author began observing RU Sco (HD - 173543) on 1970 April 23, JD 2440704. Around that time minimum brightness occurred during midsummer, when the star was poorly placed for observation. This happened year after year, as expected since the mean period on the Star Chart (1) was stated to be 368.21 days, a little over one year. Because of the small increase, the date of the minimum should slowly advance year by year. This did not happen. In recent years this date has moved backwards so that now it occurs during winter. Evidently the period has decreased.

2. RESULTS FROM OBSERVATIONS

A light curve constructed from observations by members of VSS RASNZ is shown in Paper 1. A Light Curve for RU Sco (2). From these observations the accompanying Table was constructed giving the Julian Dates and magnitudes at successive maxima and minima, and hence also the intervals between these maxima and minima. The intervals for the maxima are graphed in Figure 1, and the corresponding magnitudes in Figure 2.

A turning point (maximum or minimum) is determined by fitting a parabola through three points on the graph around that turning point. This will give an accurate result only if the points are close together and at least one is on either side of the turning point. Thus not all the minima could be determined with sufficient accuracy, and the Table contains some gaps. In these cases the average value of the period over the gap is stated. Also because of this uncertainty, graphs corresponding Figures 1 and 2 for the minima were not constructed.

3. DISCUSSION

Figure 1 shows that for a considerable time after the beginning, the times between successive maxima are scattered around the period 368.21 days, but in the later stages these times are usually well below. Because of the scatter, it is not possible to determine whether the change is gradual or, if it is sudden, where it begins. Suppose we choose, somewhat arbitrarily, the 33rd maximum. The average period between No 1 at JD 2434792.3 (1954 Feb 18) and No 33 at JD 244629.0 (1986 July 17) is 369.9 days, while the average between No 33 and No 47 at JD 2451542.6 (1999 Dec 29) is only 351.0 days.

In Figure 2 it is seen that the first 33 maxima except one are brighter than magnitude 9 while the remainder are usually fainter. The mean magnitude for the former is 8.50, while for the latter it is 9.24.

Because of the gaps in the Table for the minima, graphs corresponding to Figures 1 and 2 were not drawn. There seems to be no obvious pattern in the magnitudes of the minima.

CHANGE IN THE PERIOD OF RU SCORPII (Cont.)

4. CONCLUSION

At some time around the year 1986 RU Sco was seen to undergo a change which caused a decrease in the mean period and in the brightness at maximum.

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RU SCORPII

Table of Maxima & Minima

	MAXIMA			MINIMA		
Number	JD	Period	Mag	JD	Period	Mag
1	2434792.3		8.45	2434968.0		13.64
2	35169.0	376.7	8.50	35347.9	379.9	13.82
3	35561.6	392.6	8.98	35711.6	363.7	13.90
4	35911.2	349.6	8.34	36105.3	393.7	13.70
5	36294.0	382.8	8.50	36478.0	372.7	14.00
6	36669.1	375.1	9.16	36829.2	351.2	13.74
7	37025.1	356.0	8.59	37195.6	366.4	13.51
8	37380.5	355.4	8.45	37543.2	347.6	13.61
9	37773.8	393.3	8.60			
10	38129.5	355.7	8.44	38309.6	383.2 av	13.55
11	38496.0	366.5	8.85	38689.7	380.1	13.99
12	38875.1	379.1	8.64			
13	39235.3	360.2	7.95			
14	39602.8	367.5	8.38	39787.4	365.9 av	13.67
15	39978.9	376.1	8.39			
16	40349.9	371.0	8.54			
17	40748.3	398.4	8.01			
18	41114.8	366.5	8.55			
19	41489.0	374.2	8.88	41680.9	378.7 av	13.55
20	41868.6	379.6	8.47			
21	42239.4	370.8	8.37			
22	42607.1	367.7	8.85	42802.9	374.0 av	13.61
23	42972.4	365.3	8.44			
24	43360.3	387.9	8.32			
25	43711.7	351.4	8.67			
26	44084.0	372.3	8.17			
27	44421.1	337.1	7.78			
28	44817.0	395.9	8.72			
29	45179.9	362.9	8.40			
30	45539.3	359.4	8.27			
31	45915.8	376.5	8.31			
32	46258.4	342.6	8.79			
33	46629.0	370.6	8.69			
34	46981.5	352.5	9.72			
35	47331.5	350.0	8.81			
36*	47699.4	367.9	8.89	47865.1	361.6 av	12.61
37	48059.8	360.4	8.98			
38	48415.7	355.9	9.36			
39**	48763.2	347.5	9.25			

RU SCORPII

Table of Maxima & Minima (Cont.)

MAXIMA				MINIMA		
Number	JD	Period	Mag	JD	Period	Mag
40	49108.7	345.5	8 93	49277.9	353.2 av	13.33
41	49447.6	338.9	9.22	49626.0	348.1	13.06
42	49831.7	384.1	9.40	49990.6	364.6	12.66
43	50178.8	347.1	9.47	50344.0	353.4	12.91
44	50528.0	349.2	9.50	50687.7	343.7	12.90
45	50849.0	321.0	9.42	51055.3	367.6	12.63
46	51184.4	335.4	9.24	51360.8		
47	51542.6	358.2	9.23	51734.4	339.6 av	13.10

*There are four crests around the maximum between JD 2447600 and 2447730, and two dips around the minimum between JD 247820 and 247900.

**There was a peak of almost the same brightness as this 29.2 days earlier.

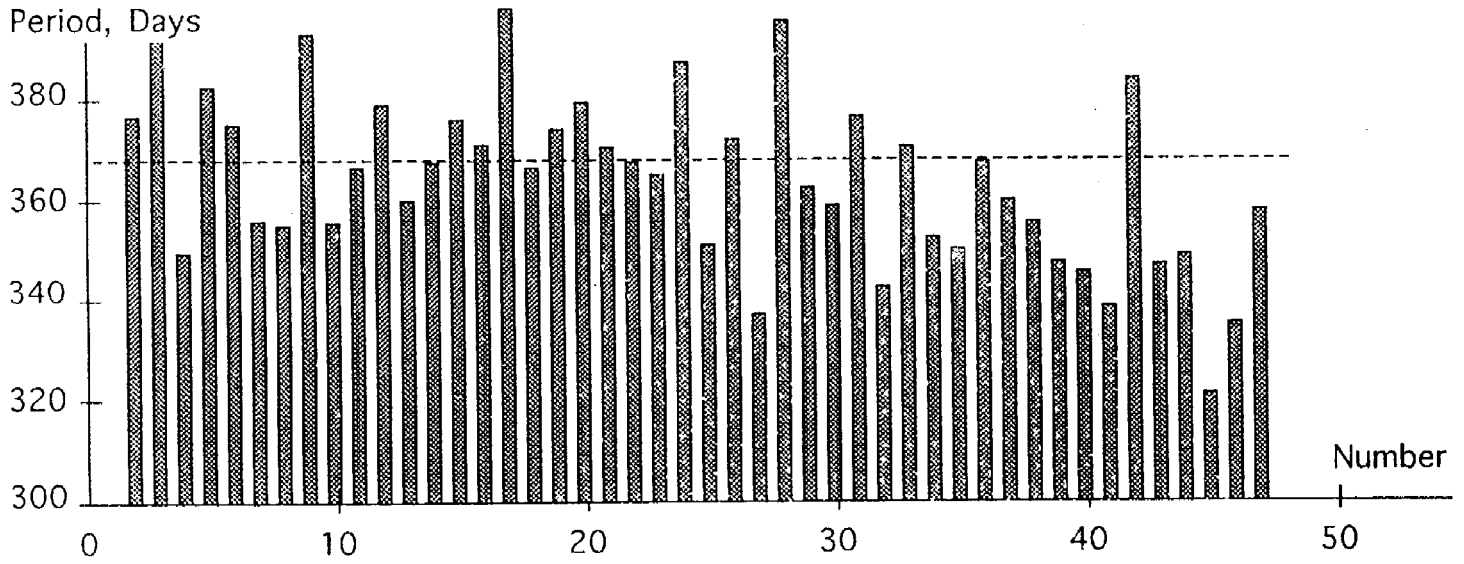

Figure 1: The intervals between successive maxima in the light curve of RU Scorpii. The average of the recent ones falls well below 368.21 days.

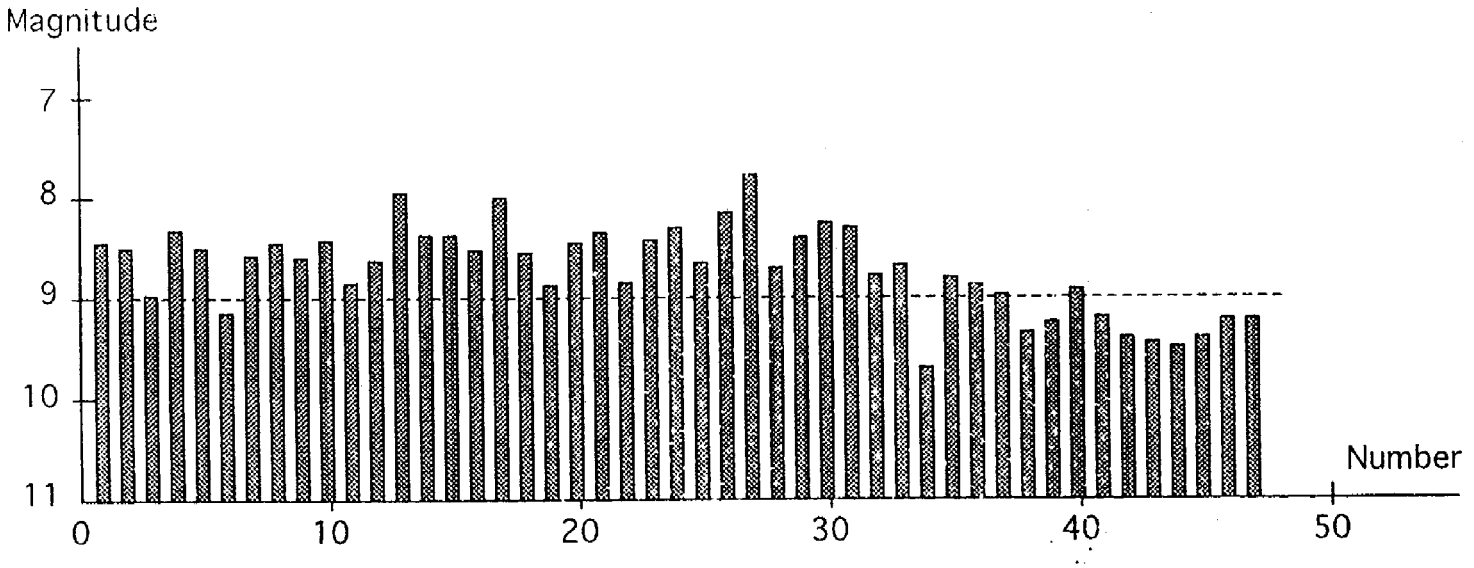

Figure 2: The magnitudes of successive maxima in the light of RU Scorpii. The earlier ones are almost all brighter than magnitude 9 and the later generally fainter.

RY SCORPII

A NEW VISUALLY DETERMINED PERIOD AND EPOCH FOR MAXIMUM BRIGHTNESS

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SUMMARY: Visual observations of the classical cepheid RY Sco obtained during the 3 year interval 1998 - 2000 indicate maximum brightness was occurring near phase 0.35 relative to current GCVS elements. Based on the visual data, a revised period and epoch for maximum are JD 2450974.454 + 20.31426 days.

INTRODUCTION

The Classical Cepheid Program was outlined by Cragg (1) in which it was suggested visual observation of long period cepheids may prove useful. Cragg (2) later presented results for l Carinae and Morel (3) drew attention to the bright cepheid U Carinae.

Morel's results for U Car suggested this star was reaching maximum some 3 days late relative to the catalogue elements. This discrepancy was confirmed by Williams (4).

This prompted the author to commence visual monitoring of several long period classical cepheids which are readily observable with binoculars and for which a chart with reliable sequence of comparison stars was available. Results for 3 years monitoring of RY Sco are discussed here.

CHART AND OBSERVATION

Chart 682 (5) shows RY Sco with a reliable V-magnitude sequence of comparison stars. The normal observing season is from May through September during which this star has been observed on a nightly basis, subject to weather, using hand held 20x80mm binoculars.

A total of 191 observations were obtained during the 3 years 1998-2000, yearly totals being 1998, 51; 1999, 63; and 2000, 77.

DISCUSSION

The 4th edition General Catalogue of Variable Stars (6) gives the elements for maximum as JD 2428256.45 + 20.31322 days. The GCVS also indicates the period of RY Sco is variable and possibly subject to a small linear progression.

All daily observations were plotted in phase according to the above elements. The resulting plot is shown as Figure 1 in which it can be clearly seen RY Sco is reaching maximum near phase 0.35, about 6 days later than expected.

To determine the dates of maximum during the interval under discussion, the observations were then plotted as seasonal light curves. To increase the number of data points available, each individual observation was then shifted +/- by one cycle of 20.313 days. Each observation is therefore used 3 times.

A mean curve was then added and the dates of maximum measured. A portion of the mean light curve is shown as Figure 2.

Using the current catalogue period of approximately 20.313 days it is apparent 42 cycles of RY Sco occurred during this interval. This gave a preliminary period of 20.32421 days for which O-C times were calculated relative to the maximum of JD 2450974.454.

RY SCORPII
A NEW VISUALLY DETERMINED PERIOD AND EPOCH FOR MAXIMUM BRIGHTNESS (Cont.)

This preliminary period was then refined to that finally adopted here as a revised epoch for maximum brightness of RY Sco :

JD 2450974.454 + 20.31426 days.

A visual magnitude range is 7.5 to 8.7 and M-m 0.33 (6.71 days).

Table 1 lists the dates of visually determined maxima during 1998 - 2000, the dates of maxima predicted by the preliminary period (P1) and the revised period (P2), and the O-C values for each. Despite the inherent uncertainty associated with visual data, the relatively small O-C values suggest these revised elements reflect the current behaviour of RY Sco.

All observations used in this paper are available from the data base of the VSS, RASNZ by contacting the Director at varstar@xtra.co.nz.

CONCLUSION

A new visually determined period for determining maximum brightness of the classical cepheid RY Sco is JD 2450974.454 + 20.31426 days. These new elements appear to satisfy the observed behaviour during the 3 year interval 1998 through 2000.

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(4) Williams, P.F. 1997 Publ. VSS, RASNZ No.22 (C97/1), p31.
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(6) Kholopov, P.N. Ed 1985 General Catalogue of Variable Stars, 4th edition Vol.3 Nauka, Moscow.

Observed Maxima of RY Sco 1998 - 2000.

Table 1

JD 2400000+ Observed	P1: 20.32421 Calculated	O-C Days	P2: 20.31426 Calculated	O-C Days
50953.492	50954.129	-0.638	50954.139	-0.647
50974.454	E	0	E	0
50994.970	50994.778	+0.192	50994.768	+0.202
51015.151	51015.102	+0.049	51015.082	+0.069
51340.114	51340.289	-0.172	51340.109	+0.005
51360.776	51360.613	+0.166	51360.423	+0.353
51381.221	51380.938	+0.287	51380.738	+0.483
51401.449	51401.262	+0.191	51401.052	+0.397
51422.111	51421.586	+0.529	51421.366	+0.745
51725.981	51726.449	-0.461	51726.079	-0.098
51746.644	51746.773	-0.122	51746.393	+0.251
51766.654	51767.097	-0.436	51766.707	-0.053
51786.555	51878.414	-0.859	51787.022	-0.467
51807.109	51807.738	-0.629	51807.336	-0.227

Fig.1. RY SCO PHASE PLOT 1998-2000

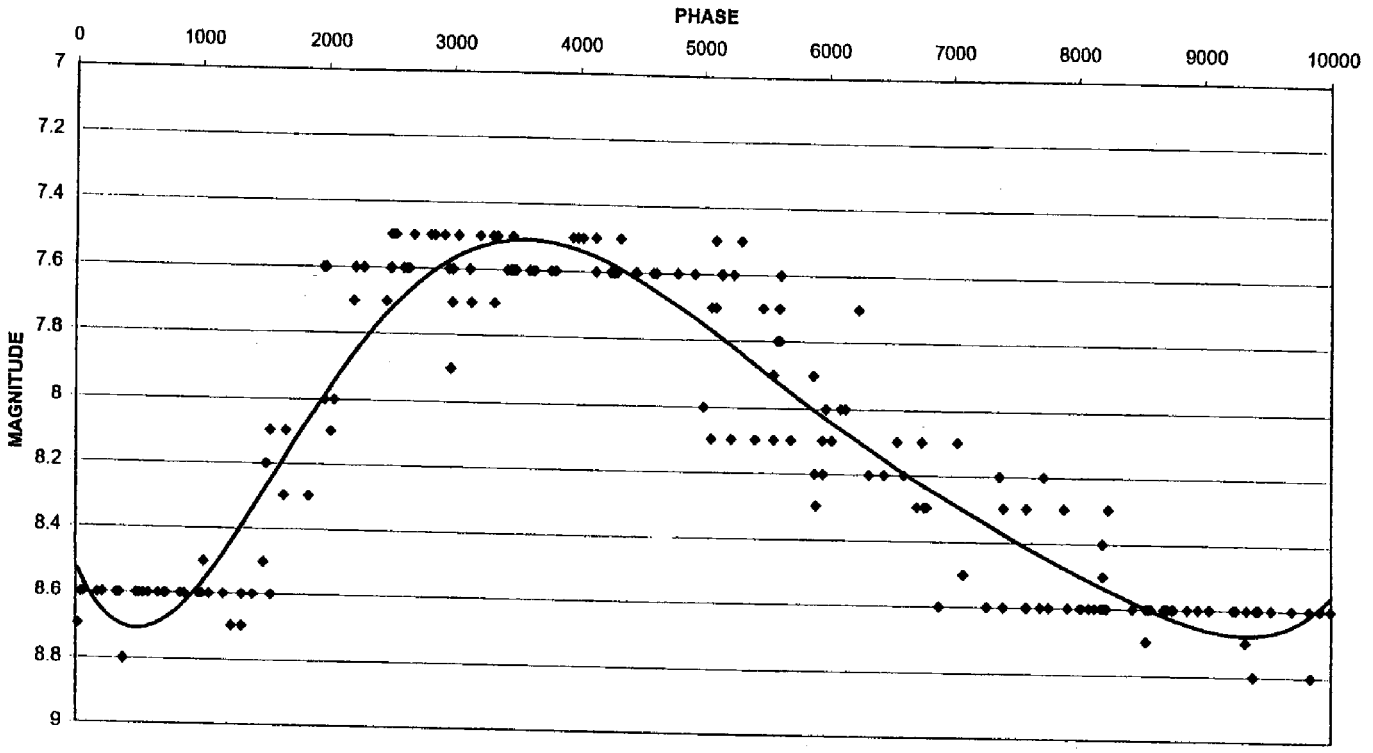
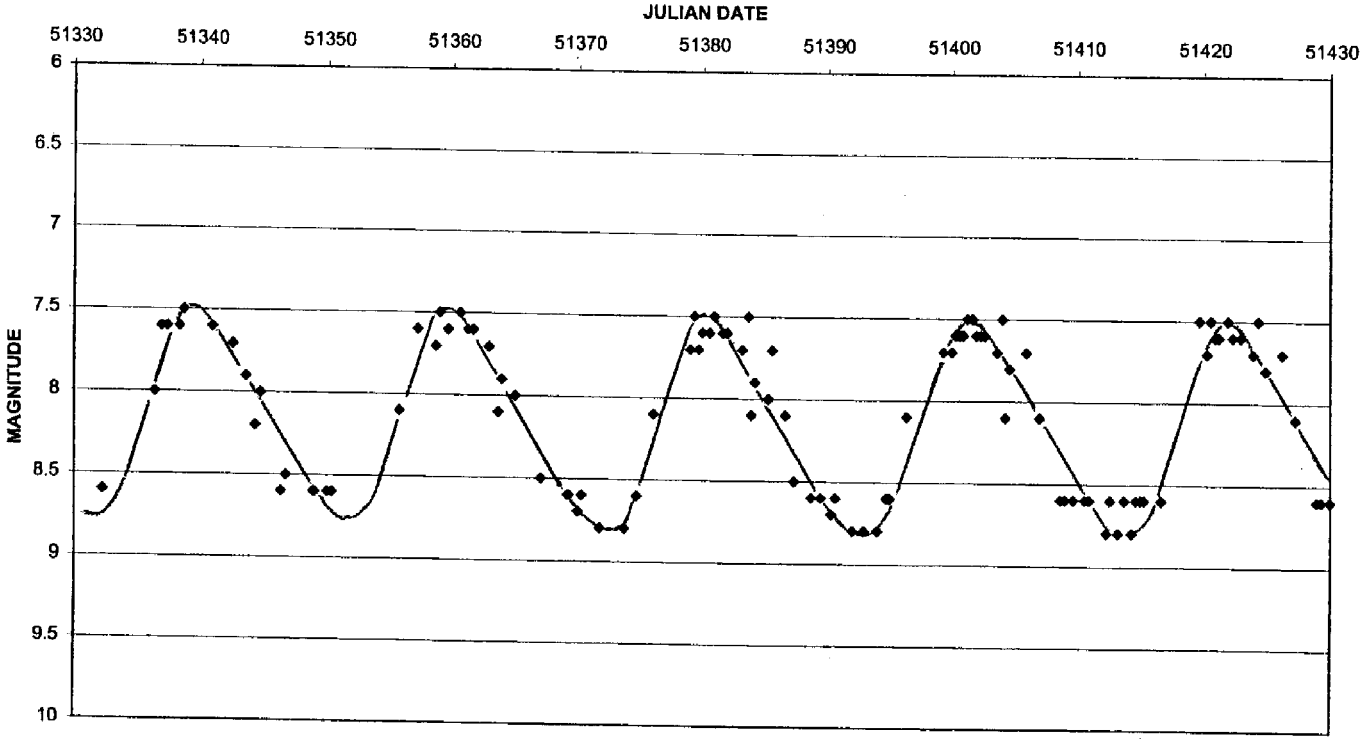


Fig.2. RY SCO 1999 PHASE SHIFT PLOT AND MEAN LIGHT CURVE



EO ERIDANI - A MIRA TYPE VARIABLE

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SUMMARY

Visual observations of EO Eri (NSV1710) covering the 9 year interval JD 2448217 to 2451634 (1990 November to 2000 March) are discussed. These indicate EO Eri is a typical long period Mira type variable of visual magnitude range 10.6 to fainter than 15.5. A mean period of 447.5 days is found but the light curve is shown to be a single wave, not double wave as had been earlier suggested. Preliminary elements for determining maximum brightness are JD 2448597 + 447.5 days.

1. INTRODUCTION.

EO Eri was included in the New Catalogue of Suspected Variable Stars (1) as the variable infrared source NSV1710 = IRC-20062 = IRAS04430-2356.

Attention was directed to this object as a large amplitude optical variable in IAUC5031 by Klemola (2) who indicated an amplitude of some 4.5 to 5.0 magnitudes in the blue spectral band. Prompted by this, Wenzel (3) examined 300 Sonneberg plates obtained during the years 1952 to 1983 and found NSV1710 to be a Mira type variable of period near 447 days and a blue magnitude range 10.3 to 18.0. He also suggested the maxima of this star were possibly double peaked.

Following the initial report by Klemola, the author decided to undertake a regular series of visual observations to further investigate the character of this star's light curve. The results of 9 years monitoring are discussed here.

NSV1710 was later assigned the variable star designation EO Eridani (4).

2. CHART AND SEQUENCE.

At the request of the principal author Mati Morel prepared a preliminary chart for this star. Fortunately, a reliable sequence of V magnitude comparison stars was available for this field and these values have been used by all observers. This chart was later published as VSS RASNZ Chart 1054 (5), resulting in more observers monitoring this star.

3. DISCUSSION.

The normal observing season for EO Eri is September through April. A total of 261 visual observations are available from the data base of the VSS RASNZ. These are plotted as individual points on the light curve shown as Figure 1.

The dates of 6 maxima can be readily determined from the light curve. Details of these are given in Table 1 where column 1 gives the cycle number, column 2 the JD of maximum and column 3 the interval to the following maximum. Column 4 lists the date of maximum predicted by a period 447.5 days relative to the epoch JD 2448597

EO ERIDANI - A MIRA TYPE VARIABLE (cont.)

and column 5 the O-C value relative to this period.

This period is only marginally longer (0.5 days) than that proposed by Wenzel but appears to give slightly improved O-C data over the relatively few cycles discussed here.

Table 2 lists 9 photographic observations of EO Eri obtained by Eugene Brings of Mendocino, California, as part of a program to photograph red NSV stars. Figure 2 shows two images obtained by Brings which clearly demonstrate the optical variability of EO Eri.

The light curve does not, however, indicate the presence of a double-peaked maximum as suggested earlier. The maxima discussed here can be grouped into two types:

(i) bright maxima reaching an average visual magnitude 10.6, and
(ii) faint maxima which peak at visual magnitude 11.6.

These two groups are shown in the smoothed composite light curves in Figure 3. Here, bright maxima are represented by cycles 2, 4 and 7 while faint maxima are represented by cycles 1, 3, 6 and 8.

Those of the fainter type (ii) are clearly much broader at maximum and appear to remain close to maximum brightness for up to 8 weeks. Despite this difference in peak brightness and shape of the light curve, the width of the light curve at 2.5 magnitudes below maximum (magnitude 13.0 for type i) and 14.0 for type (ii), respectively) is essentially the same and near 140 days.

4. CONCLUSION.

EO Eri is a typical long period Mira type variable star. The observations discussed here indicate a period of 447.5 days but there is no evidence to suggest the presence of a double wave light curve.

A visual magnitude range of 10.6 to fainter than 15.5 is found while photographs indicate a minimum brightness near magnitude 18ptg. An epoch for maximum brightness is JD 2448597 + 447.5 days.

ACKNOWLEDGEMENTS.

All observers are thanked for their observations without which this paper could not have been written. Thanks also to Frank Bateson and Ranald McIntosh for providing printouts from the VSS RASNZ data base.

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EO ERIDANI - A MIRA TYPE VARIABLE (cont.)

TABLE 1

No.	Max 2400000+	Interval	E + 447.5 2440000+	O-C
1	-	-	-	-
2	48597	449.0	E	E
3	49046	439.0	49044.5	+1.5
4	49485	452.0	49492.0	-7.0
5	(49937)	(450)	49939.5	-2.5
6	50387	446.0	50387.0	0
7	50833	452.0	50834.5	-1.5
8	51285	-	51282.0	+3.0

Table 1.
Details of observed maxima for EO Eridani for period 447.5 days. Cycle 1 has only two faint observations during decline while cycle 5 details are based on little more than speculation according to the mean light curve.

TABLE 2

JD 2400000+	MAG (ptg)
48623	11.0
48658	11.5
48690	12.0
48930	16.3
48957	16.0
48976	15.5
49311	<17.0
49340	16.8
49364	15.8

Table 2.
Photographic observations of EO Eridani by E.M. Brings.

NSV 5087 CARINAE - A LARGE AMPLITUDE RED VARIABLE

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SUMMARY: Attention is directed to NSV5087 Carinae as a large amplitude red variable. Visual observations during the 5 year interval 1998 through 2002 show NSV5087 is a typical Mira type variable star of magnitude range 11.6 to 15.2 and mean period near 274.38 days. A preliminary ephemeris for maximum brightness is JD 2451646.1 +/- 274.38 days with M-m 0.47P.

1. INTRODUCTION

NSV5087 (HV8337, CSV1705) was included in the New Catalogue of Suspected Variable Stars (1) following its initial reporting by Luyten (2) as a possible Mira type variable. The NSV Catalogue indicates a photographic magnitude range of 14.1 to 16.8 but no period or epoch for maximum brightness is given.

2. DISCUSSION

NSV5087 is plotted on chart 912 (3) for the nova-like star QU Carinae on which a lettered sequence of comparison stars is shown.

Preliminary GSC magnitudes have been assigned to these stars to allow for a reduction of the data. While the GSC values are of limited accuracy, they are sufficient for the purposes of this paper. Additional comparison stars have also been selected by the author and designated by lower case letters. All comparison stars are shown in Figure 1 which are images obtained by Tony Ainsworth of Oatley, NSW and which clearly show the variability of NSV5087.

Stars a, b and c are not shown on Chart 912 and care should be taken to ensure the variable is not confused with star b when faint.

A total of 133 observations have been obtained during the 5 year interval 1998 through 2002. The main observing season from the author's observing site is December through September and a seasonal gap is therefore evident in the data. It is also apparent the first three observations recorded actually refer to the faint field star b and not to the variable.

Figure 2 is a light curve on which all observations have been plotted as individual points. Approximately 6 cycles are clearly evident. A mean period of 274.38 days for maximum brightness is found with individual cycles ranging from 250.5 days to 282.2 days. For minimum, a mean cycle of 275.23 days is evident and individual cycles range between 269.3 and 283.4 days. The data during minimum is, however, less conclusive as the variable is at this brightness near the threshold limiting magnitude of the author's telescope and should thus be treated with due caution.

The positive observations have also been analysed by the Weighted Wavelet Z-transform program (4) available through the AAVSO web site www.aavso.org. This WWZ analysis yields periods ranging from 270.27 to 285.71 with an average of

277.86 days. This average is in good agreement with the adopted mean period of 274.38 days.

Details of the observed cycles are summarised in Table 1. Here, column 1 lists the observed date of maximum and column 2 the interval to the following maximum. Column 3 gives the maximum magnitude. Column 4 gives the date of minimum light, column 5 the interval to the following minimum and column 6 the magnitude at minimum. Uncertain values here are indicated in brackets. Column 7 gives the M-m value in days followed, in brackets, by this expressed in hundredths of the mean period.

All observations were plotted according to phase based on the 274.38 day period relative to the maximum of JD 2451646.1 to produce a mean light curve shown in Figure 3.

It is stressed the results presented here are preliminary and based on few cycles of a long period variable star. They are, however, sufficient to allow for initial further study of this object and further regular monitoring will serve to improve these elements.

All observations used in the preparation of this paper are available from the database of the VSS RASNZ by contacting the Director at varstar@xtra.co.nz.

3. CONCLUSION

Observations of NSV5087 during the 5 years 1998 through 2002 show it to be a typical Mira type variable star. A mean visual magnitude range of 11.6 to 15.2 and period 274.38 days are found. A preliminary ephemeris for determining maximum brightness is JD 2451646.1 + 274.38 days.

ACKNOWLEDGEMENTS

Tony Ainsworth is thanked for his comparative images of NSV5087.

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NSV 5087 CARINAE - A LARGE AMPLITUDE RED VARIABLE Cont.

TABLE 1

Details of observed cycles of NSV5087 during 1998 through 2002

JD MAX 2400000+	INT.	MAG	JD MIN 2400000+	INT.	MAG	M-m
(51088.2)	(275.7)	(11.6)	(51234.8)	(278.9)	(15.2)	-
51363.9	282.2	11.6	51513.7	(538.6)	15.2	129.1 (0.47)
51646.1	274.9	11.8	-	-	15.0	132.4 (0.48)
51921.0	250.5	11.3	52052.3	283.4	15.1	119.2 (0.43)
52171.5	288.6	11.7	52335.7	-	15.2	124.4 (0.45)
52460.1	-	12.2	-	-	-	-

Mean interval at maximum: 274.38 days
Mean interval at minimum : 275.23 days
Mean maximum magnitude : 11.7v
Mean minimum magnitude : 15.1v
Mean M-m value : 126.28 days (0.47P)

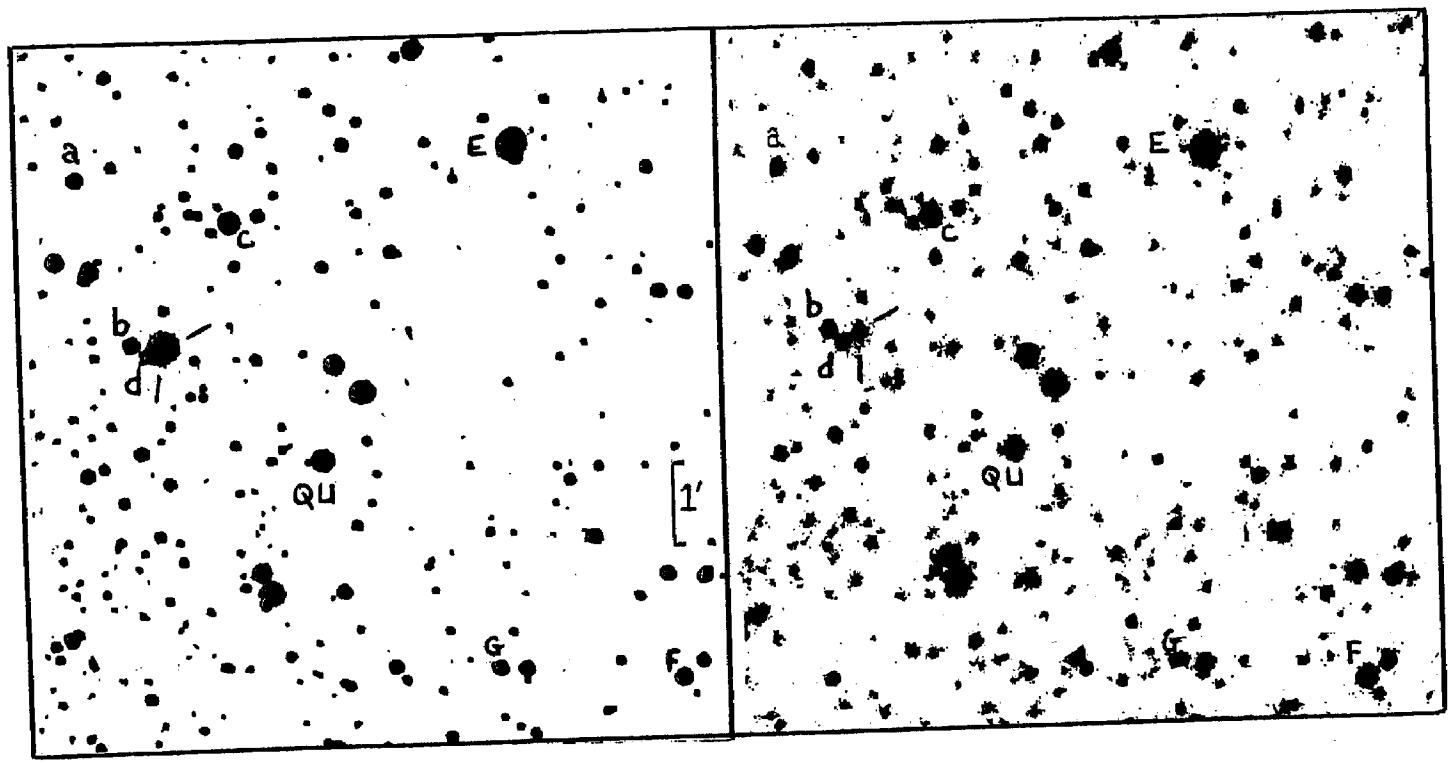

Figure 1. Comparative CCD images of NSV5087 near maximum 1999 May 12 (left) and near minimum 2000 July 26 (right). Lower case letters indicate comparison stars used in addition to upper case letters shown on VSS RASNZ Chart 912 for the nova-like variable QU Car. North at top and west to right.

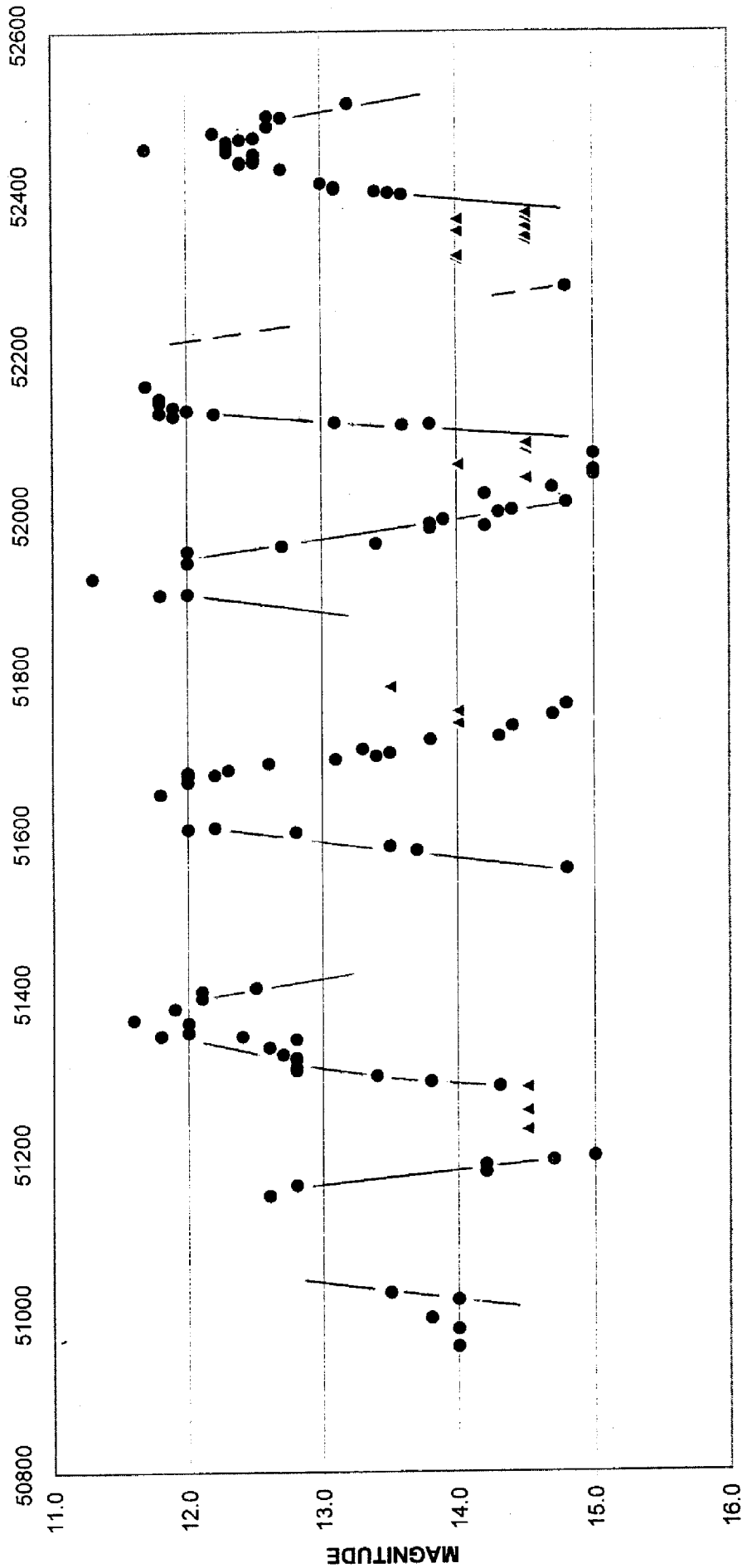

Figure 2. NSV 5087 CARINAE 1998 THROUGH 2002

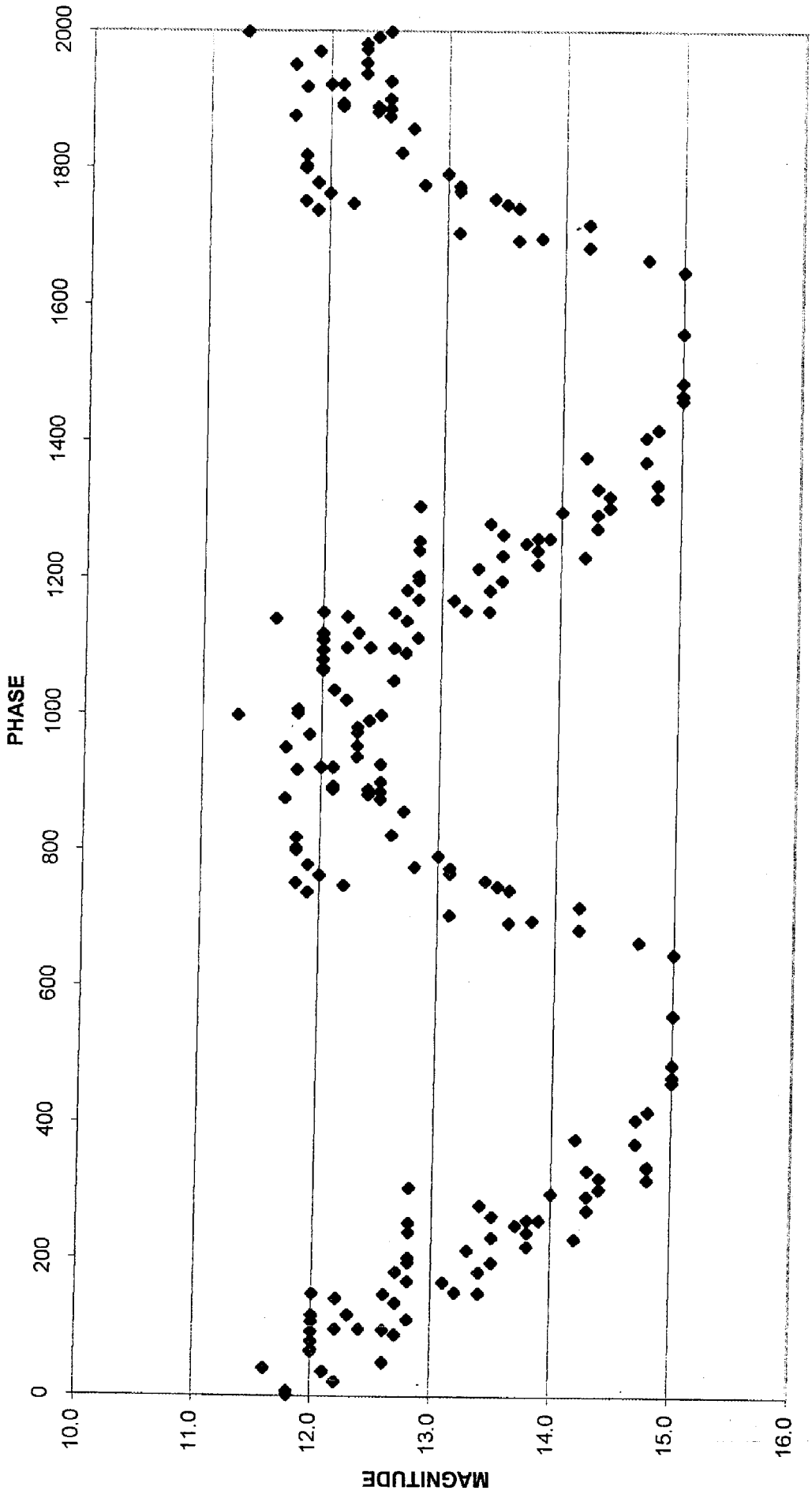

Figure 3. NSV 5087 CARINAE PHASE PLOT.