DETERMINATION OF PHOTOMETRIC PARAMETERS OF LONG-PERIOD COMETS AT LARGE HELIOCENTRIC DISTANCES. I. COMETS OBSERVED IN THE YEARS 1861 - 1946

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ABSTRACT. Using compiled photometric observations of long-period comets, their photometric parameters at large distances from the Sun were determined. This study covers the period from 1861 to 1946.

ОПРЕДЕЛЕНИЕ ФОТОМЕТРИЧЕСКИХ ПАРАМЕТРОВ ДОЛГО-ПЕРИОДИЧЕСКИХ КОМЕТ НА БОЛЬШИХ ГЕЛИОЦЕНТРИЧЕСКИХ РАССТОЯНИЯХ. КОМЕТЫ НАБЛЮДАВШИЕСЯ В 1861-1946 ГГ. На основании собранных фотометрических наблюдений долго-периодических комет в работе определены их фотометрические параметры на больших расстояниях от Солнца. Представлена работа охватывает период 1861-1946 гг.

URČENIE FOTOMETRICKÝCH PARAMETROV DLHOPERIODICKÝCH KOMÉT VO VEĽKÝCH HELIOCENTRICKÝCH VZDIALENOSTIACH. KOMÉTY POZOROVANÉ V ROKOCH 1861-1946. Na základe zozbieraných fotometrických pozorovaní dlhoperiodických komét sú v práci určované ich fotometrické parametre vo veľkých vzdialenostiach od Slnka. Predložená práca zahŕňa obdobie rokov 1861-1946.

1. INTRODUCTION

The analysed photometric observations of long-period comets at large distances from the Sun, already published in two parts (Svoreň, 1983; 1984) were used to determine the photometric parameters of comets at large r's. The photometric parameters involved are: M, n - the absolute brightness and photometric exponent which is obtained by reducing Holetschek's relation (1893) to stellar magnitude:

$$M = m - 2.5\, n \log r - 5 \log \Delta \quad . \tag{1}$$

These parameters have the advantage of being simple as compared to the parameters suggested by Vsekhsvyatskij (1936) who used an empirical law with three independent parameters to describe brightness changes. Although Eq. (1) is an interpolational relation, it is given preference even to Levin's relation (1943) based on interpreting physical processes which take place on the surface of the comet's nucleus and within the coma. The reasons for this are mainly historical because, in the past, the parameters M and n were used to analyse extensive photometric data sets. However, it can be said that they are being used generally even to-day, and that parameters of another kind are used only exceptionally.

In introducing photometric parameters was automatically assumed that a sufficient amount of data was available on comet brightness, which can be used to determine the parameters. However, the accuracy of the magnitudes entering the calculation is the principal limiting factor. The first factor which can have a distinctly positive, but also negative influence on the accuracy of the data, no matter what method is used, is the personal factor, i.e. the experience of the observer. Danger of accumulating inaccurate data occurs namely with bright comets near the perihelion when, thanks to the considerable publicity of the phenomenon, also random and inexperience observers observe it. Fortunately, their observations can usually be eliminated; these observations are either isolated, or observations made along the short arc of the orbit at the time of maximum apparent brightness of the comet.

The largest number of observations of comet brightness, mainly those which cover a sufficiently long interval of time, were made visually, especially by small instruments. Errors in observations depend, first of all, on the following three factors (Roemer, 1976):

- the observer and instrument used,
- observational conditions, in particular the brightness of the sky,
- the degree of condensation of the cometary image.

Whereas the last two factors vary from case to case, and their additional reduction, even if the observer gives a detailed description, is difficult and uncertain, data on the instrument used (in particular the diameter of the objective and the light-gathering power of the system) enable even additional corrections to be introduced during the processing. Bobrovnikoff (1941a, b) determined an empirical relation for a set of 45 comets from the years 1858-1937, which determines the change of the estimated brightness in magnitudes Δm, if the diameter of the telescope objective increases by Δd in metres:

$$\Delta m = - 6.6\, \Delta d \quad . \tag{2}$$

The fact that Bobrovnikoff gives no range within which this formula is valid, led various authors to its indiscriminate use for reducing observations made by telescopes with considerably different diameters. One must always bear in mind that, in deriving formula (2), Bobrovnikoff considered a maximum difference of $\Delta d = 0.35$ m, and he also pointed out that the dependence was not strictly linear. Vsekhsvyatskij (1958) pointed out that this correction did not compensate for all instrumental effects, since the telescope diameter is only one of several important factors. For example, if a different magnifications is used in the same instrument, a considerable difference in the estimated brightness may ensue. The values, derived from formula (2) are formal and do not truthfully express the differences in individual cases. Consequently, no corrections of this type have been used in the present study.

The main problem, as pointed out by Kresák (1965, 1973, 1974), is that any exponential law is false if the observations of the cometary head with small instruments are compared with observations of the central condensation with large instruments. The differences between the individual comets are due to the relative brightness of the nucleus and to the degree of condensation of the coma.

The solution to the problem of difficulties created by using material from various observers using different instruments and methods, ideally appears to be the use of data obtained by a single observer using the same instrument and method. However, there remains the problem that there are practically no observers who would be able to cover the whole interval in which the comet can be observed. A typical example is that of the two most persistent observers in the period after World War 2: Beyer and Roemer. Whereas Beyer's observations with small and medium instruments were only made close to the perihelion in most cases (which is mainly due to the range of the instruments), Roemer gave preference to photographic observations at large heliocentric distances by means of large reflectors. Her visual estimates using small instruments, i.e. the observations of comet 1955 VI Baade with a finder at the end of November 1955 (Roemer, 1956), are quite exceptional.

2. METHOD USED

In determing the parameters, the following procedure was adopted: for each series of observations we attempted to select an observer who was able to cover by observations the whole time interval and who was also able to observe in the region of extreme distances. The last condition is important for obtaining the most faithful determination of changes of the comet's brightness at large distances from the Sun. If such an observer was available, the parameters were calculated from his observations and the observations of the other observers were only used to calculate the correction for the scale of the primary observer. If observations of no observer were sufficient on their own to determine the photometric parameters, these were determine from the observations of observers who covered the larger range of heliocentric distances on their own. If the inclination of the regression lines and, consequently, also the photometric exponents differed by a small value only, mutual corrections were determined and the observations were reduced to a uniform scale, as a rule of the observer who observed at extreme distances from the Sun. Only after all the possibilities of determining the parameters exclusively from the data of the comet itself had been exhausted, were the corrections, determined for the appropriate pair of observers used for the other comets. Nevertheless, for some of the comets the existing photometric data were insufficient to determine the parameters in the region $r > 2.5$ AU. For comets, for which the data enabled the calculation, the photometric parameters n and M, derived from Eq. (1), together with the appropriate mean square deviations are given. Also the coefficient of correlation s between the quantities m_{Δ} and $2.5 \log r$ is given. Together with the values of M, n and s, the value m_m is given for all comets, i.e. the median of apparent magnitudes used in calculating the parameters. This value is important in assessing the actual observational conditions for the individual objects. In the preliminary processing of the material, all instrumental corrections, which the data enabled to be determined, were calculated. Since the use of an instrumental correction, derived for a single comet, for another object is only possible after a thorough analysis of the data, in this paper we only give the determinations of those instrumental corrections which were utilized in further processing. If an absolute value of a correction was determined as equal to or smaller than $0^m.25$ for an individual comet, these observations were considered to have been made on a uniform scale with a view to the accuracy of the input photometric data.

3. CALCULATION OF PHOTOMETRIC PARAMETERS FOR INDIVIDUAL COMETS AND CONSTRUCTION OF PHOTOMETRIC CURVES FOR SELECTED OBJECTS WITH SUFFICIENT NUMBER OF RELIABLE DATA

The sets of brightness values were divided into three groups according to the quality of the basic photometric data and the possibility of determining the representative parameters:

Group A - The parameters can be determined from the observations of a single observer or from the data of several observers, but the corrections have only been determined from the data for the particular comet itself (pre- and post-perihelion observations of the same comet are formally considered to be observations of two different comets) and corrections, derived for other comets, were not used. The parameters are characteristic for the changes of the brightness in the region of extreme observation.

Group B - The parameters were determined as in Group A, the only difference being that, for some reasons, they are not characteristic for the changes of the brightness in the region of extreme observation.

Group E - The representative parameters could not be calculated.

The photometric parameters were determined from the pairs $\log r, m_{\Delta}$, which are given in the whole of this section together with the number N, i.e. the ordinal number of observation in agreement with the list of observations. The list of observations have already been published separately for comets up to 1925 (Svoreň, 1983) and up to 1955 (Svoreň, 1984). In these two papers, further data concerning the observations and references to the literature used can be found by referring to the numbers N .

To save space, the terms "nucleus brightness" and "total brightness" have been used in the commentary; by the first we understand the brightness of the photometric nucleus, i.e. the central condensation irrespective of the angular dimensions.

GROUP A

Large September comet 1882 II Cruls - after perihelion

Only Schmidt observed at distances over 2.5 AU; the parameters were determined from his observations.

Table 1
Schmidt's observations

N	log r	m_Δ	N	log r	m_Δ
1	0.455	9.8	3	0.528	10.1
2	0.457	10.0			

Resultant parameters:

$n = 1.1 \pm 0.9$ $s = 0.77$

$M = 8.6 \pm 1.1$ $m_m = 11.7$

Comet 1904 I Brooks - after perihelion

a) nucleus brightness

First, the inclinations of the regression lines for nucleus observations were determined. The parameters were determined for Wirtz's and Holetschek's observations, who have most data and their observations also cover the largest values of r .

Table 2
Wirtz's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
30	0.438	9.1	107	0.447	9.6	239	0.483	10.1
36	0.439	9.1	125	0.449	8.9	253	0.492	8.7
41	0.439	9.2	151	0.457	9.4	256	0.493	9.2
57	0.440	9.0	158	0.460	8.6	261	0.494	9.7
77	0.443	9.7	167	0.461	9.5	275	0.499	9.3
85	0.443	9.4	178	0.463	10.0	283	0.512	10.0
90	0.444	8.7	198	0.473	9.2	291	0.517	11.0
97	0.446	9.7	209	0.476	8.9	293	0.518	11.0
104	0.446	9.6	231	0.481	9.9			

$n = 5.1 \pm 1.6$ $s = 0.55$

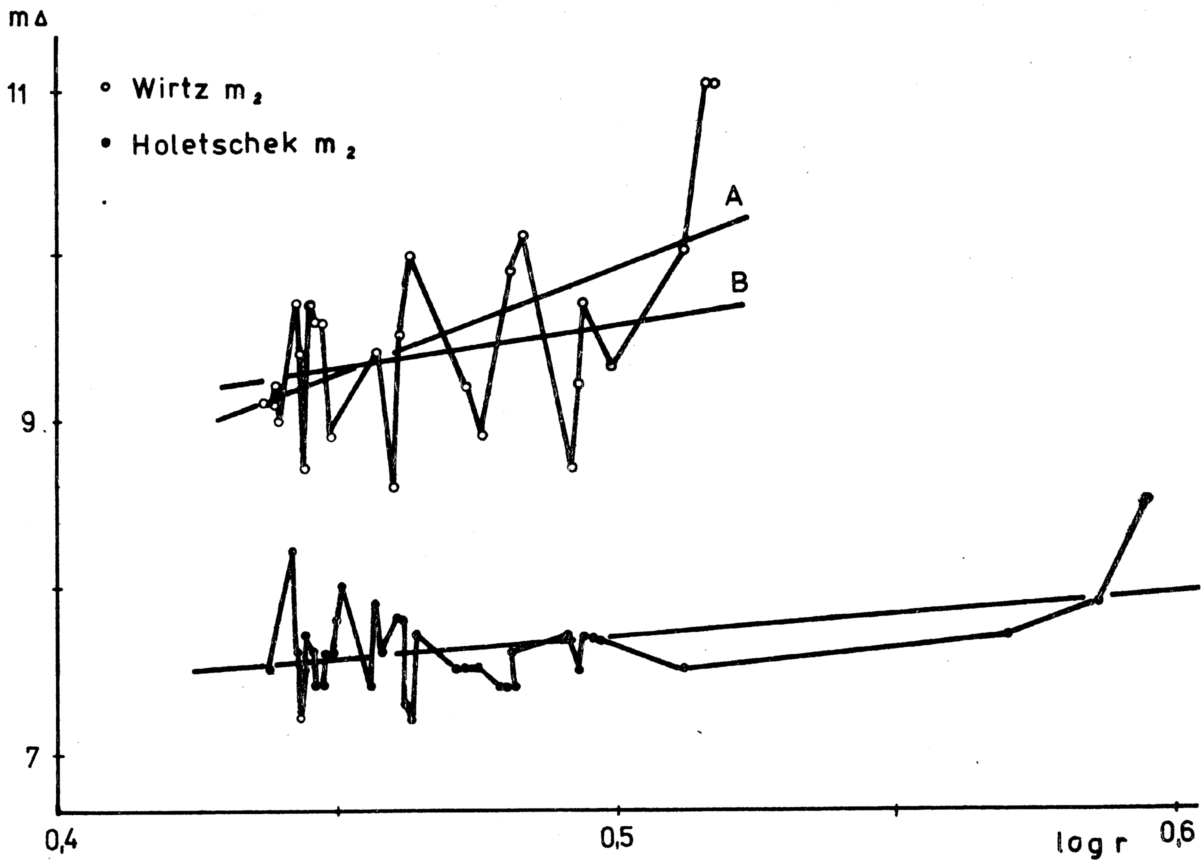

Fig. 1 : The changes of the brightness of Comet 1904 I Brooks after perihelion.

Table 3
Holetschek's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
18	0.438	7.5	142	0.456	7.4	222	0.480	7.4
68	0.442	8.2	148	0.457	7.9	226	0.480	7.4
70	0.443	7.6	155	0.458	7.6	228	0.481	7.6
82	0.443	7.2	160	0.461	7.8	247	0.491	7.7
87	0.444	7.5	163	0.461	7.8	259	0.493	7.5
93	0.444	7.7	171	0.462	7.3	263	0.494	7.7
99	0.446	7.6	174	0.463	7.2	265	0.494	7.7
101	0.446	7.4	182	0.464	7.7	268	0.495	7.7
109	0.447	7.4	191	0.471	7.5	285	0.512	7.5
112	0.448	7.6	193	0.471	7.5	301	0.570	7.7
116	0.448	7.6	202	0.475	7.5	304	0.586	7.9
131	0.450	7.8	219	0.479	7.4	308	0.595	8.5
133	0.451	8.0						

$n = 1.1 \pm 0.4$ $s = 0.41$

If we disregard the last two of Wirtz's observations, which indicate a sudden decrease in brightness (Fig. 1), we obtain $n = 1.9 \pm 1.6$, $s = 0.25$, which is close to the value of n derived from Holetschek's observations. In Fig. 1, the letter A denotes the regression line for all of Wirtz's observations and the letter B the regression line with the last two observations omitted. Figure 1 indicates that, during this period, the cometary nucleus was relatively active, in particular the scatter of Wirtz's observations is large. We then determined the differences between the nucleus brightness and the total brightness, $m_2 - m_1$, observed during the same day by one observer, again only for Wirtz (W) and Holetschek (H):

Table 4
The differences $m_2 - m_1$

date		m_2	m_1	Δm
040418	H	9.3	9.2	+ 0.1
040419	W	10.8	9.3	+ 1.5
040420	W	10.8	9.3	+ 1.5
040421	W	10.9	8.8	+ 2.1
040426	W	10.8	9.8	+ 1.0
040501	H	10.0	9.3	+ 0.7
040502	H	9.4	9.0	+ 0.4
040503	W	11.5	9.8	+ 1.7
040505	H	9.0	8.5	+ 0.5
040505	W	11.2	9.2	+ 2.0
040506	H	9.3	8.5	+ 0.8
040507	W	10.5	9.0	+ 1.5
040508	H	9.5	8.8	+ 0.7
040511	W	11.5	9.4	+ 2.1
040512	H	9.4	8.5	+ 0.9
040513	H	9.3	8.5	+ 0.8
040513	W	11.5	9.6	+ 1.9
040514	W	11.5	9.4	+ 2.1
040514	H	9.3	8.4	+ 0.9
040516	H	9.5	8.8	+ 0.7
040517	H	9.5	8.7	+ 0.8
040519	W	10.8	9.6	+ 1.2
040522	H	9.8	9.0	+ 0.8
040524	H	10.0	9.2	+ 0.8
040603	H	9.5	9.3	+ 0.2
040605	H	10.0	9.2	+ 0.8
040606	W	11.5	9.8	+ 1.7
040608	H	9.8	9.3	+ 0.5
040611	W	10.8	9.2	+ 1.6
040612	H	10.0	9.2	+ 0.8
040613	H	10.0	9.2	+ 0.8
040613	W	11.7	9.9	+ 1.8
040614	H	9.5	9.2	+ 0.3
040616	H	9.5	9.2	+ 0.3
040616	W	12.3	9.4	+ 2.9
040619	H	10.0	9.5	+ 0.5
040630	H	10.0	9.6	+ 0.4
040701	H	10.0	9.7	+ 0.3
040704	W	11.7	9.1	+ 2.6
040707	H	10.0	9.7	+ 0.3
040709	W	11.5	9.8	+ 1.7
040713	H	10.0	9.4	+ 0.6
040714	H	10.0	9.5	+ 0.5
040715	H	10.0	9.5	+ 0.5
040716	H	10.2	9.7	+ 0.5
040716	W	12.5	9.6	+ 2.9
040719	W	12.8	9.8	+ 3.0
040731	H	10.5	10.0	+ 0.5
040802	W	11.5	10.0	+ 1.5
040803	W	12.0	9.8	+ 2.2
040803	H	10.3	9.8	+ 0.5
040804	W	12.5	10.1	+ 2.4
040804	H	10.5	10.0	+ 0.5
040805	H	10.5	10.0	+ 0.5
040806	H	10.5	10.0	+ 0.5
040812	W	12.2	10.1	+ 2.1
040829	W	13.0	10.7	+ 2.3
040829	H	10.5	10.1	+ 0.4
040905	W	14.0	11.5	+ 2.5
040906	W	14.0	11.7	+ 2.3

Table 4 (cont.)

date		m_2	m_1	Δ m
041113	H	10.7	10.4	+ 0.3
041216	H	11.3	10.8	+ 0.5
041204	H	10.8	10.5	+ 0.3

One can see at first glance the large systematic difference between the Δ m-values for these observers. Holetschek's 37 values within the range of $0^m.1$ - $0^m.9$ yields an average value of + $0^m.55$, but Wirtz's 26 values within the interval $1^m.0$ - $3^m.0$ yields an average of + $2^m.0$. A detailed investigation disclosed that their observations in m_1 differ but little, however, for central condensation Wirtz estimated substantially smaller brightnesses than Holetschek. Holetschek's observations of m_1 and m_2 were obtained with a refractor, 0.16 m in diameter. For determining m_2 Wirtz used a telescope with an objective diameter of 0.47 m, and for m_1 diameters of 0.12 and 0.47 m. There are 18 days on which Wirtz observed with a finder, 0.12 m in diameter, and with a refractor 0.47 m in diameter; he gives m_1-values for both instruments. These values are in Table 5.

Table 5
Wirtz - Determination of the internal correction

date	W12	W47	12-47
040419	9.2	9.3	- 0.1
040421	8.8	9.2	- 0.4
040424	9.4	9.4	0.0
040430	9.8	9.7	+ 0.1
040513	9.6	9.6	0.0
040514	9.4	9.4	0.0
040520	10.3	10.2	+ 0.1
040530	9.8	9.6	+ 0.2
040606	9.4	9.8	- 0.4
040607	9.5	9.6	- 0.1
040613	9.3	9.9	- 0.6
040614	9.5	9.3	+ 0.2
040616	9.6	9.4	+ 0.2
040709	9.6	9.8	- 0.2
040718	10.0	9.8	+ 0.2
040721	10.0	10.1	- 0.1
040802	9.9	10.0	- 0.1
040803	9.6	9.8	- 0.2

The absolute value of the average correction is less than $0^m.1$, so that no correction need be introduced between these two instruments in virtue of the accuracy of the data. It follows that the values of the differences m_2-m_1 are not affected by the fact whether Wirtz recorded the m_1-value with the aid of the finder, or with the aid of a larger refractor.

The above enables us to draw the following conclusions: The m_1-values are less sensitive to instrument changes, provided objects of large areas, comparable with the dimensions of the instrumental fields of view are not involved. The m_2-values strongly depend on the type and diameter of the telescope used, which is probably due to the fact that the central region in any telescope, beginning with a certain value of brightness, may be considered to be the central condensation, with the exception of completely diffuse objects. This agrees with the knowledge that the actual nucleus of a comet cannot be optically distinguished by existing instruments and that the inner coma is frequently identified with the nucleus. It apparently also depends on the size and light-gathering power of the instrument, which is still considered to be part of the central condensation. The only exceptions would be comets of asteroidal appearance, e.g. P/Arend-Rigaux, although the actual nucleus is probably not observed even in this case.

b) total brightness

The observations of the comet can be divided into two periods: The 1st period is from its appearance on April 16 to September 17, 1904, the 2nd period from November 13, 1904 to May 9, 1905. The comet was considerably active during the 1st and 2nd period. With a view to the interest in the changes of the brightness in the region of extreme observation, only the 2nd period was investigated. The photometric exponents were determined for Wirtz and Holetschek separately.

Table 6

Wirtz's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
306	0.593	9.2	318	0.638	8.7	322	0.692	8.9
314	0.625	9.3	320	0.671	9.5	323	0.695	10.4
315	0.625	10.0	321	0.672	10.2	324	0.696	9.9

$n = 2.3 \pm 2.2$ $\qquad$ $s = 0.37$

Table 7

Holetschek's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
300	0.570	7.4	303	0.586	7.6	312	0.614	8.5
302	0.572	7.8	307	0.595	8.0	319	0.669	8.8

$n = 5.3 \pm 1.2$ $\qquad$ $s = 0.92$

The inclinations of the regression lines differ very considerably, so that relating them on the other than common days would be incorrect. Relating them via the common days is not possible because there are no such days in this period. Consequently, only the values derived exclusively from Wirtz's observations in this period are considered to be photometric parameters:

$n = 2.3 \pm 2.2$ $\qquad$ $s = 0.37$

$M = 5.8 \pm 3.7$ $\qquad$ $m_m = 12.7$

That this procedure is justified is supported by the fact that they also contain the extreme observation of May 9, 1905. In spite of the gradual and slow decrease of brightness, the comet was still active. Between January 25 and 26, 1905 the brightness of the comet decreased by $0\overset{m}{.}7$ (Wirtz) and to February 12, 1905 it had again increased by $1\overset{m}{.}3$ (Wirtz). This sudden increase in brightness, preceded by a decrease, is also proved by Pechule's observations: $8\overset{m}{.}3$ (January 14) - $9\overset{m}{.}2$ (February 3) - $8\overset{m}{.}2$ (February 7). Wirtz's observations also show an increase in brightness by $1\overset{m}{.}3$ between April 3 and May 3, preceded by a decrease of brightness by $0\overset{m}{.}7$, and between May 3 and 7 another decrease of $1^{m}.5$. No proof by other observers is available, because only Wirtz's observations exist for this period.

Comet 1907 I Giacobini - after perihelion

The interval is covered best by Javelle's observations made with a telescope whose objective had a diameter of 0.76 m. His visual observations with 0.40 m Coudé telescope were not included in the processing.

Table 8
Javelle's observations

N	log r	m_{Δ}	N	log r	m_{Δ}
4	0.555	10.8	12	0.607	11.6
5	0.556	11.3			

$n = 4.3 \pm 3.3$ $s = 0.79$
$M = 5.0 \pm 4.7$ $m_m = 13.5$

Comet 1912 II Gale - after perihelion

Most of the observations were made by 3 observers - Van Biesbroeck (6) and Baldet together with Sy (4). Whereas Baldet and Sy observed at larger r's (including extreme observation), Van Biesbroeck's observations covered the region of small r's better.

Table 9
Van Biesbroeck's observations

N	log r	m_{Δ}	N	log r	m_{Δ}	N	log r	m_{Δ}
1	0.404	9.3	7	0.468	10.2	13	0.509	10.2
4	0.419	9.6	10	0.481	10.3	14	0.512	10.7

$n = 4.2 \pm 0.8$ $s = 0.94$

Table 10
Baldet's and Sy's observations

N	log r	m_{Δ}	N	log r	m_{Δ}
6	0.459	10.7	15	0.525	11.1
8	0.472	11.1	16	0.554	10.8

$n = 0.1 \pm 1.3$ $s = 0.07$

With a view to the considerable difference in the inclinations of the regression lines, the linear correction of Van Biesbroeck's observations to Baldet's scale could not be determined. Consequently, Baldet's and Sy's observations, inclusive of the extreme, are considered to be the resultant parameters:

$n = 0.1 \pm 1.3$ $s = 0.07$
$M = 10.8 \pm 1.6$ $m_m = 13.8$

A more detailed analysis of Van Biesbroeck's observations also speaks in favour of the smaller value of the photometric exponent being realistic at larger r's. The last four values in Table 9 yield $n = 2.5 \pm 2.6$, $s = 0.56$.

Comet 1917 III Wolf - before perihelion

Three observers with the largest number of observations were considered: Barnard (7), Van Biesbroeck (6) and Wolf (5). Apart from them only Palisa, Schwassmann and Millosevich (one observation each) made any observations.

Table 11
Wolf's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
1	0.716	9.9	3	0.698	9.9	11	0.681	10.1
2	0.713	10.2	6	0.695	10.0			

$n = -0.4 \pm 2.1$ $s = 0.10$

Table 12
Barnard's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
7	0.691	9.5	19	0.650	10.8	21	0.640	11.3
13	0.678	10.4	20	0.646	11.3	22	0.432	8.9
16	0.674	10.7						

$n = 2.4 \pm 1.5$ $s = 0.59$

Table 13
Van Biesbroeck's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
9	0.687	10.9	15	0.677	10.9	18	0.671	9.9
10	0.681	10.9	17	0.673	9.9	23	0.402	8.6

$n = 2.8 \pm 0.8$ $s = 0.87$

A few weeks after its discovery, the comet was relatively active. Between May 6 and June 28 Barnard recorded a decrease of $1^m.8$, between May 23 and 28 Van Biesbroeck recorded an increase of $1^m.0$. The parameters determined from Van Biesbroeck's and Barnard's observations are very uncertain because of this activity and also to the half-year interruption in observations. Wolf's observations, which include extreme observations, are at the limit of usability due to the range of r (0.40 AU):

$n = -0.4 \pm 2.1$ $s = 0.10$

$M = 10.7 \pm 3.7$ $m_m = 13.0$

However from the value of the photometric exponent one can see that the comet was active already at the time of its discovery. Barnard's observations from the first half of 1916 (the first six values in Table 12) also indicate a decrease of brightness with decreasing heliocentric distance.

Comet 1917 III Wolf - after perihelion

The parameters were determined from Barnard's m_1-values (range of r = = 0.47 AU):

Table 14
Barnard's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
1	0.410	12.1	4	0.441	13.1	7	0.483	13.6
3	0.430	12.8	6	0.470	13.2			

$n = 7.1 \pm 1.7$ $s = 0.94$
$M = 5.1 \pm 1.5$ $m_m = 15.0$

The parameters may be considered characteristic also for the region of extreme observation.

Comet 1922 II Baade - after perihelion

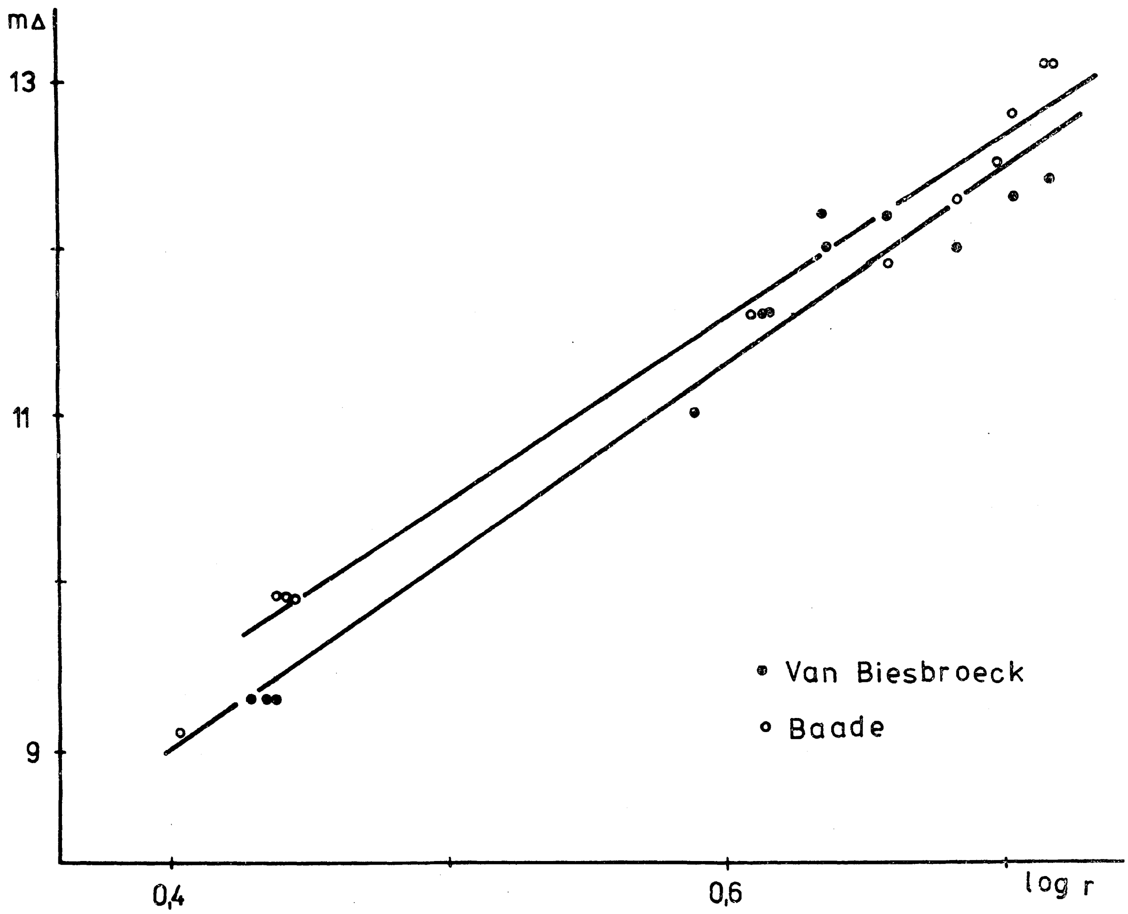

Fig. 2 : The changes of the brightness of Comet 1922 II Baade after perihelion.

The brightness curves for Baade and Van Biesbroeck were constructed first. According to Fig. 2, Van Biesbroeck's data seem to indicate that a change in the brightness of the comet occured at $r = 4.32$ AU ($\log r = 0.635$). However, Baade's series does not support this conclusion. Therefore, the parameters were calculated from the whole interval beyond 2.5 AU.

Table 15
Van Biesbroeck's observations

N	log r	m_{Δ}	N	log r	m_{Δ}	N	log r	m_{Δ}
3	0.403	9.1	17	0.613	11.6	24	0.658	12.2
8	0.429	9.3	18	0.614	11.6	29	0.683	12.0
9	0.434	9.3	20	0.635	12.2	31	0.703	12.3
10	0.437	9.3	22	0.636	12.0	35	0.716	12.4
15	0.589	11.0						

$n = 4.6 \pm 0.2$ $s = 0.98$

Table 16
Baade's observations

N	log r	m_{Δ}	N	log r	m_{Δ}	N	log r	m_{Δ}
11	0.439	9.9	23	0.658	11.9	33	0.703	12.8
13	0.442	9.9	28	0.683	12.3	34	0.715	13.1
14	0.443	9.9	30	0.698	12.5	36	0.717	13.1
16	0.610	11.6						

$n = 4.4 \pm 0.2$ $s = 0.99$

With a view to the very small difference in the inclinations of the regression lines, the correction for reducing Baade's observations to Van Biesbroeck's scale could be calculated. In Table 17 the first two columns contain Baade's m_{Δ} -values, marked as m_{Ba}, and the appropriate values of $\log r$. The third column gives the values interpolated from Van Biesbroeck's observations, given in Table 15, for the latter values of $\log r$; these values are marked m_{Bi}. Of Baade's values we only considered those for which $\log r$ falls within the interval covered by Van Biesbroeck's observations, i.e. $\log r = 0.403 - 0.716$.

Table 17
Reduction of observations to Van Biesbroeck's scale

log r	m_{Ba}	m_{Bi}	$m_{Bi} - m_{Ba}$
0.439	9.9	9.5	- 0.4
0.442	9.9	9.5	- 0.4
0.443	9.9	9.5	- 0.4
0.610	11.6	11.4	- 0.2
0.658	11.9	12.0	+ 0.1
0.683	12.3	12.3	0.0

Table 17 (cont.)

log r	m_{Ba}	m_{Bi}	$m_{Bi} - m_{Ba}$
0.698	12.5	12.5	0.0
0.703	12.8	12.5	- 0.3
0.715	13.1	12.7	- 0.4

The average value of the last column, which equals $-0^m.22$, is considered to be the resultant correction. With a view to the note in Section 2, the observations were made in a uniform scale and the parameters were determined from all of Van Biesbroeck's and Baade's values, i.e. the values in Tables 15 and 16:

$n = 4.6 \pm 0.2$ $s = 0.98$

$M = 4.6 \pm 0.3$ $m_m = 14.7$

Comet 1925 I Orkisz - after perihelion

Van Biesbroeck's and Struve's observations m_1 were considered as being observations made in a uniform scale. They were made using the same method and instruments at the Yerkes Observatory. They cover the whole interval well and also contain extreme observations:

Table 18
Van Biesbroeck's and Struve's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
3	0.536	11.3	9	0.605	11.9	17	0.704	13.0
4	0.555	11.3	11	0.652	12.7	18	0.712	12.9
7	0.601	11.4	13	0.662	12.6			

$n = 4.4 \pm 0.6$ $s = 0.95$

$M = 5.3 \pm 0.9$ $m_m = 15.0$

Comet 1925 III Reid - after perihelion

All observations, including the extreme, were carried out by Van Biesbroeck. There is a relatively large gap of more than half a year, from January 12 to July 17, 1926, in the observations of this comet. All Van Biesbroeck's observations (9 values) yield the parameters $n = 4.4 \pm 0.2$, $M = 4.9 \pm 0.4$, $s = 0.99$. However, the region of extreme observation is characterized much better by the data from July to the end of the year 1926. Since they are relatively well distributed within the interval and also the range of $r = 1.47$ AU is sufficient, the parameters used below were determined from the following 7 values:

Table 19
Van Biesbroeck's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
3	0.645	12.3	4	0.658	12.4	5	0.731	12.7

Table 19 (cont.)

N	log r	m_Δ
6	0.748	13.0
7	0.754	12.9
8	0.766	13.3
9	0.770	13.2

$n = 2.8 \pm 0.4$

$M = 7.7 \pm 0.8$

$s = 0.95$

$m_m = 16.5$

Comet 1925 VII Van Biesbroeck - after perihelion

The graphical representation in Fig. 3 indicates that a conspicuous change occured in the rate of decrease of the comet's brightness on March 9, 1926 (log r = 0.411). The sudden decrease in brightness between March 2 and 9, 1926 (Van Biesbroeck reported $0^m.8$, Simas $1^m.9$) was followed by a gradual decrease in brightness. Apart from these two observers only Krumpholz observed on March 3; naturally, his single observation cannot be used to draw conclusions about changes in brightness.

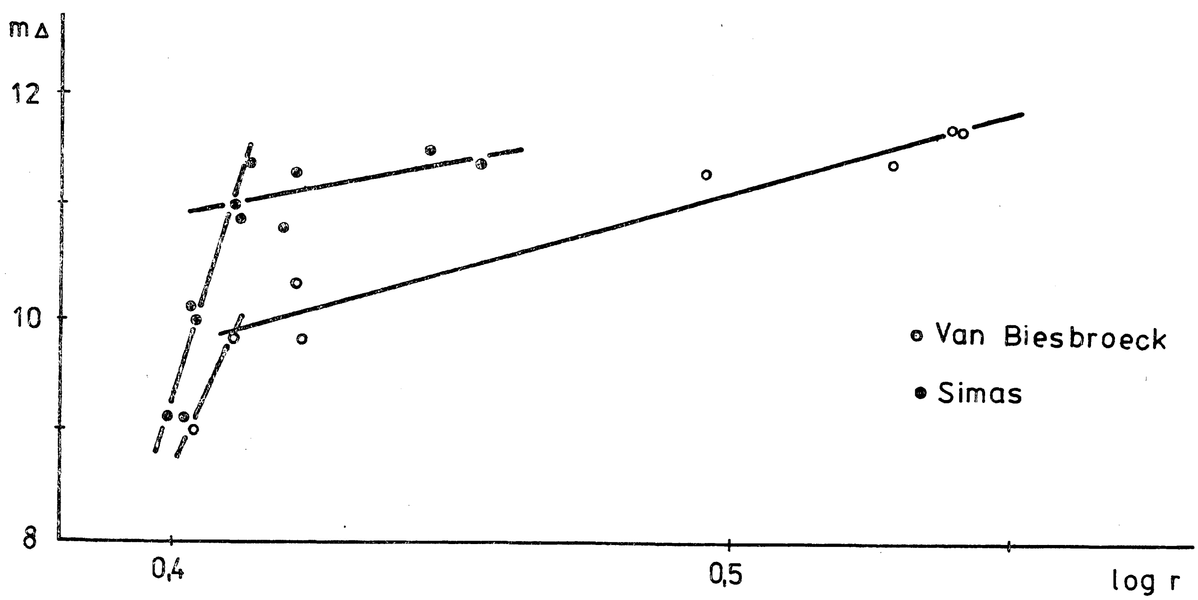

Fig. 3 : The changes of the brightness of Comet 1925 VII Van Biesbroeck after perihelion.

For the photometric parameters to provide the best description of the changes of the comet's brightness at large r's, they were computed only for the period following the sudden decrease, i.e. beginning with March 9, 1926. Since this limitation also decreased the interval of Simas'observations below a limit acceptable for calculating the parameters, these were determined from Van Biesbroeck's observations only:

Table 20
Van Biesbroeck's observations

N	log r	m_Δ
7	0.411	9.8
19	0.422	10.3
20	0.423	9.8
33	0.495	11.3
36	0.529	11.4
37	0.540	11.7
38	0.541	11.7

$n = 5.6 \pm 0.6$ $s = 0.97$
$M = 4.1 \pm 0.7$ $m_m = 13.5$

Hargreaves' and Merton's observations were reduced to Van Biesbroeck's scale. The symbols have the same meaning as in Table 17 - all tables used to reduced observations to another scale are arranged in the same way.

Table 21
Reduction of observations to Van Biesbroeck's scale

log r	m_{H+M}	m_{Bi}	$m_{Bi} - m_{H+M}$
0.460	10.6	10.6	0.0
0.461	10.9	10.6	- 0.3
0.463	10.8	10.6	- 0.2

Comet 1927 IV Stearns - after perihelion

The whole observation interval can be divided into three periods:

1st period from March 28 to July 2, 1927:

In this period, the brightness increased conspicuously and decreased equally rapidly, which was observed by a number of observers. The amplitudes of the brightness increase, reported by the individual observers, varied considerably (e.g. Plakidis $3\overset{m}{.}2$, Adamopoulos $2\overset{m}{.}0$; but Struve $0\overset{m}{.}7$, Alexandrov $0\overset{m}{.}6$) and Van Biesbroeck recorded no increase at all. The brightness decrease at the end of May and in the course of June, he reported, however, is quite distinct ($1\overset{m}{.}8$). It is interesting that observers who estimated the brightness of the nucleus recorded the largest increase. This seems as if the increase in brightness was mainly manifest in the region of the central condensation and that it had little effect on the change in the total brightness; this would also explain why Van Biesbroeck, observing the total brightness, did not record this phenomenon. Therefore, a weaker outburst of a kind similar to that observed on P/Schwassmann - Wachmann 1 could have occured. There is evidently no sense in calculating the photometric parameters for this period.

2nd period from July 2, 1927 to July 20, 1928:

In this period, the comet was still quite active and unsuitable for calculating the parameters.

3rd period from September 8, 1928 to March 12, 1931:

The activity of the comet decreased, although its brightness still fluctuated slightly. Baade, Schneider (once) and Van Biesbroeck observed during this period. First, the regression lines for Baade and Van Biesbroeck were determined separately:

Table 22
Baade's observations

N	log r	m_Δ
126	0.808	11.4
136	0.907	12.0
150	1.014	12.3
153	1.022	12.5

n = 1.9 ± 0.3 s = 0.98

Table 23
Van Biesbroeck's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
120	0.768	10.6	134	0.898	11.5	148	0.981	11.5
122	0.773	10.6	137	0.910	11.5	149	1.000	11.5
124	0.780	11.1	138	0.918	12.0	151	1.020	11.5
125	0.793	11.5	139	0.919	12.0	152	1.020	11.5
127	0.811	11.4	140	0.919	11.5	154	1.028	12.0
128	0.818	11.4	142	0.920	11.5	155	1.035	12.4
129	0.845	11.2	144	0.936	11.9	156	1.043	11.8
130	0.859	11.1	145	0.939	11.4	157	1.049	11.8
132	0.889	11.0	146	0.948	11.3	158	1.055	12.2
133	0.897	11.5	147	0.981	11.5	159	1.061	12.1

n = 1.3 ± 0.2 s = 0.73

With a view to the similarity of the photometric exponents, Baade's data were reduced to Van Biesbroeck's scale.

Table 24
Reduction of observations to Van Biesbroeck's scale

log r	m_{Ba}	m_{Bi}	$m_{Bi} - m_{Ba}$
0.808	11.4	11.1	- 0.3
0.907	12.0	11.5	- 0.5
1.014	12.3	11.8	- 0.5
1.022	12.5	11.8	- 0.7

Average correction = $- 0^m.5$.

The resultant parameters were determined from Van Biesbroeck's original values and from Baade's values corrected by $- 0^m.5$:

Table 25
Van Biesbroeck's and Baade's observations on Van Biesbroeck's scale

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
120	0.768	10.6	124	0.780	11.1	126	0.808	10.9
122	0.773	10.6	125	0.793	11.5	127	0.811	11.4

Table 25 (cont.)

N	log r	m_Δ
128	0.818	11.4
129	0.845	11.2
130	0.859	11.1
132	0.889	11.0
133	0.897	11.5
134	0.898	11.5
136	0.907	11.5
137	0.910	11.5
138	0.918	12.0
139	0.919	12.0
140	0.919	11.5
142	0.920	11.5
144	0.936	11.9
145	0.939	11.4
146	0.948	11.3
147	0.981	11.5
148	0.981	11.5
149	1.000	11.5
150	1.014	11.8
151	1.020	11.5
152	1.020	11.5
153	1.022	12.0
154	1.028	12.0
155	1.035	12.4
156	1.043	11.8
157	1.049	11.8
158	1.055	12.2
159	1.061	12.1

$n = 1.4 \pm 0.2$ $\quad$ $s = 0.76$

$M = 8.3 \pm 0.5$ $\quad$ $m_m = 16.2$

The resultant regression line is practically identical with Van Biesbroeck's one.

Comet 1930 IV Beyer - after perihelion

All of Van Biesbroeck's observations were used to calculate the parameters, with the exception of the estimates of nucleus brightness; they covered the whole interval, including extreme observation, and form 92% of the data of this kind. The differences of the values for m_2 and m_1 and for the same days fluctuate very much, so that no conclusions can be drawn about the brightness m_2 at the time of the extreme observation.

Table 26
Van Biesbroeck's observations

N	log r	m_Δ
2	0.406	10.6
4	0.430	11.0
5	0.436	10.5
7	0.474	11.3
8	0.506	12.2
9	0.537	12.0
10	0.548	11.0
11	0.552	12.0
12	0.568	12.4
13	0.577	11.9
14	0.595	12.4
15	0.625	12.3
16	0.649	11.8
17	0.655	12.8
18	0.670	12.8
19	0.671	12.8
20	0.695	12.8
23	0.710	13.7
24	0.717	13.7
25	0.717	14.2
26	0.735	14.0
27	0.735	14.0

$n = 3.8 \pm 0.4$ $\quad$ $s = 0.92$

$M = 6.6 \pm 0.6$ $\quad$ $m_m = 15.0$

Comet 1931 III Nagata - after perihelion

Most observations (86%) are due to Van Biesbroeck. They were used to determine the photometric parameters:

Table 27
Van Biesbroeck's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
2	0.405	9.4	6	0.428	10.3	10	0.550	12.0
3	0.407	9.3	7	0.536	12.5	11	0.579	13.0
4	0.409	10.3	8	0.546	13.0	13	0.618	14.5
5	0.426	10.3	9	0.547	13.0	14	0.619	14.5

$n = 8.6 \pm 0.6$ $s = 0.98$
$M = 0.9 \pm 0.7$ $m_m = 15.2$

Comet 1932 VI Geddes - after perihelion

For purposes of calculating the parameters, observers with the largest number of observations were considered: Van Biesbroeck 22, Beyer 22, Krumpholz 10, and Jeffers' observations containing extreme r . The photometric exponents were determined separately for each of these observers.

Table 28
Jeffers' observations

N	log r	m_Δ	N	log r	m_Δ
53	0.497	9.2	107	0.795	12.6
54	0.498	9.2	111	0.834	13.2

$n = 4.7 \pm 0.1$ $s = 1.00$

Table 29
Krumpholz's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
8	0.442	8.0	33	0.488	7.8	70	0.520	7.5
9	0.446	8.0	46	0.492	8.2	84	0.543	9.1
12	0.465	8.2	49	0.494	8.2	93	0.579	10.0
17	0.480	7.8						

$n = 5.0 \pm 1.7$ $s = 0.73$

Table 30
Beyer's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
3	0.430	7.7	36	0.488	8.1	62	0.511	8.3
10	0.465	7.9	38	0.489	8.0	64	0.516	8.3
21	0.484	8.1	40	0.490	8.0	66	0.517	8.3
23	0.485	8.0	47	0.493	8.2	67	0.518	8.4
27	0.486	8.1	57	0.507	8.2	68	0.519	8.4
29	0.487	8.2	58	0.508	8.3	71	0.520	8.4

Table 30 (cont.)

N	log r	m_Δ	N	log r	m_Δ
73	0.521	8.3	80	0.537	8.7
78	0.534	8.5	86	0.543	8.9

$n = 3.8 \pm 0.3$ $s = 0.93$

Table 31
Van Biesbroeck's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
1	0.401	8.5	96	0.592	9.8	103	0.765	10.9
2	0.407	8.0	97	0.604	10.2	104	0.783	11.2
7	0.441	8.4	98	0.647	10.9	105	0.784	11.2
16	0.480	9.3	99	0.650	10.9	106	0.794	11.6
81	0.537	9.7	100	0.669	10.4	108	0.798	12.0
88	0.546	10.0	101	0.714	10.5	109	0.801	12.5
90	0.563	9.7	102	0.749	11.5	110	0.802	13.0
94	0.589	9.9						

$n = 3.6 \pm 0.3$ $s = 0.94$

Beyer's observations were reduced to Van Biesbroeck's scale without difficulty - the inclinations of their respective regression lines were practically the same. Also Jeffers' observations were used because they contain extreme values of r . Krumpholz's observations were discarded because of the difference in the regression line inclinations, but mainly because of the large scatter of values in the interval which was covered well by Beyer and Van Biesbroeck.

Table 32
Reduction of Jeffers' observations to Van Biesbroeck's scale

log r	m_J	m_{Bi}	$m_{Bi} - m_J$
0.497	9.2	9.2	0.0
0.498	9.2	9.2	0.0
0.795	12.6	11.8	- 0.8

Average correction = $- 0^m.27$.

Table 33
Reduction of Beyer's observations to Van Biesbroeck's scale

log r	m_{Be}	m_{Bi}	$m_{Bi} - m_{Be}$
0.430	7.7	8.6	+ 0.9
0.465	7.9	8.9	+ 1.0
0.484	8.1	9.0	+ 0.9
0.485	8.0	9.1	+ 1.1

Table 33 (cont.)

log r	m_{Be}	m_{Bi}	$m_{Bi} - m_{Be}$
0.486	8.1	9.1	+ 1.0
0.487	8.2	9.1	+ 0.9
0.488	8.1	9.1	+ 1.0
0.489	8.0	9.1	+ 1.1
0.490	8.0	9.1	+ 1.1
0.493	8.2	9.1	+ 0.9
0.507	8.2	9.3	+ 1.1
0.508	8.3	9.3	+ 1.0
0.511	8.3	9.3	+ 1.0
0.516	8.3	9.3	+ 1.0
0.517	8.3	9.3	+ 1.0
0.518	8.4	9.4	+ 1.0
0.519	8.4	9.4	+ 1.0
0.520	8.4	9.4	+ 1.0
0.521	8.3	9.4	+ 1.1
0.534	8.5	9.5	+ 1.0
0.537	8.7	9.5	+ 0.8
0.543	8.9	9.6	+ 0.7

Average correction = + $0^m.98$; its constancy is remarkable.

For processing the data of GROUP B , Schorr's observations were reduced to Van Biesbroeck's scale.

Table 34
Reduction of Schorr's observations to Van Biesbroeck's scale

log r	m_S	m_{Bi}	$m_{Bi} - m_S$
0.466	7.9	8.9	+ 1.0
0.466	9.2	8.9	- 0.3
0.520	8.5	9.4	+ 0.9
0.568	10.2	9.8	- 0.4

The large difference in the individual values of the differences is caused by different methods being used to obtain the brightness values by Schorr (the 2nd and 4th values were obtained photographically, the 1st and 3rd visually).

The resultant parameters were determined from Van Biesbroeck's original values, Beyer's observations corrected by + $1^m.0$ and Jeffers' observations corrected by - $0^m.3$:

Table 35
Van Biesbroeck's, Beyer's and Jeffers' observations on a Van Biesbroeck's scale

N	log r	m_{Δ}	N	log r	m_{Δ}	N	log r	m_{Δ}
1	0.401	8.5	57	0.507	9.2	96	0.592	9.8
2	0.407	8.0	58	0.508	9.3	97	0.604	10.2
3	0.430	8.7	62	0.511	9.3	98	0.647	10.9
7	0.441	8.4	64	0.516	9.3	99	0.650	10.9
10	0.465	8.9	66	0.517	9.3	100	0.669	10.4
16	0.480	9.3	67	0.518	9.4	101	0.714	10.5
21	0.484	9.1	68	0.519	9.4	102	0.749	11.5
23	0.485	9.0	71	0.520	9.4	103	0.765	10.9
27	0.486	9.1	73	0.521	9.3	104	0.783	11.2
29	0.487	9.2	78	0.534	9.5	105	0.784	11.2
36	0.488	9.1	80	0.537	9.7	106	0.794	11.6
38	0.489	9.0	81	0.537	9.7	107	0.795	12.3
40	0.490	9.0	86	0.543	9.9	108	0.798	12.0
47	0.493	9.2	88	0.546	10.0	109	0.801	12.5
53	0.497	8.9	90	0.563	9.7	110	0.802	13.0
54	0.498	8.9	94	0.589	9.9	111	0.834	12.9

$n = 3.7 \pm 0.2$ $s = 0.96$
$M = 4.5 \pm 0.2$ $m_m = 11.0$

Comet 1941 IV De Kock - Paraskevopoulos - after perihelion

Two of Jeffers' observations, containing extreme observations (range of $r = 0.65$ AU) were used to calculate the parameters. With a view to their small number, the results are very uncertain.

Table 36
Jeffers' observations

N	log r	m_{Δ}
2	0.459	12.7
3	0.548	14.9

$n = 9.9$
$M = 1.4$ $m_m = 16.0$

Comet 1945 I Väisälä - after perihelion

All observations were made by Van Biesbroeck. A considerable increase in brightness (by $1^{m}.5$) occured between August 8 and 9, 1945 (Fig. 4). Consequently, the parameters determined from all the values are not representative; a single value recorded at the time of the increase changes the formal photometric exponent to positive and close to zero. Therefore, the resultant parameters were determined from the values after September 3, 1945 (inclusive):

Table 37

Van Biesbroeck's observations

N	log r	m_{Δ}	N	log r	m_{Δ}	N	log r	m_{Δ}
4	0.547	13.5	7	0.602	13.2	10	0.647	13.1
5	0.550	13.4	8	0.622	13.4	11	0.647	13.1
6	0.579	13.6	9	0.625	13.4			

$n = -1.3 \pm 0.5$ $s = 0.71$

$M = 15.3 \pm 0.8$ $m_m = 16.2$

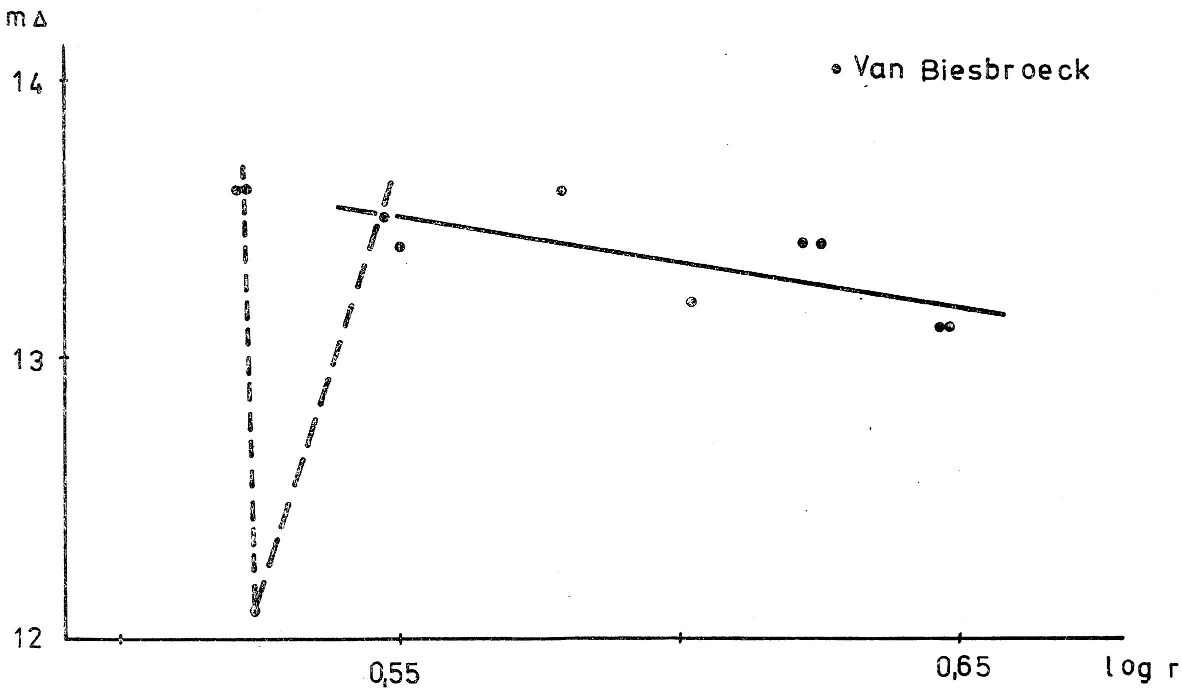

Fig. 4 : The changes of the brightness of Comet 1945 I Väisälä after perihelion

Comet 1946 I Timmers - after perihelion

The photometric exponents were first determined separately for Jeffers' observations with an 0.91-m reflector, which covered the whole interval relatively well, as well as for two pairs of Martynov's and Van Biesbroeck's observations, which covered a small range of r .

Table 38

Martynov's observations

N	log r	m_{Δ}
1	0.398	12.1
4	0.464	13.0

n = 5.4

Table 39
Van Biesbroeck's observations

N	log r	m_Δ
2	0.422	12.9
6	0.473	13.4

n = 3.9

Table 40
Jeffers' observations

N	log r	m_Δ
3	0.431	12.3
5	0.469	13.7
7	0.713	16.1
8	0.713	16.1
9	0.726	16.2
10	0.745	16.1

n = 4.6 ± 0.5   s = 0.98

With a view to the small scatter of the regression line inclinations, all observations were considered. For Martynov's value of $13^{m}.0$ at log r = = 0.464, Jeffers' interpolated value comes out at $13^{m}.1$, and for Van Biesbroeck's value of $13^{m}.4$ at log r = 0.473 Jeffers' interpolated value comes out at $13^{m}.2$. Therefore, all values (i.e. the data from Tables 38, 39 and 40) were used without correction to calculate the resultant parameters:

n = 4.6 ± 0.3   s = 0.98
M = 7.8 ± 0.4 m_m = 16.1

Comet 1946 VI Jones - after perihelion

Four observers with the largest number of observations of the total brightness were consider for the calculation: Beyer (13), Van Biesbroeck (10), Boyer (9) and Jeffers (7). Observations of m_2 were not considered because their range was smaller than 1 AU and also outside the region of extreme observation. The photometric exponents were first determined separately for each observer:

Table 41
Beyer's observations

N	log r	m_Δ
4	0.440	9.1
8	0.447	9.2
11	0.452	9.3
14	0.474	9.2
18	0.487	9.5
20	0.490	9.4
24	0.491	9.6
27	0.493	9.5
29	0.498	9.9
30	0.501	9.8
31	0.502	9.9
33	0.504	9.9
34	0.506	10.0

n = 4.8 ± 0.8   s = 0.88

Table 42
Boyer's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
1	0.405	10.2	26	0.493	10.7	45	0.533	11.0
10	0.451	10.8	38	0.525	11.1	49	0.560	10.8
13	0.454	10.7	39	0.527	11.0	50	0.562	10.9

$n = 1.5 \pm 0.5$ $s = 0.77$

Table 43
Jeffers' observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
35	0.525	11.2	55	0.685	13.0	58	0.849	13.7
48	0.559	11.0	57	0.815	14.3	63	0.912	14.7
51	0.627	11.9						

$n = 3.8 \pm 0.4$ $s = 0.97$

Table 44
Van Biesbroeck's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
46	0.542	10.1	54	0.683	12.6	60	0.877	13.8
47	0.556	11.0	56	0.713	12.8	61	0.890	14.7
52	0.636	11.0	59	0.865	13.3	62	0.890	14.7
53	0.657	12.8						

$n = 4.2 \pm 0.6$ $s = 0.93$

The resultant parameters were calculated only from Van Biesbroeck's and Jeffers' observations, because they have no interval in common with Beyer's, and Boyer's observations, which partly overlap, have a completely different inclinations of the regression lines. The corrections for reducing Jeffers' and Boyer's observations to Van Biesbroeck's scale were determined.

Table 45
Reduction of Jeffers' observations to Van Biesbroeck's scale

log r	m_J	m_{Bi}	$m_{Bi} - m_J$
0.559	11.0	10.9	- 0.1
0.627	11.9	11.6	- 0.3
0.685	13.0	12.2	- 0.8
0.815	14.3	13.9	+ 0.2

Average correction = $- 0\overset{m}{.}34$.

Table 46
Reduction of Boyer's observations to Van Biesbroeck's scale

log r	m_{Bo}	m_{Bi}	$m_{Bi} - m_{Bo}$
0.560	10.8	10.9	+ 0.1
0.562	10.9	10.9	0.0

The resultant parameters were determined from Van Biesbroeck's original data and from Jeffers' observations corrected by - $0\overset{m}{.}3$:

Table 47
Van Biesbroeck's and Jeffers' observations on Van Biesbroeck's scale

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
35	0.525	10.9	53	0.657	12.8	59	0.865	13.3
46	0.542	10.1	54	0.683	12.6	60	0.877	13.8
47	0.556	11.0	55	0.685	12.7	61	0.890	14.7
48	0.559	10.7	56	0.713	12.8	62	0.890	14.7
51	0.627	11.6	57	0.815	14.0	63	0.912	14.4
52	0.636	11.0	58	0.849	13.4			

$n = 4.0 \pm 0.4$ $s = 0.94$
$M = 5.3 \pm 0.7$ $m_m = 16.5$

GROUP B

Comet 1889 I Barnard - after perihelion

The largest range of r is covered by Spitaler's observations m_1, which were used to determine the parameters.

Table 48
Spitaler's observations

N	log r	m_Δ	N	log r	m_Δ
3	0.405	6.6	23	0.767	10.5
21	0.739	10.7			

$n = 4.6 \pm 0.8$ $s = 0.99$
$M = 2.0 \pm 0.5$ $m_m = 14.0$

The faithfulness of these data in the region of extreme observation is decreased by nearly a year's interruption between the 1st and 2nd value of Table 48.

Comet 1890 II Brooks - after perihelion

n was determined separately for the observers with the largest number of best distributed observations. Since Holetschek's observations of 1890 show a sudden increase in brightness (by $0^m.9$), only the 1891 observations were used.

Table 49
Holetschek's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
4	0.517	8.5	12	0.570	8.2	17	0.600	8.5
7	0.548	8.4	16	0.592	8.7			

$n = 0.5 \pm 1.2$ $s = 0.23$

Table 50
Renz's observations

N	log r	m_Δ	N	log r	m_Δ
8	0.560	8.8	19	0.630	9.4
10	0.562	8.8			

$n = 3.5 \pm 0.1$ $s = 1.00$

Table 51
Luther's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
5	0.538	9.9	9	0.561	10.3	18	0.619	9.6
6	0.541	9.5	13	0.576	9.7			

$n = -0.9 \pm 2.2$ $s = 0.23$

The photometric exponents differ so much that the individual series cannot be tied in with each other. The values derived from Luther's observations (his observations cover the largest range of r) are considered to be resultant parameters; however, they are not characteristic for the changes of the comet's brightness in the region of extreme observation either:

$n = -0.9 \pm 2.2$ $s = 0.23$
$M = 11.0 \pm 3.1$ $m_m = 12.0$

Comet 1892 I Swift - after perihelion

The whole interval with the exception of the extreme observation is covered well by Holetschek's observations.

Table 52
Holetschek's observations

N	log r	m_Δ	N	log r	m_Δ	n	log r	m_Δ
1	0.409	7.1	12	0.484	8.3	14	0.555	8.5
4	0.424	7.6	13	0.509	8.3	15	0.570	8.8
9	0.469	7.9						

$n = 3.6 \pm 0.5$ $s = 0.95$
$M = 3.6 \pm 0.6$ $m_m = 10.0$

Comet 1907 IV Daniel - after perihelion

The observations of Millosevich, Zappa and Bianchi were considered to have been made on a uniform scale (Fig. 5).

Table 53
Observations of Millosevich et al.

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
5	0.451	7.9	13	0.538	10.0	24	0.575	9.8
11	0.527	10.0	21	0.565	9.9	25	0.580	9.7
12	0.532	10.0	23	0.572	9.8			

$n = 5.3 \pm 1.7$ $s = 0.79$

These parameters (line A in Fig. 5) are greatly affected by a single value in the region of small r's - the observation of February 12, 1908. After omitting it, the remaining 7 observations yield (line B in Fig. 5):
$n = -2.0 \pm 0.3$ $s = 0.94$.

After this observation had been omitted, Van Biesbroeck's observations cover the longest interval of r (0.57 AU) and, therefore, the values derived from them were considered to be the resultant parameters.

Table 54
Van Biesbroeck's observations

N	log r	m_Δ	N	log r	m_Δ
7	0.490	8.5	16	0.547	8.9
15	0.545	8.9	18	0.564	8.9

$n = 2.4 \pm 0.5$ $s = 0.96$
$M = 5.6 \pm 0.6$ $m_m = 11.0$

None of the above-mentioned parameters are representative of the changes of the comet's brightness in the region of extreme observation.

There is the question whether Javelle's estimate of June 24, 1908 is realistic. This apparently involves the brightness of some condensation limited in time, because the next day this "nucleus" could no longer be found.

Wolf's extreme observation could not be tied in with that of any other observer.

Comet 1915 II Mellish - after perihelion

For the interval used to calculate the parameters to be as long as possible, it is necessary to tie in the observations of some observer with Van Biesbroeck's observations made with a 1.02-m refractor. Of the observers who come into consideration, corrections in this paper have been determined for

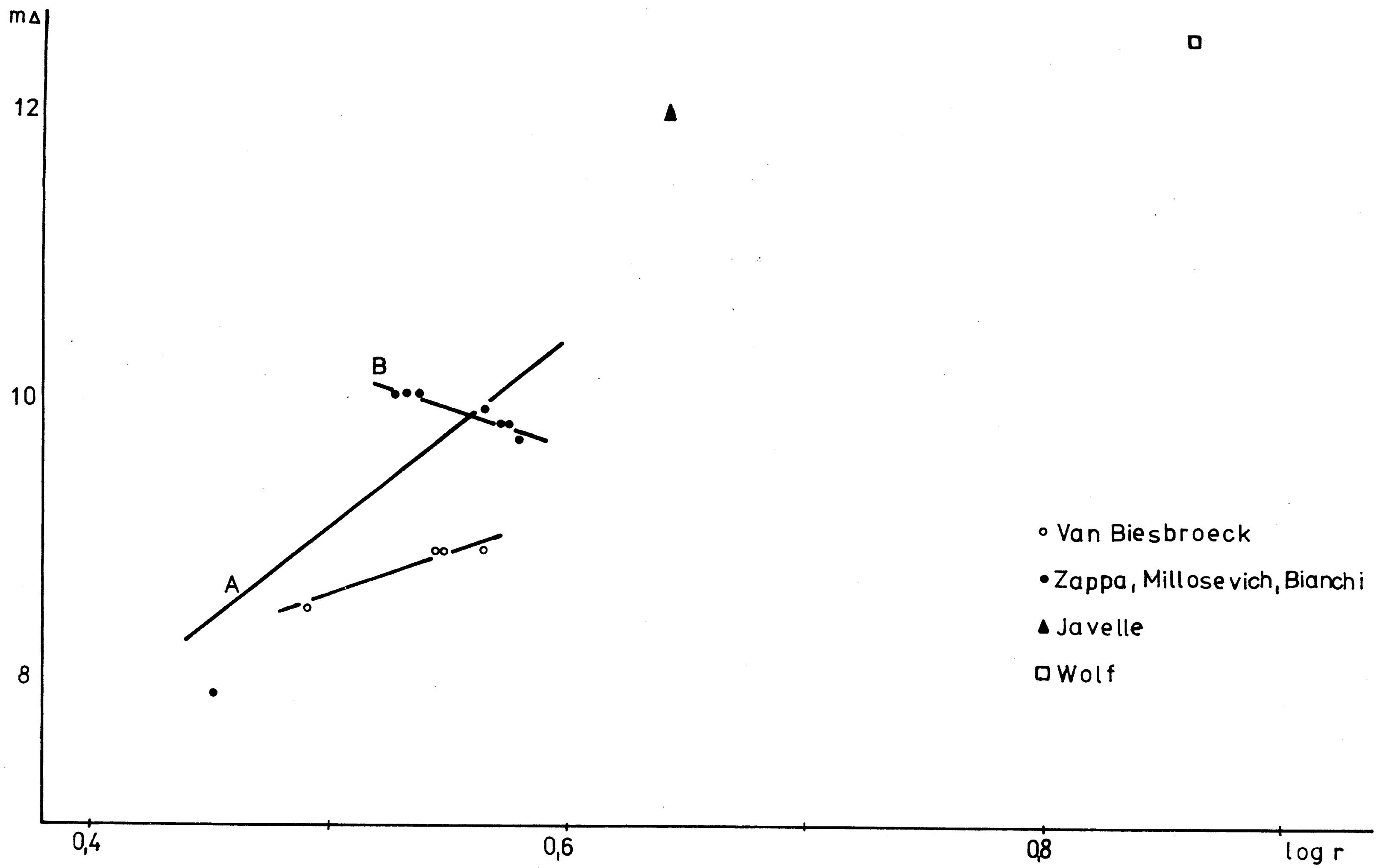

Fig. 5 : The changes of the brightness of Comet 1907 IV Daniel after perihelion.

Schorr (for comet 1932 VI). However, since they differ considerably for brightness determined photographically ($-0^m.35$) and visually ($+0^m.95$) and since the method used for this comet is not given, they cannot be used. The parameters were determined from Van Biesbroeck's observations of the nucleus brightness. Since the observations were made with different instruments and the scales cannot be compared, they were included in GROUP B .

Table 55
Van Biesbroeck's observations

N	log r	m_Δ
6	0.438	10.5
10	0.524	11.4

n = 4.2
M = 5.9 m_m = 13.0

Comet 1936 I Van Biesbroeck - after perihelion

During the whole interval in which the comet could be observed, it was very active which prevented us in determining the corrections for Jeffers and Dieckvoss with Sandig to Van Biesbroeck's scale. Between May 14 and 27, 1936, the brightness increased appreciably (Van Biesbroeck reported $0^m.9$). The photometric parameters were determined from Van Biesbroeck's values after this increase (beginning with July 24 until the extreme observation). However, the

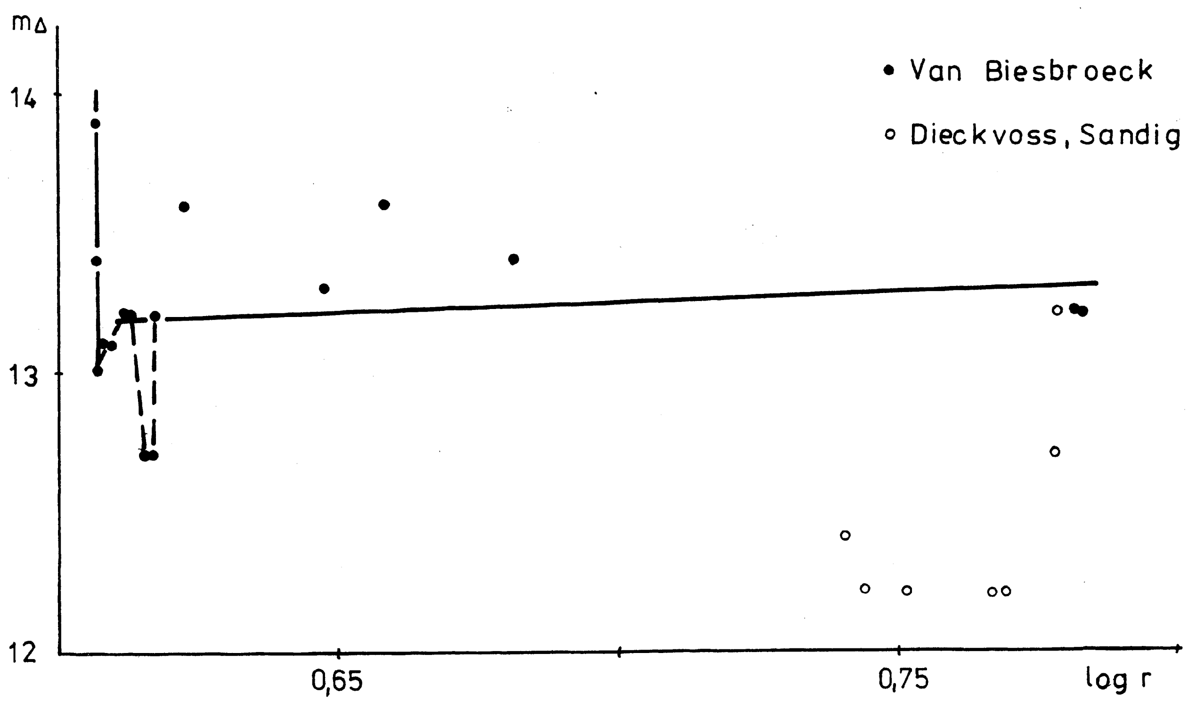

Fig. 6 : The changes of the brightness of Comet 1936 I Van Biesbroeck after perihelion.

parameters are very formal, because Sandig's and Dieckvoss' observations seem to indicate that the increase occured between March 17 and August 11, 1937, too. This is supported by the good agreement of their observation of November 3 with Van Biesbroeck's values of November 9 and 12, 1937 (Fig. 6).

Table 56
Van Biesbroeck's observations

N	log r	m_Δ	N	log r	m_Δ	N	log r	m_Δ
8	0.612	13.2	12	0.617	12.7	18	0.658	13.6
9	0.612	13.2	13	0.617	13.2	19	0.682	13.4
10	0.613	13.2	15	0.623	13.6	27	0.781	13.2
11	0.616	12.7	17	0.648	13.3	28	0.782	13.2

$n = 0.3 \pm 0.6$ $s = 0.16$
$M = 12.7 \pm 0.9$ $m_m = 16.2$

After perihelion, the brightness of the comet was considerably lower than before: the median of 21 values of m_Δ before perihelion is $11^m.5$, the median of 28 values of m_Δ after perihelion is $13^m.2$. The difference of $1^m.7$ agrees well with the sudden decrease before perihelion.

GROUP E

For completeness, a list of comets of the selected sample is given, for which the photometric parameters could not be determined using the methods described above:

- 1861 II Tebbutt after perihelion - sudden increase in brightness just before the extreme observation,
- 1881 III Tebbutt after perihelion - all observations at $r > 2.5$ AU on the same day,
- 1889 I Barnard before perihelion - range of r = 0.09 AU,
- 1889 II Barnard after perihelion - no series of a single observer can be used on its own and the appropriate corrections could not be determined,
- 1895 IV Perrine after perihelion - only one observation beyond 2.5 AU,
- 1898 VII Coddington-Pauly after perihelion - only one observation beyond 2.5 AU,
- 1914 V Delavan before and after perihelion - the comet was all the time very active,
- 1915 II Mellish before perihelion - range of r = 0.07 AU,
- 1927 IV Stearns before perihelion - range of r = 0.001 AU,
- 1930 IV Beyer before perihelion - problems with identifying standard stars,
- 1932 VI Geddes before perihelion - no series of a single observer can be used on its own and the appropriate corrections could not be determined,
- 1936 I Van Biesbroeck before perihelion - the comet was very active,
- 1945 I Väisälä before perihelion - the corrections could not be determined.

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