

# ASTRONOMISCHE NACHRICHTEN.

N<sup>o</sup> 2988-89.

## Physical and Micrometrical Observations of the Companions to Comet 1889 V (Brooks).

Made with the 12 inch and 36 inch Refractors of the Lick Observatory.

By *E. E. Barnard.*

On the morning of August 2<sup>nd</sup> 1889, while observing the position of Brooks' Comet 1889 V with the 12 inch equatorial, I discovered two small companions which were subsequently found to be moving with the main comet.

This discovery was announced telegraphically on the morning of August 3<sup>rd</sup>, after it had been carefully verified (A. N. 2914), and on the morning of August 5<sup>th</sup> two other very faint companions were discovered with the great telescope. After receiving this announcement at Vienna, the companions were observed there on the morning of August 5<sup>th</sup> (A. N. 2922). A number of other faint nebulosities, observed near the comet on August 2<sup>nd</sup> (A. N. 2919) have not since been seen though they have been looked for on several occasions. The sky was never sufficiently pure while their place was favorably situated to decide if they were nebulae.

The term »fragments« as applied so frequently to these small bodies, is altogether inappropriate as it implies knowledge of the method of their formation which we certainly do not possess. The measures clearly show that the separation of the companions from the main comet could not have been a very recent event, their formation as distinct bodies possibly having occurred at the appulse with Jupiter in 1886, as pointed out by M. Chandler (A. J. 205). The expression is otherwise misleading, for these objects were in every respect distinctly separate comets, as perfect in form and individuality as the main comet itself. The companions were not seen by me previous to August 1<sup>st</sup> because moonlight interfered at the observations here on July 8, 9, 10, and after the moon withdrew the 12 inch equatorial could not be used on account of repairs until August 1<sup>st</sup> when they were discovered.

Some confusion has been introduced in designating these objects, the method at Vienna differing from the one adopted at Mt. Hamilton while this in turn differs from that at Pulkowa. It seems best to retain the method adopted at Mt. Hamilton, as this series of observations is the largest of any.

The companions discovered here I have numbered *B*, *C*, *D* and *E*, the main comet being called *A*. I have identified the companions observed at Vienna as follows:

$$\begin{aligned}\mathcal{L}_1 &= B \\ \mathcal{L}_2 &= C \\ \mathcal{L}_3 &= E\end{aligned}$$

*D* which was brighter than *E*, and between it and *C*, appears not to have been seen at Vienna.

Those observed at Pulkowa I have partially identified as

$$(3) = B$$

$$(4) = C$$

The comet (2) of Pulkowa I have not seen.

As this comet will become historical, not only on account of the companions, but also because of its possible identity with Lexell's comet of 1770 as indicated by Mr. Chandler (A. J. 205), it is well that some statements which have been printed should be carefully examined, as there is strong negative evidence against some of them. This comet was constantly and thoroughly observed here with the great refractor on every possible occasion from the time of the discovery of the companions until they disappeared from sight. Frequently during these observations the region near the comet was carefully examined for new objects or any abnormal appearances. It would therefore appear that the following remarks should have considerable weight.

As previously stated (A. J. 202) the nebulous sheath reported from Vienna as enclosing the entire group, was not seen here on the same dates with either the 12 inch or the 36 inch telescopes, though a connecting nebulosity was looked for. The additional companion reported from Pulkowa on August 20, and seen only once in position angle 30° and distance 1' was not visible here on that or other dates, though it could not have escaped in the 36 inch unless its existence was of less than eight hours duration. All this time the comet was passing through a region of faint and unknown nebulae, quite a number of which were discovered close to it at different times with the great telescope and notably one which was seen about 2' south of the nucleus on August 22. As the Pulkowa object was only seen once it is possible that it was one of these faint nebulae. »A fragment seen drifting backwards over the tail of the comet« by Mr. Brooks on Aug. 7 (Sid. Mess. Nr. 78 for October 1889) was not seen at the Lick Observatory and could hardly have been a companion. It was doubtless the nebula N.G.C. 38 whose place corresponds to the observation.

The drawing of this comet group made at Vienna (A. N. 2922) differs in several respects from the one made here (A. N. 2919), but principally in showing the region

back of the head dark in *A* and *B* while the Lick Observatory drawing shows it to be the brightest part of the tail. My notes verify this fact. The companions are somewhat incorrectly located on the Vienna drawing, as will be seen from the published position angles and distances covering the date of the drawing. The Mt. Hamilton drawing truly represents the appearance of the group as seen here on August 4<sup>th</sup>; in subsequent observations it was perfectly satisfactory and I saw nothing to alter in it.

It would seem that the closest companion *B* was only measured at the Lick Observatory and at Vienna, though it was seen at Pulkowa. The distant companion *C*, however, was well observed at Pulkowa, Nice, Vienna, Marseilles, Strassburg and Algiers as well as at the Lick Observatory.

I have had occasion to convert all the observations that have come under my notice, into position angle and distance for comparison with my own observations and insert them in this paper for the convenience of others. It appears that all the observations except those at Pulkowa, were differences of right ascension and declination. At Vienna and Strassburg the observations of the companions were referred direct to the larger comet, while at Algiers, Nice and Marseilles direct comparisons were made of  $\Delta\alpha$  and  $\Delta\delta$  between each comet individually and a companion star. These last I have corrected for motion before reducing to distance and angle. The Pulkowa observations were originally distance and position angle and were afterwards reduced to  $\Delta\alpha$  and  $\Delta\delta$ ; I have changed them again into angle and distance.

From a note in Monthly Notices for November 1889 it appears that Mr. J. J. Plummer made quite a number of comparisons between *A* and *C*. I regret that his observations have not been published so that they could be incorporated here as they would probably complete the list of measures that were made of the companion *C*.

I have plotted all my observations of the companions *B* and *C* and have drawn through them curves that best

represented the places. From the curves so drawn I have interpolated ephemerides for Mt. Hamilton Midnight. I have also reduced all the observations to Mt. Hamilton Midnight and compared each with the ephemeris place. The residuals thus obtained are placed in tables I and II under the head of their respective observatories. From these residuals I have deduced the following probable errors for a single night's observations.

For companion *B*

Mt. Hamilton	$\pm 0''.12$ ,	$\pm 0^\circ.41$ *)
Vienna	$\pm 3.00$ ,	$\pm 10.38$

For companion *C*

Mt. Hamilton	$\pm 0''.43$ **),	$\pm 0^\circ.12$
Strassburg	$\pm 1.39$ ,	$\pm 0.21$
Pulkowa	$\pm 1.58$ ,	$\pm 0.13$
Nice	$\pm 2.63$ ,	$\pm 0.50$
Algiers	$\pm 2.83$ ,	$\pm 0.44$
Marseilles	$\pm 3.21$ ,	$\pm 0.46$
Vienna	$\pm 6.32$ ,	$\pm 2.40$

Following are the observations of the companions.

(The observations for position of the main comet — on thirty-two nights — have been published in the *Astronomical Journal* No. 217).

For the reductions of the observations with the 36 inch equatorial the adopted value of the micrometer screw was 9".905 which is the mean of the value determined by transits in 1888 by Mr. Keeler, 9".904, (*A. J.* 178) and that of a recent determination by Mr. Burnham, 9".907, from numerous measures of differences of declination. The value adopted for the 12 inch micrometer screw was 14".057 as determined by myself from measures of difference of declination.

\*) Omitting position angle of August 2.

\*\*) Omitting distances of Nov. 24-25.

**Mt. Hamilton Observations of the Companions.**

Distances and Position Angles of the Companion *B* referred to the Main Comet.

Observer E. E. Barnard.

1889	Mt.H.M.T.	$\Delta$	$p$	Cp.	Tel.
Aug. 1	14 <sup>h</sup> 16 <sup>m</sup>	64".8	59°.4	2.2	12
2	14 40	65.7	64.0*)	3.4	12
3	13 0	66.5	59.9	6.4	36
4	14 9	68.5	60.5	8.4	36
5	12 30	67.9	59.9	6.4	36
16	13 25	72.4	61.3	6.4	36
17	13 30	73.8	61.7	8.4	36
18	13 0	73.4	61.2	8.4	36
19	12 50	73.9	61.3	8.4	36
20	13 0	73.4	61.5	8.4	36
21	13 30	73.7	61.0	8.4	36
22	13 30	73.5	61.6	8.4	36

\*) Rejected.

1889	Mt.H.M.T.	$\Delta$	$p$	Cp.	Tel.
Aug. 23	13 <sup>h</sup> 20 <sup>m</sup>	73".7	61°.3	8.4	36
24	11 45	74.1	60.5	8.4	36
25	11 40	74.3	61.4	8.4	36
26	12 50	72.3	61.3	8.4	36
27	11 50	74.6	62.7	8.4	36
28	12 25	73.2	63.2	8.4	36
29	13 47	73.2	63.3	8.4	36
31	13 10	72.6	62.0	8.6	36
Sept. 2	12 20	71.1	63.9	9.4	36
4	13 10	71.6	65.0	8.4	36
5	14 30	62.6*)	62.5	8.4	36

Distances and Position Angles of the Companion *C* referred to the Main Comet.  
Observer E. E. Barnard.

1889						1889					
	Mt.H.M.T.	<i>A</i>	<i>p</i>	Cp.	Tel.		Mt.H.M.T.	<i>A</i>	<i>p</i>	Cp.	Tel.
Aug. 2	14 <sup>h</sup> 50 <sup>m</sup>	265".1	63° 6')	4.3	12	Sept. 19	11 <sup>h</sup> 57 <sup>m</sup>	356".4	61° 6'	5.4	36
3	13 8	263.6	61.4	4.4	36	20	12 19	357.3	61.5	5.4	36
4	14 19	267.6	61.5	4.4	36	21	10 14	356.1	61.2	5.5	36
5	12 40	270.3	61.4	4.4	36	22	10 5	356.3	61.4	5.4	36
16	13 40	300.1	61.5	4.4	36	23	9 47	354.8	61.6	7.5	36
17	13 36	303.1	61.9	4.6	36	24	12 42	356.2	61.3	5.4	36
18	13 8	306.2	61.7	4.4	36	25	11 58	355.8	61.3	10.5	36
19	12 59	308.7	61.8	4.4	36	26	12 44	355.5	61.2	9.6	36
20	13 7	310.9	62.1	4.4	36	27	9 11	355.4	61.4	9.4	36
21	13 36	314.1	61.0	4.4	36	28	13 31	353.7	61.4	10.4	36
22	13 42	316.1	61.8	4.4	36	29	9 28	352.6	61.3	10.4	36
23	13 28	318.5	61.8	4.4	36	30	8 59	352.7	61.4	11.5	36
24	11 54	322.2	61.5	4.4	36	Oct. 1	9 0	351.1	61.2	10.5	36
25	11 45	323.8	61.7	5.4	36	2	9 31	351.1	—	5.0	36
26	12 56	324.8	61.3	4.4	36	3	9 32	349.5	—	3.0	36
27	11 57	327.0	61.4	4.4	36	4	9 8	348.9	61.1	11.4	36
28	12 33	328.6	61.6	4.4	36	10	8 10	340.8	61.3	5.4	36
29	13 54	331.4	61.5	4.4	36	11	9 1	337.3	60.9	6.4	36
31	13 21	336.2	61.4	4.4	36	14	10 7	332.8	60.6	10.4	36
Sept. 2	12 28	339.1	61.3	4.4	36	15	9 49	330.8	60.9	10.4	36
3	12 10	342.1	61.7	4.4	12	23	9 25	315.1	60.3	12.5	36
4	13 17	343.5	61.7	4.4	36	24	9 59	313.7	60.7	11.4	36
5	14 38	345.7	61.8	4.4	36	28	8 52	305.6	59.9	10.5	36
12	11 10	—	61.8	0.3	12	30	9 4	300.5	60.2	10.5	36
14	12 21	355.7	61.9	7.4	12	Nov. 10	7 20	279.1	59.6	10.5	36
15	9 43	356.6	62.1	5.4	12	11	6 59	277.2	59.2	10.5	36
16	10 59	355.4	61.7	5.4	36	13	7 10	273.7	59.4	10.5	36
17	10 12	355.4	61.6	6.4	36	16	6 30	—	59.3	0.5	36
18	9 24	356.1	61.7	6.4	36	24	7 50	247.8	59.4	5.3	36
						25	8 59	250.8	60.0	7.5	36

\*) Rejected.

The following is the only measure that was obtained of the companion *D*, referred to *C*:

*C* and *D*.

Aug. 4<sup>d</sup> 15<sup>h</sup> 78".2 (4 obs.) 23° 3' (4 obs.).

At the same time *E* was estimated:

*C* and *E*.

Aug. 4<sup>d</sup> 15<sup>h</sup> 156" 23°.

These two companions were never seen except with the 36 inch.

The two last columns contain the number of comparisons (Cp.) and the telescope (Tel.).

All the observations of the companion *B* after Aug. 2<sup>nd</sup> were double distances.

Corrections for refraction have been applied to all the observations.

The following additional observations of the companion *C* were made with the 12 inch.

1889 Sept. 4 <sup>d</sup>	14 <sup>h</sup> 11 <sup>m</sup>	341".8	61° 9'	+1".9	—0".2
" 5	13 22	345.0	61.9	+0.4	—0.1
" 19	10 42	358.1	61.6	—1.8	0.0

It is evident that there must have been an error of about 3° in the adopted zero of the position circle on August 2<sup>nd</sup> as indicated by the derived position angles of both companions on that date; the position angles for August 2<sup>nd</sup> are therefore to be rejected but the distances are to stand, because  $s \cos \Delta p = s \cos 3^\circ$  is not more than 0".1 for *B* and 0".4 for *C* or not greater than their probable errors. The micrometer had been removed before the observations for examination of the comets with a low power.

#### Observations of the Companions made elsewhere.

The following are all the observations made elsewhere that have been published\*). I have converted all of them into position angle and distance. They are in local mean time of their respective observatories.

\*) Die Beobachtungen in Dresden, Lyon, München, Padua, Palermo und Paris scheinen übersehen worden zu sein. Kr.

Observations at Strassburg.  
Companion C.  
Observer Prof. Becker, A. N. 2964.

1889	Strassb. M.T.	$\Delta$	$p$
Sept. 17	11 <sup>h</sup> 56 <sup>m</sup> 37 <sup>s</sup>	354.0	61.5
18	9 18 30	357.6	61.8
Oct. 19	11 22 27	325.8	60.3

Observations at Algiers.  
Companion C.

Observers Rambaud and Sy, Bull. Astr. for Nov. 1889.

1889	Alg. M.T.	$\Delta$	$p$	Obs.
Sept. 14	8 <sup>h</sup> 39 <sup>m</sup>	351.0	62.9	R
18	9 58	358.0	62.1	R
21	9 35	355.9	61.7	R
23	9 16	361.8	61.2	R
24	8 43	353.4	61.8	R
28	9 29	361.2	61.2	R
Oct. 21	10 32	321.0	60.2	R
21	11 7	318.0	60.6	R
22	9 24	318.7	60.3	R
22	9 55	315.5	59.3	S

Observations at Marseilles.  
Companion C.

Observer Borrelly, Bull. Astr. for Dec. 1889.

1889	Mars. M.T.	$\Delta$	$p$
Sept. 14	9 <sup>h</sup> 38 <sup>m</sup>	353.9	60.8
15	9 44	345.9	61.9
16	9 50	352.9	62.0
17	9 4	351.6	62.5
19	10 55	355.9	62.0
20	10 33	353.5	62.0
21	8 20	354.6	62.3
23	8 35	355.7	60.8
24	8 48	348.2	61.7
26	8 48	351.9	61.7
27	8 51	349.2	61.6
28	9 9	351.6	59.6
Oct. 1	10 24	345.7	62.0
2	10 42	347.9	61.2
17	7 55	325.4	61.7
23	8 20	311.8	60.5

Observations at Nice.  
Companion C.

Observer Charlois, Bull. Astr. for Oct. 1889.

1889	Nice M.T.	$\Delta$	$p$
Aug. 28	12 <sup>h</sup> 47 <sup>m</sup>	324.0	63.1
29	10 43	325.6	61.5
30	11 3	330.4	61.8
31	10 51	333.8	61.8
Sept. 1	11 15	334.1	61.4
5	13 20	342.3	61.8

Observations at Pulkowa.  
Companion C.

Observer Renz, A. N. 2927.

1889	Pu. M.T.	$\Delta$	$p$
Aug. 26	12 <sup>h</sup> 9	319.7	61.8
28	13.9	327.7	61.5
29	13.3	329.6	61.3
Sept. 2	12.9	340.5	61.6
15	10.7	354.4	61.7
17	11.1	356.4	61.5
18	11.4	355.6	61.4
22	10.4	358.5	61.3

Observations at Vienna.

1889	V. M. T.	$\Delta$	$p$	Obs.
------	----------	----------	-----	------

Companion B.

Observers Spitaler and Palisa, A. N. 2922.

Aug. 4	14 <sup>h</sup> 5	51.2	79.7	S
5	14.5	63.9	75.5	S
7	14.5	71.5	69.7	S
19	12.5	72.4	65.0	P

Companion C.

Observers Spitaler and Palisa, A. N. 2922, 2933.

Aug. 4	14.5	254.7	69.3	S
5	14.5	254.4	62.5	S
7	14.5	272.6	62.8	S
19	12.5	304.1	61.3	P
Oct. 23	10.5	321.0	61.3	S
24	10.5	315.6	60.8	S

Table I. Companion B.

Ephemeris for Mt. Hamilton Midnight.

1889	$\Delta$	$p$	1889	$\Delta$	$p$	1889	$\Delta$	$p$
Aug. 1	64.6	59.4	Aug. 5	68.4	60.3	Aug. 16	73.2	61.3
2	65.6	59.7	6	69.1	60.4	17	73.4	61.3
3	66.6	59.9	7	69.6	60.6	18	73.5	61.3
4	67.5	60.1				19	73.6	61.3

1889	$\Delta$	$p$
Aug. 20	73.6	61.3
21	73.6	61.3
22	73.6	61.3
23	73.6	61.3
24	73.6	61.3
25	73.5	61.3

1889	$\Delta$	$p$
Aug. 26	73.5	61.6
27	73.4	62.3
28	73.3	62.9
29	73.1	63.4
30	72.9	63.7
31	72.6	63.8

1889	$\Delta$	$p$
Sept. 1	72.3	63.9
2	72.0	63.9
3	71.6	63.9
4	71.0	63.9
5	—	63.9

Comparison of the ephemeris with the observations (C — O).

Mount Hamilton.

1889	$d\Delta$	$dp$
Aug. 1	-0.1	0.0
2	0.0	-4.3
3	+0.1	0.0
4	-0.9	-0.4
5	+0.5	+0.4
16	+0.8	0.0
17	-0.4	-0.4
18	+0.1	-0.1
19	-0.3	0.0
20	+0.2	-0.2
21	-0.1	+0.3
22	+0.1	-0.3

1889	$d\Delta$	$dp$
Aug. 23	-0.1	0.0
24	-0.5	+0.8
25	-0.8	-0.1
26	+1.2	+0.3
27	-1.2	-0.4
28	+0.1	-0.3
29	-0.1	+0.1
31	0.0	+1.8
Sept. 2	+0.9	0.0
4	-0.7	-1.1
5	—	+1.4
Mean deviation	-0.06	+0.08

Vienna.

1889	$d\Delta$	$dp$
Aug. 4	+6.0	-19.6
5	+4.2	-15.2
7	-2.1	-9.1
19	+1.2	-3.7
Mean deviation	+2.32	-9.40

Table II. Companion C.

Ephemeris for Mt. Hamilton Midnight.

1889	$\Delta$	$p$
Aug. 2	263.0	61.3
3	265.5	61.4
4	268.0	61.5
5	270.6	61.5
6	273.3	61.5
7	276.0	61.6
16	300.5	61.6
17	303.3	61.7
18	306.0	61.7
19	308.7	61.8
20	311.3	61.8
21	313.8	61.8
22	316.3	61.8
23	318.7	61.8
24	321.0	61.7
25	323.3	61.6
26	325.5	61.5
27	327.6	61.5
28	329.7	61.5
29	331.8	61.5
30	333.8	61.5
31	335.7	61.5
Sept. 1	337.7	61.5
2	339.6	61.5
3	341.5	61.6

1889	$\Delta$	$p$
Sept. 4	343.5	61.7
5	345.4	61.8
14	355.7	61.8
15	355.9	61.8
16	356.0	61.8
17	356.1	61.7
18	356.2	61.6
19	356.3	61.6
20	356.3	61.5
21	356.3	61.4
22	356.3	61.4
23	356.2	61.4
24	356.1	61.3
25	355.9	61.3
26	355.5	61.3
27	354.8	61.3
28	354.1	61.3
29	353.2	61.3
30	352.2	61.3
Oct. 1	351.4	61.3
2	350.5	61.2
3	349.5	61.2
4	348.5	61.1
10	339.8	61.1

1889	$\Delta$	$p$
Oct. 11	338.1	61.1
12	336.4	61.0
13	334.6	60.9
14	332.8	60.9
15	330.9	60.8
16	329.1	60.8
17	327.2	60.8
19	323.6	60.7
21	318.9	60.6
22	317.0	60.6
23	315.1	60.5
24	313.1	60.5
25	311.1	60.4
26	309.0	60.4
27	306.9	60.3
28	304.8	60.2
29	302.7	60.2
30	300.5	60.1
Nov. 10	278.7	59.4
11	277.1	59.4
12	275.3	59.4
13	273.6	59.4
16	—	59.4
24	250.0	59.4
25	248.0	59.4

## Comparison of the ephemeris with the observations (C - O).

1889	dA	dp	1889	dA	dp	1889	dA	dp
Mount Hamilton.								
Aug. 2	-1".8	-2".3	Oct. 3	+0".1	-	Sept. 27	+6".0	-0".3
3	+2.0	0.0	4	-0.3	0".0	28	+2.9	+1.7
4	+0.6	0.0	10	-0.7	-0.2	Oct. 1	+6.1	-0.7
5	+0.4	+0.1	11	+1.0	+0.2	2	+3.0	0.0
16	+0.6	+0.1	14	+0.2	+0.3	17	+2.8	-0.9
17	+0.4	-0.2	15	+0.3	-0.1	23	+4.3	0.0
18	-0.1	0.0	23	+0.2	+0.2	Mean deviation	+3.85	-0.14
19	-0.1	0.0	24	-0.4	-0.2	Nice.		
20	+0.5	-0.3	28	-0.5	+0.3	Aug. 28	+5.0	-1.6
21	-0.1	+0.8	30	+0.3	-0.1	29	+5.4	0.0
22	+0.4	0.0	Nov. 10	-0.1	-0.2	30	+2.6	-0.3
23	+0.3	0.0	11	+0.4	+0.2	31	+1.1	-0.3
24	-1.2	+0.2	13	+0.3	0.0	Sept. 1	+2.8	+0.1
25	-0.5	-0.1	16	-	+0.1	5	+2.5	0.0
26	+0.8	+0.2	24	+2.5	0.0	Mean deviation	+3.24	-0.35
27	+0.6	+0.1	25	-2.5	-0.6	Pulkowa.		
28	+1.2	-0.1	Mean deviation	+0.11	-0.03	Aug. 26	+5.0	-0.3
29	+0.6	0.0	Algiers.			28	+1.2	0.0
31	-0.4	+0.1	Sept. 14	+5.6	-1.1	29	+1.5	+0.2
Sept. 2	+0.5	+0.2	18	-1.8	-0.5	Sept. 2	-1.6	-0.1
3	-0.5	-0.1	21	+0.4	-0.3	15	+1.4	+0.1
4	+0.2	0.0	23	-5.5	+0.2	17	-0.3	+0.2
5	-0.2	0.0	24	+2.8	-0.5	18	+0.6	+0.2
14	0.0	-0.1	28	-6.7	+0.1	22	-2.2	+0.1
15	-0.7	-0.3	Oct. 21	-1.3	+0.4	Mean deviation	+0.70	+0.05
16	+0.6	+0.1	21	+1.6	0.0	Strassburg.		
17	+0.7	+0.1	22	-0.8	+0.3	Sept. 17	+2.0	+0.2
18	+0.1	-0.1	22	+2.3	+1.3	18	-1.5	0.0
19	-0.1	0.0	Mean deviation	-0.34	+0.09	Oct. 19	-1.5	+0.4
20	-1.0	0.0	Marseilles.			Mean deviation	-0.33	+0.20
21	+0.2	+0.2	Sept. 14	+1.8	+1.0	Vienna.		
22	0.0	0.0	15	+9.9	-0.1	Aug. 4	+12.5	-7.8
23	+1.4	-0.2	16	+3.0	-0.2	5	+15.4	-1.0
24	-0.1	0.0	17	+4.5	-0.8	7	+2.5	-1.2
25	+0.1	0.0	19	+0.4	-0.4	19	+3.6	+0.5
26	0.0	+0.1	20	+2.8	-0.5	Oct. 23	-4.9	-0.8
27	-0.5	-0.1	21	+1.7	-0.9	24	-1.5	-0.3
28	+0.3	-0.1	23	+0.5	+0.6	Mean deviation	+5.67	-1.77
29	+0.7	0.0	24	+8.0	-0.4			
30	-0.4	-0.1	26	+3.9	-0.4			
Oct. 1	+0.4	+0.1						
2	-0.5	-						

It is evident that considerable personality exists among these observations. At Mt. Hamilton the nuclei were always bisected when they were visible.

## Notes on the appearance of the Companions.

Considering the importance of any information concerning this remarkable comet, I have collected all my notes of it and present them here almost in full as they may be of value in aiding us to understand the singular phenomena presented by the comet.

1889 July 8. The comet is pretty bright, very slender,

with a tail 7' or 8' long, pointing slightly south of preceding.

July 9. The tail points slightly south of preceding; one measure gives its position angle = 245°.3.

July 10. Moon interfered with any physical observations.

July 11. Could not be found on account of moonlight.

July 23. Observed for position with the  $6\frac{1}{2}$  inch equatorial, the 12 inch being out of order. Nothing abnormal noticed.

Aug. 1. After closing photographic work on the milky way, observed the comet with the 12 inch — the first observation of it that was possible with this instrument since July 10, the eye end having been away for repairs. A faint nebulosity seen close following and north of the nucleus; angle and distance measured. It is small and has a very small faint nucleus. Another nebulous object  $6' \pm$  north and  $10' \pm$  preceding the comparison star (= SD.  $-8^{\circ}10'$ ), it is small, round and faint.

Aug. 2. The two nebulous bodies near the comet found to be companions moving with it.  $A$  = main comet, has a fan-shaped tail  $15'$  long in position angle  $320^{\circ} \pm$ , it has a small nucleus of 12 magnitude in a narrow head of 11 magnitude, a long brightening runs back  $\frac{1}{2}'$  into the tail: the n. p. edge of the tail is the most distinct.  $B$  is the companion nearest to  $A$ . It is a miniature of  $A$ , and is of 13 magnitude and has an e e small stellar nucleus and an e e faint tail extending nearly to  $A$ .  $C$  is the most distant companion, it is larger than  $B$  — say  $10''$  in diameter — and has an e e e faint stellar nucleus and extension towards  $B$ . I am not certain that there are not two objects at the place of  $C$  [not subsequently verified]. Other nebulous objects seen near the comet (A. N. 2919).

Aug. 3. First observation with the 36 inch. Laying the wires along the objects it is found that  $C$  is just sensibly greater in position angle than  $B$ . Each companion has a faint tail and indefinite nucleus. Afterwards searched near the comet with the 12 inch for the objects seen yesterday; sky thick and only one object seen — this was measured with reference to a small double star — it is very faint. A number of small brightish nebulae were seen some  $15'$  following the comet in the 36 inch.

After this in the notes (36) indicates that the observation (description) was made with the 36 inch telescope while (12) represents the 12 inch.

Aug. 4. (36) Two new companions,  $D$  and  $E$ , seen. The object observed near the double star yesterday is a nebula.

Aug. 5. (36) Comet rather too low, saw  $D$  several times but too faint to measure. It was located apparently as before.

Aug. 6. (36) Saw  $D$  with the utmost difficulty. No measures of any of the companions. In all the observations with the great telescope,  $A$  has been easily visible in the four inch finder.

Aug. 16. (36)  $C$  is considerably brighter than  $B$ .

Aug. 17. (36)  $D$  is seen distinctly, but I could not measure it. It does not seem to have changed its position.

Aug. 20. (36) No remarks. (12)  $A$  is not at all bright; its tail is  $15'$  or  $20'$  long.  $C$  is easily seen, but  $B$  is not at all easy. Examined carefully about the comet for more companions and for the objects seen near the comet on Aug. 2. A faint nebula is found  $10' \pm p$  and  $13' \pm$  south of nucleus, very small and very faint.

Aug. 21. (36) A small nebula  $1^m 6^s$  following and same declination as the comet.

Aug. 22. (36) The nebula seen yesterday is close to the comet  $2'$  south of the nucleus.

Aug. 23. (36) I think  $D$  must have faded out.  $B$  has always been the most difficult to observe: it is not nearly so bright and distinct nor so large as  $C$ . The descriptions previously given will cover the present appearance of the group, except that each one is brighter (except  $B$ ). I have seen  $D$  and  $E$  only at the times previously recorded.

Aug. 25. (36)  $B$  is much more diffused and fainter and larger than formerly, having lost its central brightness.  $C$  holds its own well, and has an almost stellar nucleus. Each of the companions has a faint tail in the line to the head of  $A$ . The condensation in the head of  $A$  is  $2''$  or  $3''$  diameter. (12)  $A$  is pretty bright, so also is  $C$ ; both are bright in the middle and easy to observe.  $B$  is seen with the utmost difficulty.

Aug. 27. (36)  $B$  is excessively faint and diffused and is scarcely visible with the wire on it: it is extremely faint even when the lamp is put out. Sky pretty thick.  $C$  is quite as easy as previously.

Aug. 28. (36)  $C$  is pretty bright, its nucleus is almost stellar; it is just like  $A$ , except that its nuclear condensation is much smaller and better defined.  $B$  is faint and difficult, its brightest part is  $5''$  or  $6''$  in diameter, and hard to bisect accurately on account of its faintness.

Aug. 29. (36) I see  $D$  but it is too faint to measure. I feel sure that I saw  $E$  also. A faint object was seen 13 seconds preceding the nucleus and involved in the north edge of the tail; the seeing was so poor that I could not tell if it was nebulosity or a faint star. (12)  $A$  and  $C$  alone are visible. (36)  $B$  was very faint at the measures but I think they will be more satisfactory than those for the past few mornings. It now appears to be elongated so as to blend with  $A$  — the very diffused tail of  $B$  diffusing into the nebulosity of  $A$ . The tail of  $C$  scarcely goes further than  $\frac{1}{2}$  way to  $B$ .  $C$  is pretty bright — well developed — with a central condensation in the head that is almost a stellar nucleus — more so than  $A$  which has no nucleus now but a large brightening in the head.  $C$  appears like  $A$  and is about  $\frac{1}{3}$  or  $\frac{1}{4}$  as large,  $B$  appears as if it were being absorbed into  $A$ . (12) The tail of  $A$  is  $\frac{1}{2}'$  long, its axis passes  $5^{\circ}$  or  $10^{\circ}$  north of the line  $AC$  or in  $p$  about  $251^{\circ}$ , but this seems to shift as it is more or less well seen.

Aug. 31. (12)  $A$  is apparently not so bright,  $C$  is easy, but  $B$  not visible. (36)  $B$  was very faint and diffused, while  $C$  was just perceptibly brighter than  $A$ ! It is very small with bright nucleus or bright center and is  $\frac{1}{4}$  as large as  $A$ .  $A$  is less bright than at last observation, both in 12 inch and in 36 inch.

Sept. 2. (36) The central condensation of  $C$  is about as bright as that of  $A$ .  $B$  is so faint and so diffused that it is almost impossible to measure it.

Sept. 3. (12) No trace of  $B$ .  $C$  is easy. 36 inch could not be used.

Sept. 4. (36)  $B$  was excessively faint and difficult. (12) No trace of  $B$ , but  $C$  is fairly well seen.

Sept. 5. (36)  $B$  is excessively difficult and the observation worthless and is to be rejected.

Sept. 12. (12) *A* is brightish. *C* is clearly seen and is easy, small, round and brighter in the middle; clouds prevented measures.

Sept. 13. (12) *C* seen but thick sky and clouds prevented observations.

Sept. 14. (12) *A* roundish, not bright, g b M. *C* small roundish b M but faint; sky thick and moon up.

Sept. 15. (12) *A* has a considerable tail, there is only a slight extension to *C* — a faint tail. Both *A* and *C* are pretty bright, m b M to nearly a nucleus. *C* looks as vigorous as ever.

Sept. 16. (12) Both comets are pretty bright. (36) Not a trace of *B*. Sky somewhat thick. I am not certain that there is not a faint nebulosity close south of *A*, but the sky is too thick to be certain. *A* and *C* are bright, the central brightness of *A* is about 3" diameter, while that of *C* is 2" ±.

Sept. 17. (36) No trace of *B*; sky thick.

Sept. 18. (36) The sky is very thick with smoke, *A* and *C* are both pretty well seen. The atmosphere has been filled with dense smoky haze now for some days, and has been getting thicker all the time.

Sept. 19. (36) No trace of *B*, the sky is somewhat thick but clear enough to show the companion if it were as distinct as at the last observation. *C* is about  $\frac{1}{3}$  as large as *A* and is just perceptibly less bright than *A*. Both have strong central condensations. *A* has a tail  $\frac{1}{4}^\circ$  long. *C* has scarcely any tail, but there is a diffusion towards *A*. There is a small nebulous object  $2.4 \pm$  sf. *A*.

Sept. 20. (36) Sky pretty clear — the object seen close to *A* last night is a nebula. No trace of *B*. Seeing good.

Sept. 22. (36) Transparent sky. For some time there has been no nucleus in either *A* or *C*, only a strong condensation. *A* is a little brighter than *C*, and three times as large. No trace of *B*. Both *A* and *C* are quite easily seen in the four inch finder, in which *A* appears quite conspicuous on account of its greater size.

Sept. 24. (36) Sky pretty clear, no trace of *B*, *D* or *E*.

Sept. 27. (36) *A* is considerably brighter than *C* and from two to three times as large.

Sept. 29. (36) *A* is large and diffused with ill defined nucleus and very large diffused tail; it is considerably brighter than *C* and is about 1' diameter. *C* is pretty large, round and pretty diffused, much brighter in the middle to a faint poorly defined nucleus. It is about  $\frac{1}{3}$  as large as *A*. I think it has become fainter and more diffused of late — seeing good. No trace of *B*, *D* or *E*.

Sept. 30. (36) *C* is diffused and rather faint, it has faded considerably of late, and has certainly become much more diffused.

Oct. 2. (36) *C* is faint and diffused; both comets very faint from thick hazy sky.

Oct. 3. (36) A south wind blowing in the face of the telescope making it scarcely possible to keep the wires on the comets for a second at a time. *C* was very very faint — much more so than *A*.

Oct. 4. (12) Bright moonlight. I can see *A* faintly but no trace of *C*. (36) *C* is excessively faint from moonlight; it is a mere spot of very faint haze, pretty small,

brighter in the middle to an ill defined speck; it has certainly faded very very much of late, for the contrast between it and *A* is now very great. *A* quite conspicuous, not large, round, bright in the middle to an indefinite nucleus; it is just distinguishable as a very very faint hazy spot in the 4 inch finder.

Oct. 10. (36) *C* is excessively faint. *A* is considerably bright, round, gradually brighter in the middle. Moonlight.

Oct. 11. (12) *C* was seen before the moon rose; it was faint and much diffused — larger than formerly. *A* was moderately bright, much brighter in the middle to an indefinite brightening. (36) *C* is faint and diffused but the observations good.

Oct. 14. (36) *A* is pretty large, round and gradually brighter in the middle to a very very faint nucleus. *C* is  $\frac{1}{4}$  or  $\frac{1}{3}$  the size of *A*, elliptical, very gradually brighter in the middle to a very very faint ill defined nucleus; the nebulosity of *C* extends towards *A*.

Oct. 15. (36) The small indefinite nucleus of *A* is now in the preceding part of the coma which branches out following. The same description for *C*. (12) The tail of *A* is preceding, large and hazy, 15' long.

Oct. 23. (36) *C* is very faint and difficult; the wind is shaking the telescope and there is probably moisture on the object glass.

Oct. 24. (36) *C* is rather faint, about 13 magnitude; it is elongated in the parallel. *A* is much brighter than *C*, and is nearly round, gradually brighter in the middle, about 1' diameter. Very high wind shaking telescope badly.

Oct. 28. (36) Sky clear. *A* is pretty brightly condensed, somewhat round, about 11 $\frac{1}{2}$  magnitude with a diffused tail pointing towards *C*. *C* is rather faint, 13 magnitude, and is extended nearly in the parallel. A nest of nebulae — a half dozen or so — is  $15' \pm$  following the comet; three of these measured. (12) *C* is diffused and faint. I compared it with one of the nebulae and found it identical in appearance and brightness to the nebula. This nebula was referred to SD. —  $3^\circ 57' 04$ , position angle  $306^\circ 1$  (5), distance  $144'' 2$  (4).

Oct. 30. (36) Telescope vibrating in very high wind. *C* is very faint; *A* is conspicuous — the group of nebulae is seen again.

Nov. 9. (12) *A* is faint, gradually brighter in the middle to an ill defined nucleus. (36) *C* is small, diffused and faint; the moon rose and made *C* very faint. I looked carefully before moon rise for any other objects near. The tail of *A* is pretty bright with indefinite condensation to an ill defined speck in the preceding part of the nebulosity. The tail of *A* is 3' or 4' long. The sky is clear, but wind shaking the telescope.

Nov. 10. (12) No trace of *C*. (36) *C* is pretty faint and pretty small, and diffused and very gradually brighter in the middle; a faint tail is following in same direction as that of *A*, and perhaps 1' long.

Nov. 11. (36) A small star occulted by the nucleus of *A* (see A. J. No. 217).

Nov. 13. (36) *A* is at least ten times as bright as *C* which is faint = 14 magnitude.  $A = 12\frac{1}{2}$  magnitude.



The wind is shaking the telescope. (12) *C* is seen with great difficulty. *A* is brightish = 12 magnitude.

Nov. 15. (12) *C* is visible but very faint. *A* is easy and has a faint diffused tail following.

Nov. 16. (36) *A* is rather faint. *C* is most excessively faint and seen only by glimpses (moisture on obj.?).

Nov. 22. (12) *C* is seen with the utmost difficulty — fogged and observations prevented.

Nov. 24. (36) *C* is at the utmost limit of visibility and is seen only after long waiting. An 11<sup>m</sup> star was centrally occulted by *A* at first part of observations. The central brightness of *A* = 12<sup>1</sup>/<sub>2</sub> magnitude.

Nov. 25. (36) *C* is excessively difficult, the utmost limit of visibility. The comet was not looked at with the great telescope after this date.

#### Remarks on the Physical Changes of the Companions.

It is interesting to mark the changes in the physical appearance and brightness of the companions.

At first *B* was pretty well developed, small and considerably bright with a nucleus and tail, while *C* though larger was not near so definite in form, being more diffused. After remaining a couple of weeks with but slight change *B* began to enlarge and diffuse as if it were going to pieces. In the latter part of August each successive night showed a marked change as it became rapidly more diffused and fainter, at the same time increasing in size and losing its central condensation. It seemed to diffuse towards *A* as if it were being absorbed into it. During the last few days of its existence these changes were very marked and on Sept. 5 there was only a large and excessively faint and diluted nebulosity at its place. After this the place of *B* was to all appearances entirely void. There is not the slightest doubt but that this companion actually dissipated itself into space and absolutely ceased to exist if indeed it were not absorbed into the main comet. Up to this time the comets were approaching us and theoretically increasing in brightness.

At the first observations *C* was larger and more diffused than *B* and fainter. It had a small nucleus and tail and was very faint and though conspicuous in the 12 inch it was very faint compared with *A*. From recollection, alone, I should say it was at least five times less bright than *A*. Gradually increasing in brightness, it became more definite in form and developed a strong condensation and nucleus. On August 31<sup>st</sup> it had actually become brighter than the main comet. It was then well developed with a nucleus and tail. About this time, for a few days, *A* seemed to diminish slightly in brightness. For some time after August 31<sup>st</sup> *A* and *C* were of equal brightness. From the middle of September *C* gradually began

to fade and by September 27 *A* was considerably brighter than it, and from this date on, *C* continued to fade rather rapidly, diffusing and becoming larger in the mean time; and by the first of October there was a very marked difference in the brightness of the two comets. Throughout these changes *C* seemed to undergo the same process of disintegration that *B* went through.

It finally faded from view in the 36 inch on the 25<sup>th</sup> of November while *A* was followed with the 12 inch and observed for position until 1890 March 20. This companion *C*, though it attained and exceeded the brightness of *A*, was at best apparently only about one third as large.

I think there is no doubt but that both *B* and *C* have ceased to exist as individual bodies.

It will be seen on examining the position angles of the companion *C* that there are two well marked maxima. These occurred about August 20 (max. = 61°8) and September 10 (max. = 61°8).

The sudden change in the position angle of *B* about August 26 is real and seems to have been intimately connected with the rapid disintegration this companion underwent in the next ten days and which culminated in its total dissolution about September 5. The zero of the position circle was determined each night at the close of the observations so that the position angles are free of any accumulated errors from that source.

I am at a loss to understand the observation at Vienna on Oct. 23<sup>rd</sup> of the companion *B*. It was certainly not visible here on that date with the great telescope. The statement that it could not be seen on the following day (24) under the same atmospheric conditions, would lead to the suspicion that the object seen on the 23<sup>rd</sup> of Oct. was a nebula. See my notes to Oct. 28 which show that the comet was still in a nebulous region.

#### Remarks on the Great Telescope.

In the observations with the great telescope, it was found that a decided advantage was gained over the 12 inch in an increased brightness of the objects and in the much larger scale; the measurements being far more easy and certain than with the smaller glass. The definition was all that could be desired. Towards the close of the observations of *C* this advantage was not so marked, because our bad weather had set in and the great telescope suffered from this more in comparison than did the 12 inch.

It would appear that the great glass would serve admirably in following an important comet far beyond the reach of smaller instruments. From what I have seen of its performance in these observations, and the number of unknown nebulae that were incidently found during the work — even in a region supposed to be poor in nebulae — I have no doubt but that the great telescope would readily reveal more unknown nebulae than the entire number now contained in the latest catalogue of Dreyer.

Mt. Hamilton 1890 May 22.

**P. S. Additional observations of the Companion C.** The following additional observations of the companion *C* made at Pulkowa by F. Renz, and published in A. N. 2974 I have rereduced to position angle and distance for comparison with my ephemeris.

1889 Sept. 24	10 <sup>h</sup> 3	61°6	357".2	-0°3	-1"0	1889 Oct. 14	11 <sup>h</sup> 4	61°2	335".5	-0°3	-1"9
» 28	11.2	61.5	353.7	-0.2	+0.8	» 24	8.8	61.2	312.1	-0.7	+2.2
Oct. 2	11.6	61.6	351.8	-0.4	-0.9	» 27	9.6	60.3	310.9	±0.0	-3.0
» 3	11.2	61.5	347.5	-0.2	+2.4					Mean deviation from the Eph.	-0.30 -0.20

For comparison with the ephemeris the above observations were reduced to Mt. Hamilton Midnight.

Mt. Hamilton 1890 July 7.

*E. E. Barnard.*

### Markree Double-Star Observations.

By *W. Doberck.*

The following observations are published in continuation of those printed in *Astr. Nachr.* Nos. 2187, 2196-2199 and 2242.

The value of one revolution of the screw of Merz's micrometer was obtained in 1882 by comparing measures of differences of declination of stars in the cluster h Persei

with the results obtained by Professor Krueger in 1862. The separate results expressed in turns of the screw are exhibited in the following table, in which the stars are numbered as in Krueger's paper (*Der Sternhaufen h Persei. Beobachtungen desselben am Bonner Heliometer nebst deren Berechnung 1864*).

1882	Hour Angle	Therm.	Nos. 24-25	Nos. 25-4	Nos. 4-2	Nos. 2-1	Nos. 1-6	Nos. 6-13	Nos. 13-20	Nos. 20-5	Sum
Sept. 13	-0 <sup>h</sup> 3	35°1	18 <sup>R</sup> 699	13 <sup>R</sup> 300	15 <sup>R</sup> 842	13 <sup>R</sup> 912	—	—	—	—	113 <sup>R</sup> 761
25	-1.1	37.0	—	—	—	—	14 <sup>R</sup> 440	13 <sup>R</sup> 768	11 <sup>R</sup> 743	12 <sup>R</sup> 057	
25	-0.3	36.0	658	310	860	14.010	427	754	622	12.039	113.680
Oct. 12	-0.8	43.0	650	357	752	14.033	472	780	710	12.120	113.874
20	-1.4	42.0	704	361	553	14.033	522	733	710	12.046	113.662
24	-1.5	32.5	736	350	701	14.018	495	823	740	12.095	113.958
26	-0.5	34.0	668	368	693	13.933	507	795	779	12.059	113.862
28	-0.7	30.1	—	—	602	14.000	580	773	779	12.057	113.806
30	-0.4	39.0	691	324	—	—	—	—	—	—	
30	+0.9	36.0	680	438	505	13.599	581	724	895	11.979	113.401
Dec. 7	-1.5	34.0	676	463	460	14.074	697	749	873	12.033	114.025
Means	—	—	18.685	13.363	15.663	13.964	14.525	13.766	11.761	12.054	113.781

A correction for refraction having been applied, the value of a revolution was calculated from the differences in declination between Nos. 24 and 1, Nos. 1 and 5 and Nos. 24 and 5. Those differences and the resulting scale-values are exhibited in the following table.

1882	Nos. 24-1	Value	Nos. 1-5	Value	Nos. 24-5	Value
Sept. 13	61 <sup>R</sup> 783	8".717	52 <sup>R</sup> 008	8".739	113 <sup>R</sup> 761	8".727
25	638	706	51.842	767	113.680	733
Oct. 12	792	712	52.082	727	113.874	718
20	651	732	52.011	739	113.662	735
24	805	710	52.153	715	113.958	712
26	722	722	52.140	717	113.862	720
28	617	736	52.190	709	113.806	724
30	222	793	52.179	711	113.401	755
Dec. 7	673	729	52.352	682	114.025	708
Means	—	8.729	—	8.723	—	8.726