Nova Herculis 1963

Genderen, A.M. van

B.A.N. **17**, no. 4, 293–297; *Communication from the Observatory at Leiden*

NOVA HERCULIS 1963

A. M. VAN GENDEREN

Received January 7, 1964

Nova Herculis 1963 has been observed photo-electrically in *U*, *B* and *V* from February to October 1963 at the Leiden Observatory. The light-curve, the colour-curves and the path in the two-colour-diagram based on observations in 43 nights are given. The absolute magnitude derived from the M_{pg}-log $t_{3,v}$ relation gives $-7^m.4 \pm 0^m.4$ p.e. The corresponding distance is 1200 pc ± 350 pc p.e. The distance derived from $M_{15,v}$ is 800 pc ± 110 pc p.e. and the corresponding $M_{pg} = -6^m.5 \pm 0^m.5$ p.e.

1. Introduction

The nova was discovered on February 6th nearly simultaneously by L. Peltier (Delphos, Ohio U.S.A.) and E. Dahlgren (Vikmanshyttan, Sweden). The apparent visual magnitude was then about $+3^m.9$. At that moment the outburst must have occurred more than a week ago. On Baker-Nunn films of satellite tracking stations in Cambridge (U.S.A.), Tokio and San Fernando (Spain) one found the following rough magnitudes:

January 26	$+8^m$
January 30	$+3^m$
February 3	$+4^m$

They are marked in figure 2 by crosses.

Spectroscopic observations of McLaughlin (1963) in the beginning of February indicate that the maximum has taken place before February 1, possibly January 27. He found a close agreement between this spectrum and that of DN Gem 1912. Assuming that the two novae are of the same type he found by extrapolation for the maximum brightness a value of about $+3^m$. Other spectroscopic observations were made by Y. Andrillat and M. Bloch (1963) and M. Bloch and D. Chalonge (1963).

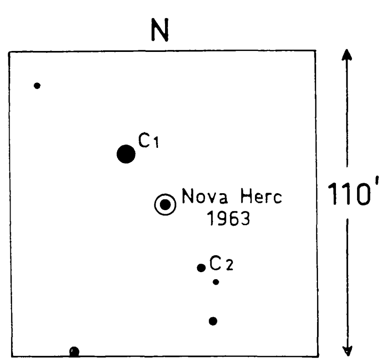

Figure 1

Interesting is the article of K. Löchel (1963). He investigated plates of the Sonneberg Observatory, taken from March 1941 to October 1962. On the two plates of the Mt Palomar Sky Survey Atlas (O 324 and E 324) the possible pre-nova was found to be one component of a close pair, but on the Sonneberg plates the two stars form a single image. The total brightness was about $+13^m.5$ and till 1962.0 it showed no appreciable light-variations, but in March 1962 the magnitude had decreased to $+12^m.7$ and in October of the same year it was already $+12^m.2$. Unfortunately no more plates were available.

The coordinates of Nova Herculis 1963 for the equinox of 1950.0 were determined by Dr S. Arend (*I.A.U. Circ.* No. 1824) and Dr L. Pajdusakova (*I.A.U. Circ.* No. 1832). They got respectively

$$\alpha = 18^h 12^m 46^s.33 \quad \delta = +41° 50' 22''.1 \quad \text{and}$$
$$\alpha = 18\ 12\ 46.63 \quad \delta = +41\ 50\ 22.5$$

The galactic coordinates are $l^{II} = 68°$, $b^{II} = +24°$.

2. Observations and reductions

The observations at the Leiden Observatory were made with the 45-cm Zunderman reflector, equipped with an E.M.I. photo-multiplier of type 6094. The *U*,

TABLE 1
Data of the comparison stars

Star	α(1963)	δ(1963)	BD No.	HD No.	Sp.
c_1	$18^{\rm h}$ $14^{\rm m}.5$	+ 42° 10'.1	+ 42° 3035	167965	B5
c_2	18 11.9	+ 41 28.6	+ 41 3013	167389	F8
BD + 61° 1451	14 41.6	+ 61 25.9	+ 61 1451	129798	F2

B and *V* filters were the same as used by Johnson for his *UBV* photometry.

In the first six nights the Johnson standard star BD + 61° 1451 was used as comparison star. The sec *z* difference was large, therefore magnitudes and colours obtained may be rather uncertain. The other observations were made with comparison star BD + 42° 3035 (= c_1) near the nova (figure 1).

The observations were made as follows: sky – comparison star – sky – nova – sky etc.

The magnitude and colours in the *U B V* system of c_1 and a second star near the nova BD + 41° 3013 (= c_2) were determined by means of five Johnson standard stars. We measured them during two nights, from which the extinction coefficients and the transformation from our instrumental system to that of Johnson and Morgan could be derived. The formulae used in these computations are the same as those of J. STEBBINS, A. E. WHITFORD and H. L. JOHNSON (1950). The resulting magnitudes and colours for c_1 and c_2 and those for the standard stars given by Johnson and Morgan are listed in table 2. Moreover c_1 and c_2 have been plotted in the two-colour-diagram in figure 4. Other particulars of the comparison stars are given in table 1.

The magnitude and colours for the nova have been determined only relative to c_1 because its spectral type (B5) is close to that of the nova, while c_2 is of a much later spectral type (F8). The magnitude differences were derived in three decimals and corrected for differential extinction if necessary. The resulting *V*, (*B* – *V*) and (*U* – *B*) mean values of the nova are given in two decimals in table 3. The numbers of measures per night are given in the table.

In table 3, every night is indicated by a number in the first column. In this way the track of the nova in the two-colour-diagram is easy to follow (figure 4).

In the column for the remarks we have inserted a question mark when the given magnitude and colours are somewhat doubtful in our opinion. In the nights 11 and 16, BD + 61° 1451 and c_1 were used as comparison stars. The magnitude and colours of the nova derived separately from both comparison stars are in satisfactory agreement, the largest difference being $0^{\rm m}.03$ for the (*B* – *V*) colour.

The observations ended in October as the nova became too faint for our telescope.

TABLE 2
Magnitudes and colours of the comparison and standard stars

Star	*V*	*B* – *V*	*U* – *B*
c_1	$+ 5^{\rm m}.602 \pm {}^{\rm m}.006$ m.e.	$- {}^{\rm m}.065 \pm {}^{\rm m}.015$ m.e.	$- {}^{\rm m}.447 \pm {}^{\rm m}.008$ m.e.
c_2	+ 7.412 ± .007	+ .650 ± .017	+ .172 ± .030
BD + 61° 1451	+ 6.25	+ .41	+ .01
BD + 67 1014	+ 6.43	+ .76	+ .29
BD + 71 1112	+ 6.38	– .05	– .18
BD + 80 347	+ 7.32	+ .55	+ .04
BD + 38 3095	+ 6.392	+ .879	+ .597

TABLE 3
The magnitudes and colours of Nova Herculis 1963

No	Date 1963	J.D.-2438000	V	B-V	U-B	Number of observ. in V,B,U	Remarks
1	21/22 Feb.	82.54	+ 5.08	-.08	-.68	4 4 4	? clear
2	25/26 "	86.54	+ 4.92	.00	-.70	2 2 2	? very clear
3	27/28 "	88.54	+ 4.74	+.02	-.72	3 3 3	? variable extinction
4	28 Feb. /1 March	89.56	+ 4.84	-.04	-.68	2 2 2	? variable extinction
5	3/4 March	92.58	+ 5.56	-.08	-.75	3 3 3	? clear
6	29/30 March	118.52	+ 6.23	-.15	-.74	4 4 2	? very clear with small clouds
7	4/5 April	124.48	+ 6.60	-.28	-.70	1 1 1	for a short time clear
8	6/7 "	126.48	+ 6.78	-.31	-.68	4 4 4	very hazy
9	7/8 "	127.52	+ 7.08	-.33	-.70	4 4 4	hazy
10	10/11 "	130.47	+ 7.12	-.35	-.75	2 1 1	for a short time clear
11	11/12 "	131.49	+ 7.23	-.27	-.76	1 1 1	for a short time clear
12	16/17 "	136.37	+ 7.23	-.36	-.63	2 5 3	? bad sky
13	18/19 "	138.51	+ 7.47	-.34	-.61	3 4 4	clouds
14	22/23 "	142.46	+ 7.36	-.40	-.57	2 2 1	? hazy
15	23/24 "	143.50	+ 7.22	-.37	-.62	2 1 2	? hazy
16	26/27 "	146.52	+ 7.55	-.33	-.59	6 8 6	very clear
17	7/8 May	157.57	+ 7.81	-.50	-.45	4 2 2	clear
18	9/10 "	159.43	+ 7.79	-.50	-.42	2 2 2	clear
19	17/18 "	167.44	+ 8.03	-.48	-.35	1 1 1	for a short time clear
20	3/4 June	184.47	+ 8.39	-.42	-.32	1 1 1	for a short time clear
21	26/27 "	207.47	+ 8.72	-.38	-.10	1 1 1	for a short time clear
22	1/2 July	212.46	+ 8.80	-.39	-.14	2 2 2	variable extinction
23	21/22 "	232.45	+ 9.10	-.33	+.03	13 12 7	? bad sky
23A	23/24 "	234.43	-	-	-	0 1 0	B =+8.75, clouds
24	25/26 "	236.52	+ 9.12	-.30	.00	5 5 5	very clear
25	26/27 "	237.43	+ 9.14	-.29	.00	2 2 2	very clear, stopped by clouds
26	27/28 "	238.43	+ 9.15	-.29	-.01	2 2 2	very clear, stopped by clouds
27	28/29 "	239.42	+ 9.19	-.32	+.01	5 5 5	very clear
28	29/30 "	240.42	+ 9.22	-.32	-.01	5 5 5	very clear
29	30/31 "	241.41	+ 9.24	-.32	+.01	5 5 5	very clear
30	31 July/1 Aug.	242.48	+ 9.24	-.36	+.13	5 5 5	hazy
30A	13/14 Aug.	255.48	+ 9.38	-.26	-	1 1 0	? hazy, stopped by clouds
31	17/18 "	259.40	+ 9.40	-.23	+.13	5 5 5	clear with some clouds
32	20/21 "	262.39	+ 9.46	-.25	+.13	3 3 3	clouds
33	24/25 "	266.51	+ 9.62	-.30	+.18	1 1 1	? clouds
34	27/28 "	269.36	+ 9.54	-.20	+.15	4 3 5	hazy
35	29/30 "	271.35	+ 9.55	-.17	+.15	4 4 4	clear
36	9/10 Sept.	282.35	+ 9.64	-.03	+.04	6 4 4	? bad sky
37	12/13 "	285.35	+ 9.73	-.11	+.11	5 5 5	clear
38	14/15 "	287.35	+ 9.74	-.05	+.11	4 5 5	clear
39	16/17 "	289.32	+ 9.85	-.20	+.17	3 3 3	? very hazy
40	19/20 "	292.35	+ 9.77	-.07	+.11	6 5 5	clear
41	18/19 Oct.	321.37	+10.07	+.01	+.13	4 4 5	very clear

3. Discussion

The light-curves in *U*, *B* and *V*, shown in figure 2, are rather regular and characteristic for a fast nova. The time needed for the first drop in light-intensity of 2 magnitudes is about 25 days. The gap in the month of March is the result of bad weather conditions.

Novae with a rate of decline like Nova Herculis 1963 are for instance DN Gem (1912), 368 Agl (1936) and 528 Agl (1945). As already mentioned the spectrum of our nova showed also a resemblance with DN Gem (1912).

The distance and absolute magnitude can be derived in two manners. According to SCHMIDT (1957) the absolute photographic magnitude of novae at maximum is given by the relation

$$M_{pg} = -11.5 + 2.5 \log t_{3,v} \qquad (M_{pg} - M_v = 0^m.25),$$

where $t_{3,v}$ is the time needed for the first drop of 3 magnitudes in brightness. Assuming that the maximum fell on January 27 with a brightness of $+3^m.0 \pm 0^m.5$ p.e. and using the visual light-curve given in the *B.A.V.* (QUESTER, 1963), $t_{3,v} = 44^d \pm 10^d$ p.e., $\log t_{3,v} = 1.64 \pm 0.10$ p.e. and $M_{pg} = -7^m.4 \pm 0^m.4$ p.e.

The corresponding distance is 1200 pc $\pm$ 350 pc p.e.

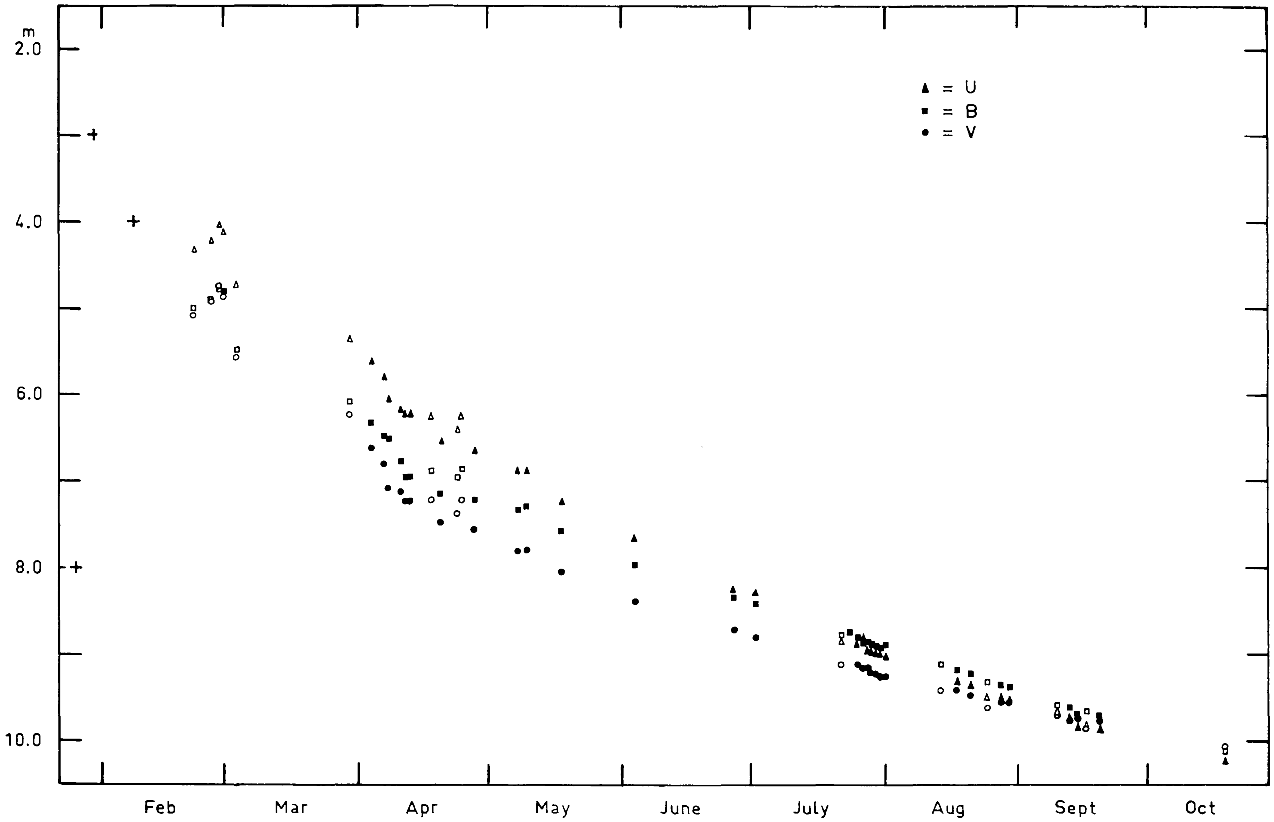

Figure 2. The lightcurve in *U*, *B* and *V* of Nova Herculis 1963. Open symbols are doubtful observations.

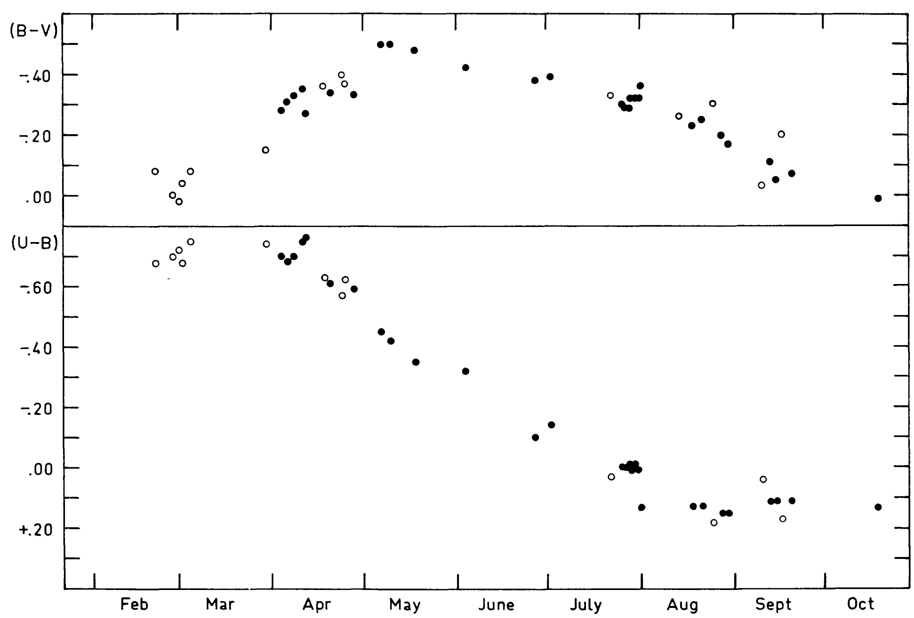

Figure 3. The colour-curves of Nova Herculis 1963. Open circles are doubtful points.

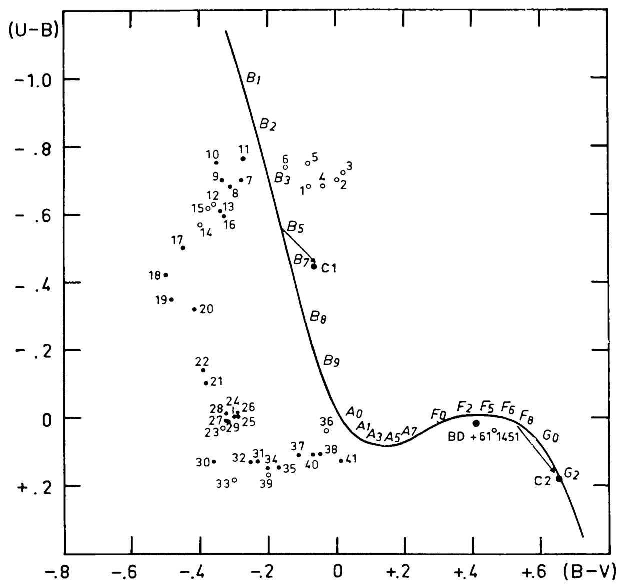

Figure 4. The path of Nova Herculis 1963 in the two-colour-diagram. The numbers correspond with those in table 3.

The correction for the interstellar absorption has been omitted as the maximum brightness is very inaccurate.

BUSCOMBE and DE VAUCOULEURS (1955) found that the mean visual absolute magnitude of novae of all types 15 days past maximum is equal to $M_{15,\mathrm{v}} = -5^{\mathrm{m}}.2 \pm 0^{\mathrm{m}}.1$ p.e. Starting again from the visual light-curve the observed magnitude at this phase $m_{\mathrm{v}} = +4^{\mathrm{m}}.7 \pm 0^{\mathrm{m}}.3$ p.e. When we assume a total visual interstellar absorption $A_{\mathrm{v}} = 0^{\mathrm{m}}.4$, $m_{\mathrm{v}} = +4^{\mathrm{m}}.3$ and the distance $r = 800$ pc $\pm$ 110 pc p.e., while the corresponding absolute photographic magnitude for the maximum brightness $M_{\mathrm{pg}} = -6^{\mathrm{m}}.5 \pm 0^{\mathrm{m}}.5$ p.e.

The large difference between these two values of M_{pg} and r must be caused by the poor observations during the first two weeks. The adopted absorption of $0^{\mathrm{m}}.4$ is a rather arbitrary and rough estimate. The E_{B-V} for c_1 (distance $\approx$ 200 pc) and c_2 (distance $\approx$ 50 pc) are about $0^{\mathrm{m}}.1$ if we assume that they are main-sequence stars. If $A_{\mathrm{v}} = 3.0\ E_{B-V}$, then $A_{\mathrm{v}} = 0^{\mathrm{m}}.3$. From the counts of extra-galactic nebulae as a function of galactic latitude, we may expect for the nova at a distance of about 1000 pc an absorption of $A_{\mathrm{v}} = 0^{\mathrm{m}}.4$.

As we cannot determine the interstellar reddening accurately we have given in figures 3 and 4 the observed colour-curves and the observed path in the two-colour-diagram respectively. As the nova spectrum displays emission features throughout most of its life, this two-colour-diagram in itself is perhaps not of such a great significance. It may be interesting however to intercompare the paths of different novae in the two-colour-diagram. ARP (1961) made a two-colour-diagram for a supernova in NGC 7331 and its path looks quite different from that of our nova.

According to SCHMIDT (1957) the normal colour of novae at maximum $(B - V) = +0^{\mathrm{m}}.35 \pm 0^{\mathrm{m}}.05$. Indeed, there is the tendency for Nova Herculis 1963 to come from that direction of the two-colour-diagram.

Many thanks are due to Mr A. G. Jansen for his observations of Nova Herculis 1963 in the month of July.

References

Y. ANDRILLAT and M. BLOCH, 1963, *Publ. de l'Obs. de Haute Provence* **6** No. 31

H. ARP, 1961, *Ap. J.* **133** 883

M. BLOCH and D. CHALONGE, 1963, *Publ. de l'Obs. de Haute Provence* **6** No. 33

K. LÖCHEL, 1963, *M.V.S.* Bd **2** Heft 1, 14

D. B. MCLAUGHLIN, 1963, *Sky and Telescope* **25** No. 4

TH. SCHMIDT, 1957, *Zs. f. Ap.* **41** 182

J. STEBBINS, A. E. WHITFORD and H. L. JOHNSON, 1950, *Ap. J.* **112** 469

W. QUESTER, 1963, *B.A.V.* Jhrg **12** 38 (No. 3)