

A PHOTOMETRIC STUDY OF NGC 3587

Planetary nebula NGC 3587, known as Owl nebula M97 lies in South-East direction from the star β of the constellation Ursa Major and is one of the brightest and largest planetary nebulae. To its position

$AR_{1900.0} = 11^{\text{h}}09^{\text{m}}00^{\text{s}}$ and $\text{Decl.}_{1900.0} = +55^{\circ}33'7''$ correspond the galactic coordinates (in accordance with the Olson's system)

$$l_{1900.0} = 114^{\circ}3' \text{ and } b_{1900.0} = +58^{\circ}0'$$

Voroncov—Veljaminev [1] gives as further characteristics the following quantities:

The nebula is of the type IIIa; this type includes all planetary nebulae of oval shape with unequal distribution of surface brightness. The dimension of nebula is $199'' \times 203''$ what is in full conformity with data found by H. Curtis [2]. The nebula brightness is 12.0 mag. and the central star brightness 14.3 mag. The central star has a temperature 40000 °C. The distance of NGC 3587 is 2290 parsec and its diameter measures 458000 astronomical units. H. Zanstra [3] in his analysis of planetary nebulae fixed the approximate temperature of the central star at 55000 °C from the difference between the nebula brightness $m_{\text{neb.}}$ and that one of the central star m_* by the formula

$$m_* - m_{\text{neb.}} = d$$

where $m_* = 14.3$ mag. and $m_{\text{neb.}} = 9.4$ mag.; the result is $d = 4.9$ mag.; $m_{\text{neb.}}$ denotes the total of the observed brightness of the nebula and of the central star. According to Bermann [4] the apparent brightness of the nebula is fixed at 11.1 mag. and the distance at 3630 parsec. G. L. Camm [5]

made studies on the galactic rotation based on the velocity of planetary nebulae. The distance of NGC 3587 is 330 parsec and the brightness S of the nebula is 27.6, which corresponds to the equation

$$S = M + 5 \log D = m + 5 + 5 \log \alpha$$

where

$$M = m + 5 - 5 \log r$$

and

$$D = r \cdot \alpha$$

m denotes the apparent magnitude of nebula, M is the absolute magnitude, α means the major angular diameter in seconds of arc, D the major linear diameter in astronomical units and r is the distance from the Sun in parsec. In a Voroncov—Veljaminev's later work [6] the distance of NGC 3587 is fixed to 2500 parsec and the diameter at 500000 astronomical units; further, the absolute brightness of the nebula is $M_{\text{neb.}} = -0.5$ mag., the absolute brightness of the central star $M = 1.8$ mag. and the absorption is 0.5 mag.

The subject of our study is the photometric analysis of NGC 3587.

It was said that the surface brightness distribution of nebula is irregular, but it is possible to observe clearly a symmetric distribution of the areas of the maximal and minimal brightness with regard to the central star. The minimal brightness area is found at the position angle of about 194° near to the disc center and the area of maximal brightness is found at the position angle of about 340° . On the photographs taken with longer exposures it is possible to observe a weak outer cover round the nebula observable almost on its whole periphery.

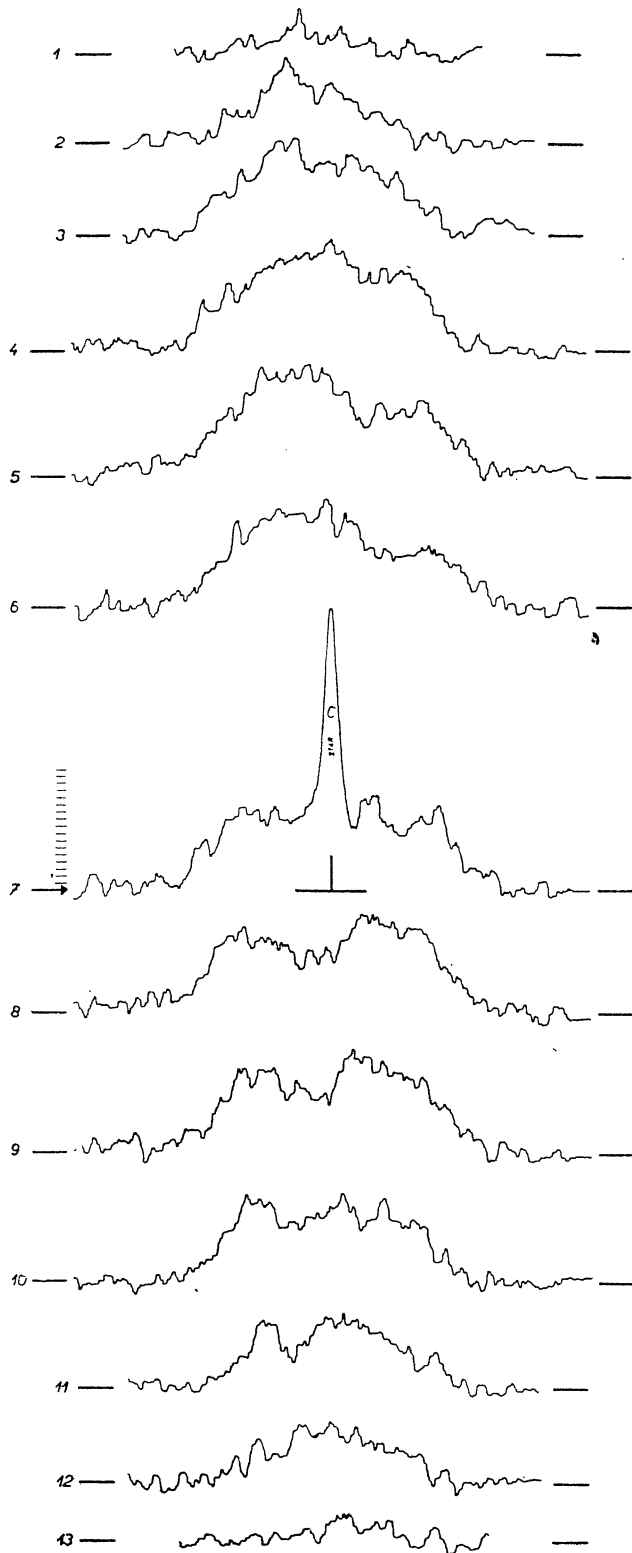


Figure 1.

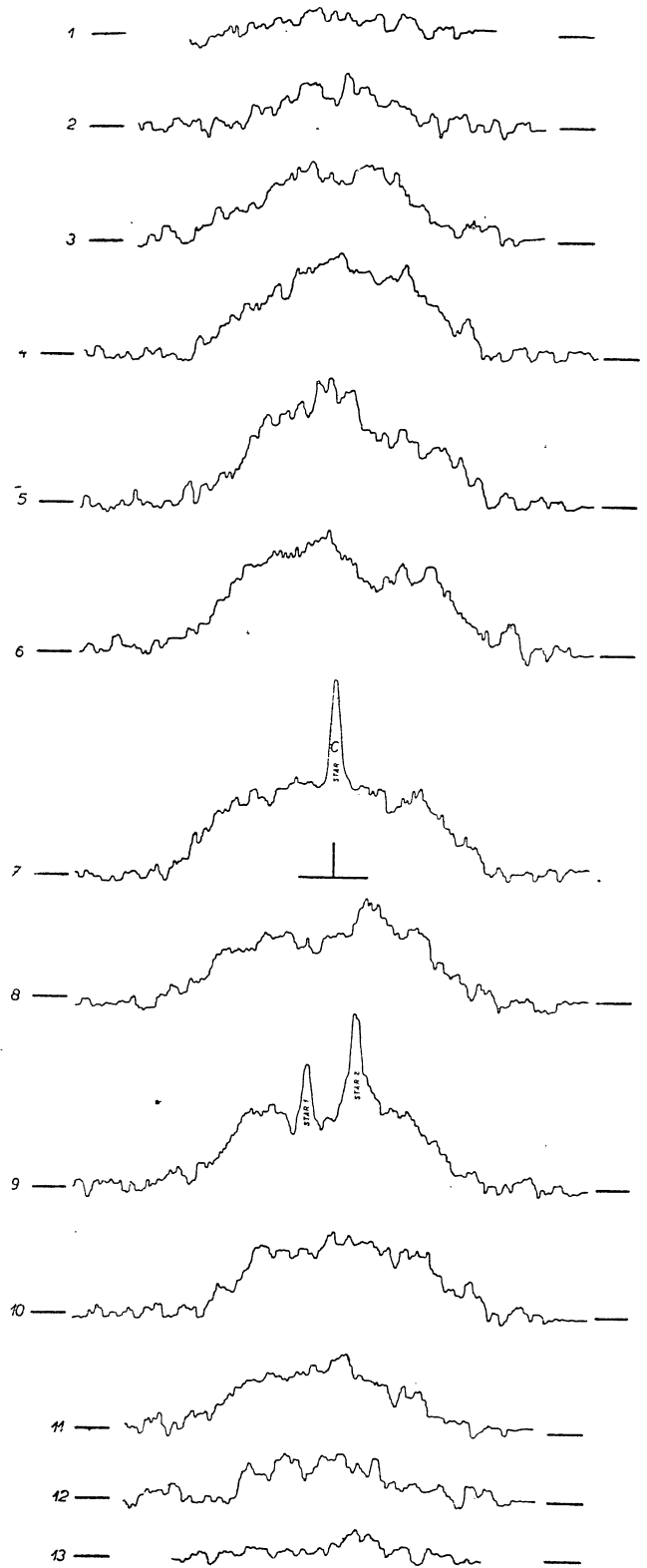


Figure 2.

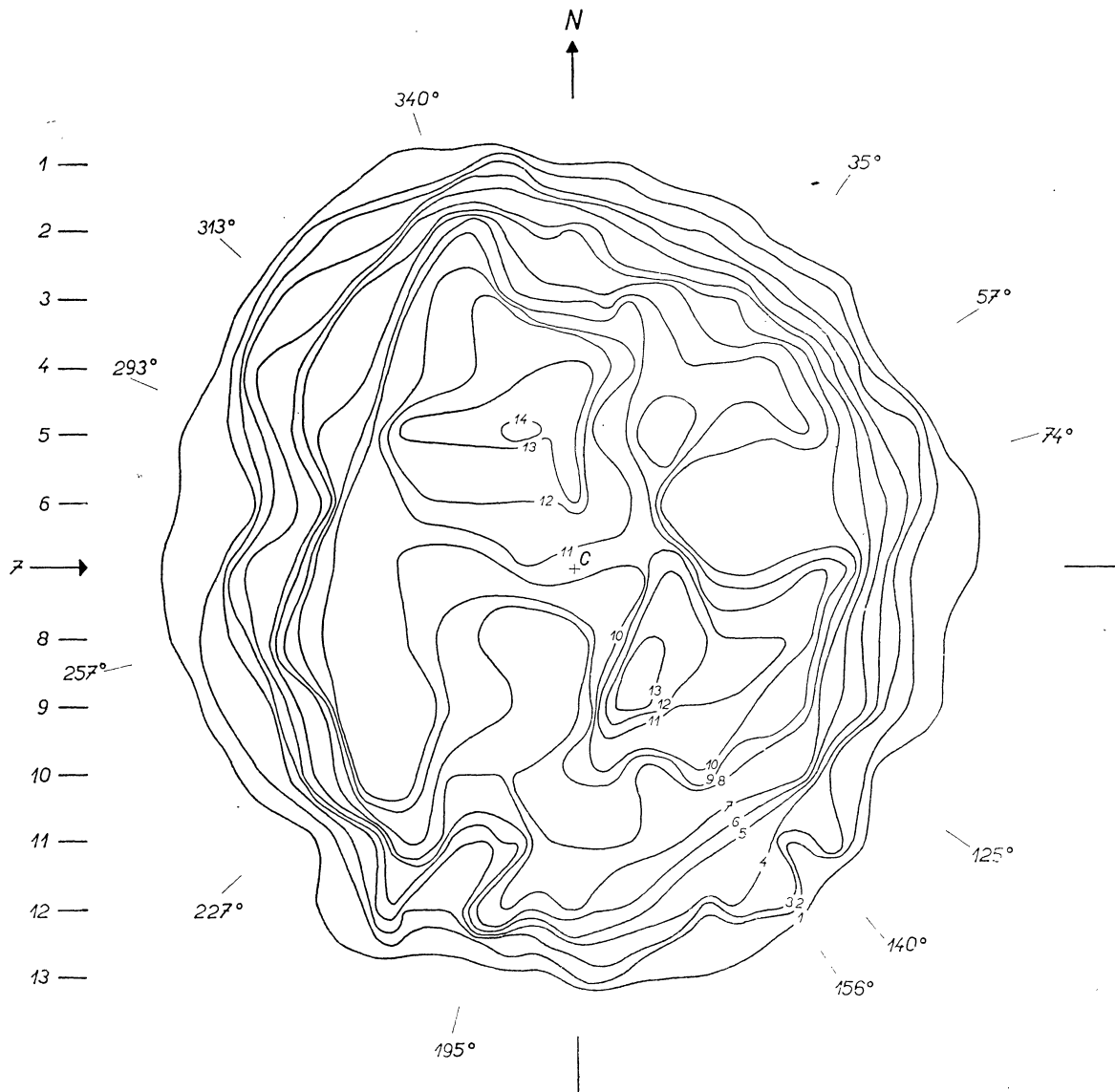


Figure 3.

1. Instruments and materials

For our purposes we have used the main reflector diameter = 60 cm, focus = 330 cm of the Observa-

tory at Skalnaté Pleso. The following plates have been used for our study:

No.	Plate	Exposure	Emulsion	Date of exposure	Filter	Observer
1.	90a	120m	Agfa-Astro	1956. V. 4.	Schott BG1	Antal
2.	93a	60	Agfa-Astro	1956. V. 5.	Schott GG11	Antal
3.	96a	180	Agfa-Astro	1956. V. 6.	Schott GG11	Antal
4.	102a	60	Agfa-ISS	1956. V. 11.	—	Bajcárová
5.	106a	60	Agfa-ISS	1956. V. 28.	—	Antal

The basic plates have been measured with the self-registering microphotometer of the Astronomical Institute of MU Brno and partly with the microphotometer MF-2 at the Observatory at Skal-

naté Pleso. The measuring was carried out by following way:

The whole picture of the nebula is cut into 13 parallel sections perpendicular to the line North-

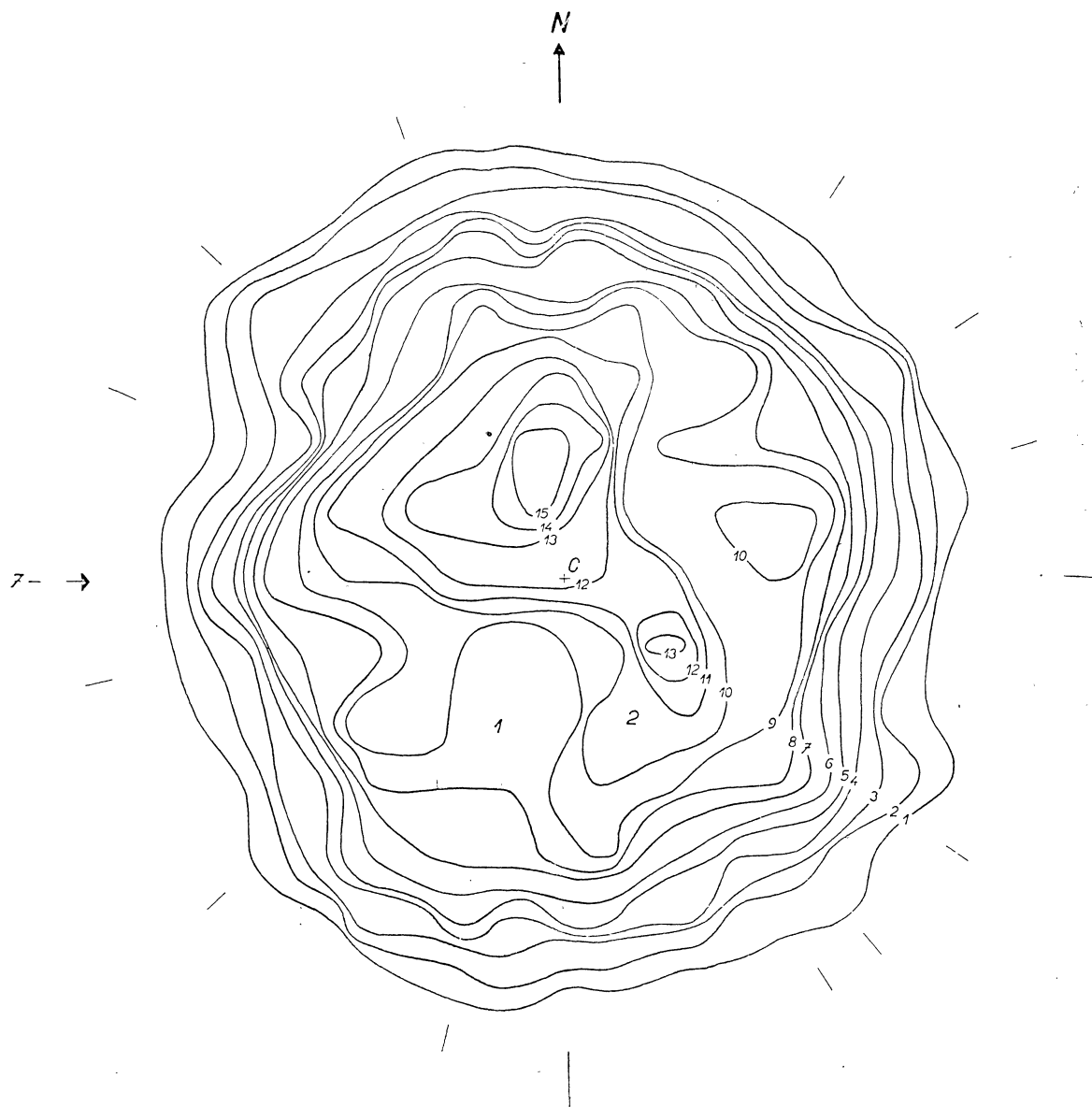


Figure 4.

South; the Section 7 goes through the central star. 1 mm on the plate is equal to 44.8 mm on the registration roll. Plates 1,3 and 4 have been measured with the self-registering microphotometer and Plates 1, 3, 4 and 5 also in radial cuts at interval 10 to 15° by means of the microphotometer MF-2.

All plates have been calibrated by extrafocal exposures of polar sequence stars. The Polar Sequence stars have been taken on a half of a plate having the same exposure times and centered at the star No. 18 NPS.

The curves resulting from measuring with the

self-registering microphotometer with regard to the parallel section of the NGC 3587 nebula are represented by Fig. 1 for Plate No. 1, and by Fig. 2 for Plate No. 3. The curves are denoted with numbers 1 to 13, where section No. 1 is the northest section, perpendicular to the, line North-South, Section 7 crosses the central star and Section 13 is the southest section of the nebula. The arrows in Fig. 3. denote the section orientations to the nebula. The centres of the microphotometric sections are connected by the line North-South crossing the central star.

Isophotes of the NGC 3587 nebula shown in

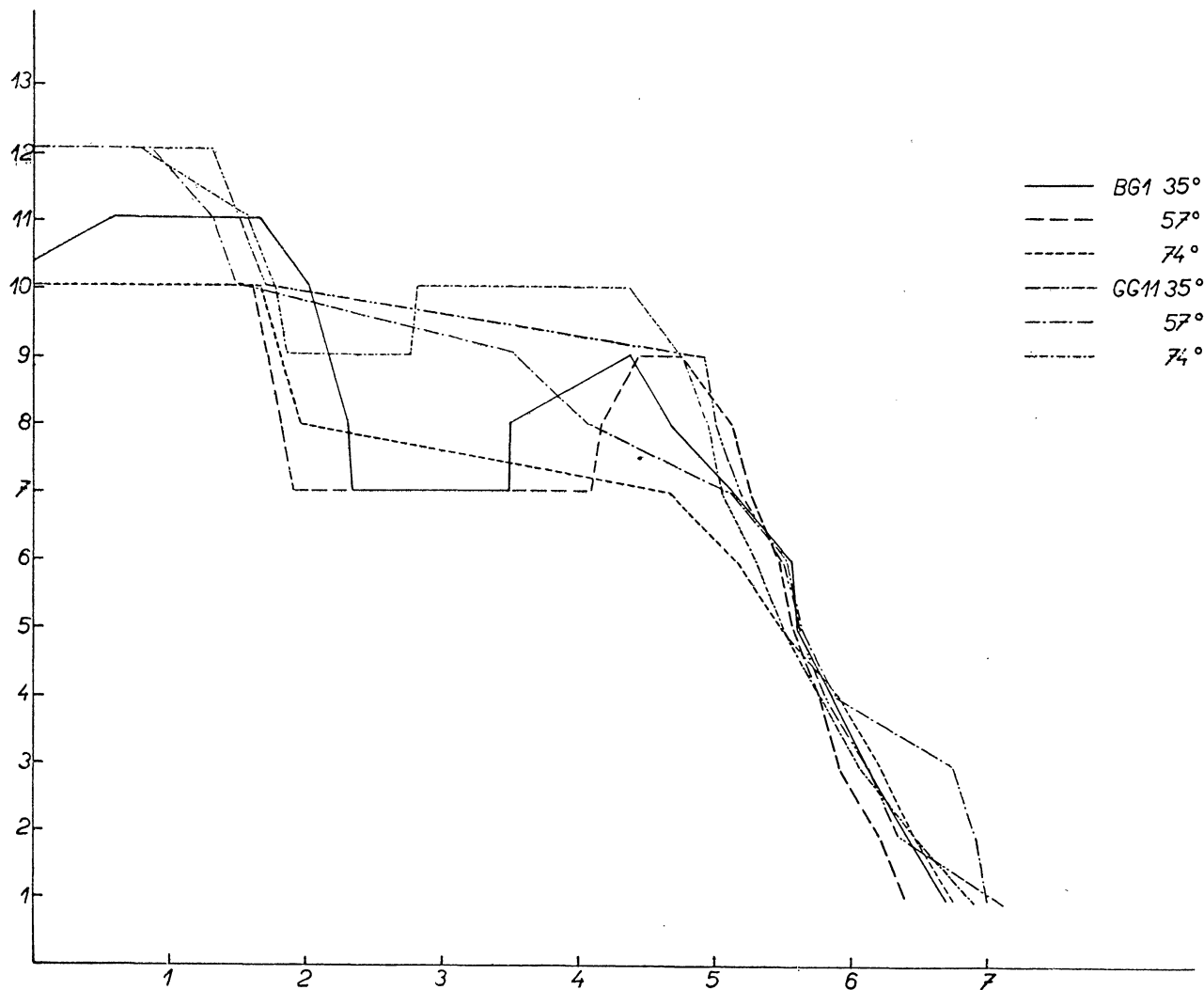


Figure 5.

Fig. 3 are obtained by measuring the plate No. 1 taken with the filter Schott BG 1. Isophotes are outlined in relative graduation from 1 to 14, where 14 denotes the maximal brightness of the nebula detail. The central star position is marked in the figures by $+C$. The small lines on the nebula periphery give the direction of the radial nebula sections from the central star to the border in quoted degrees shown in Fig. 5, 6, 7 and 8.

Isophotes of the nebula obtained from the picture No. 3 with the filter Schott GG 11 are shown in Fig. 4 having the same orientation as Fig. 3. The isophotes portions are the same as in the foregoing figures, but the maximal brightness of detail is

No. 15. The letters a and b denote two additional stars in the nebula.

The Fig. 5, 6, 7 and 8 represent the nebula section in given position angle from the central star to the border of the nebula. On the vertical axis are marked the relative portions for isophotes and on the horizontal axis the distances from the central star in sum according to the distances in Fig. 3 and 4.

Finally, the Fig. 9 gives the reciprocal comparison of the nebula sections in position angles 74° , 156° , 195° , and 340° from the Plate 1 taken with filter BG 1 and the Fig. 10 shows the comparison of sections in the same position angles from the Plate 3 taken with filter GG 11.

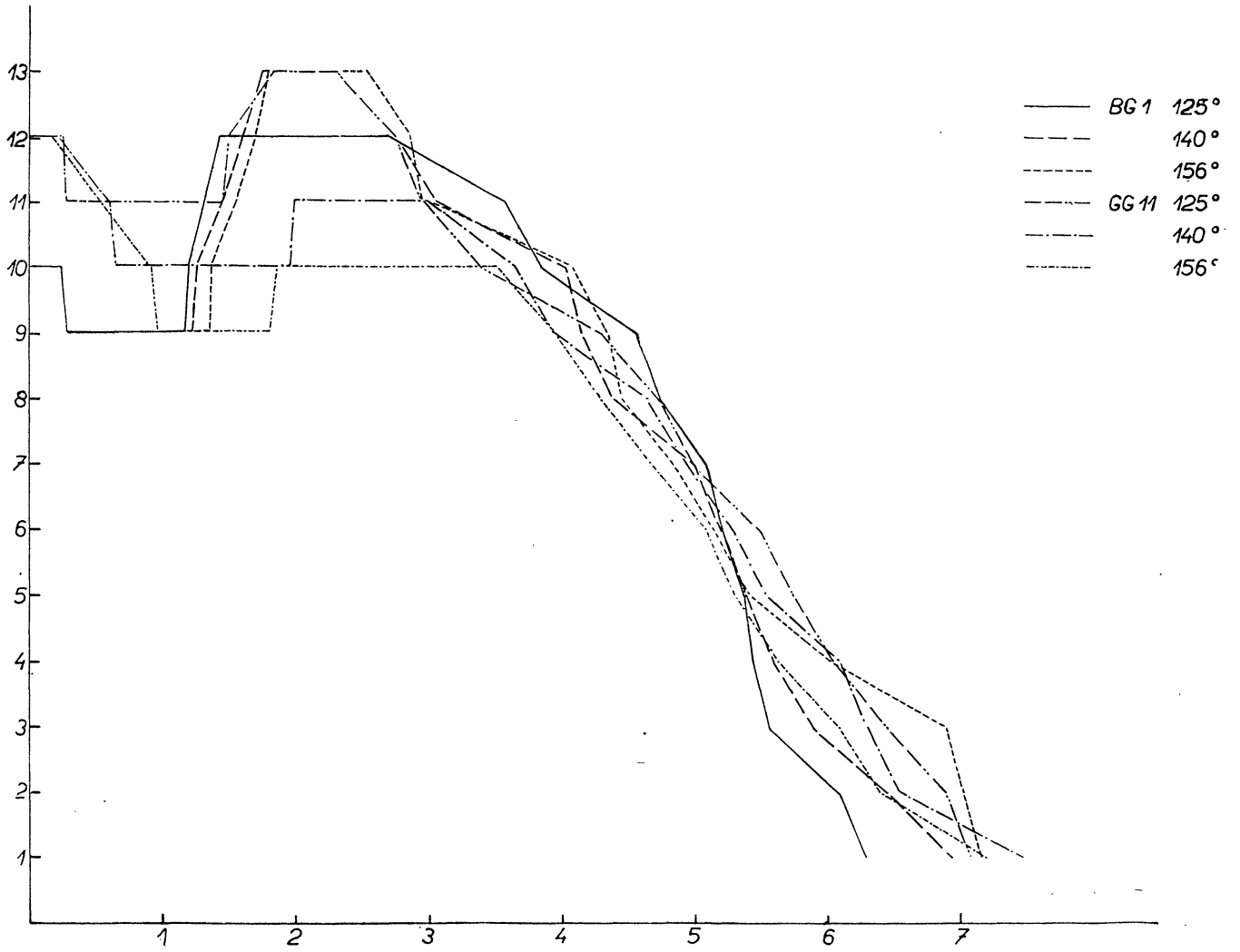


Figure 6.

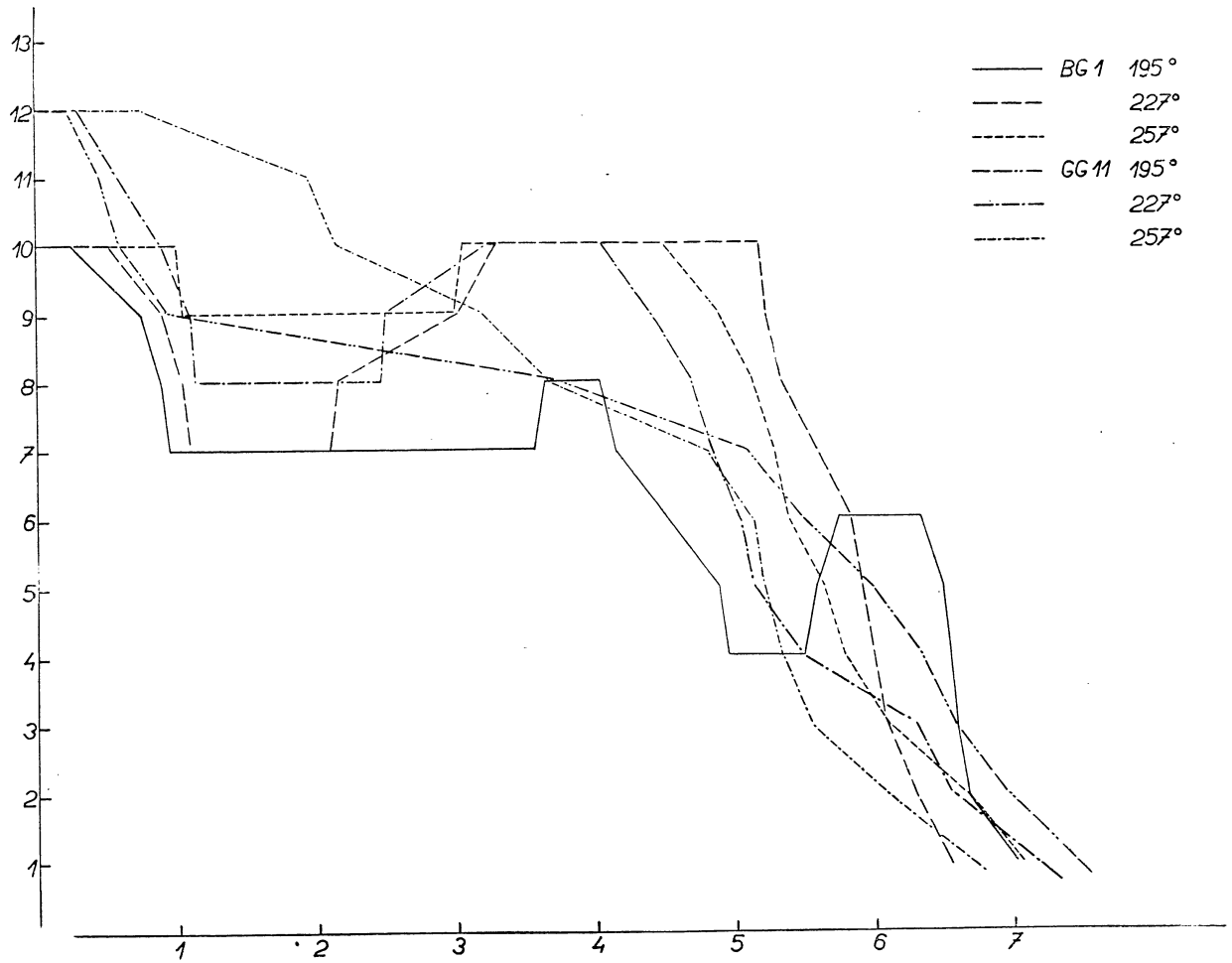


Figure 7.

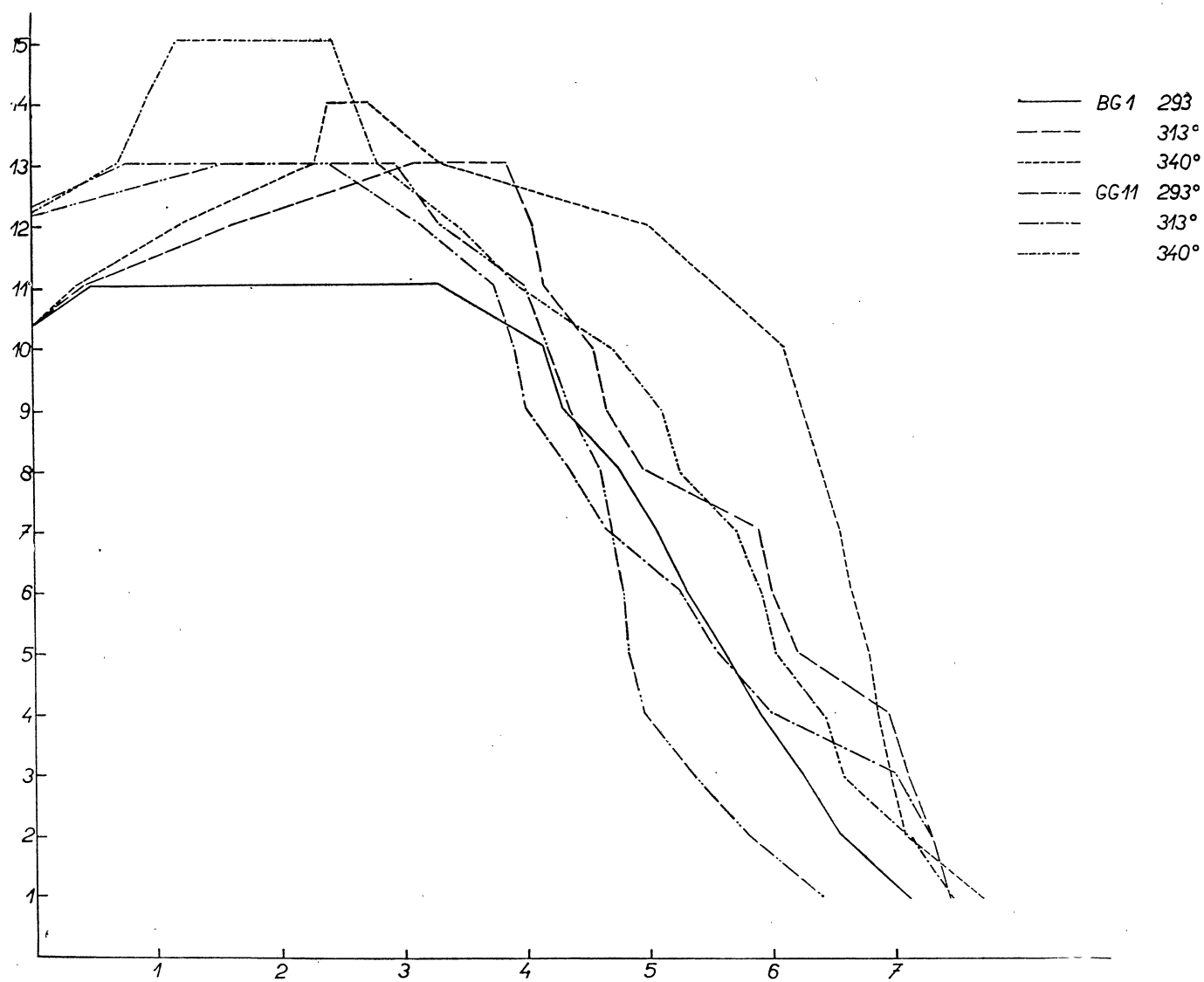


Figure 8.

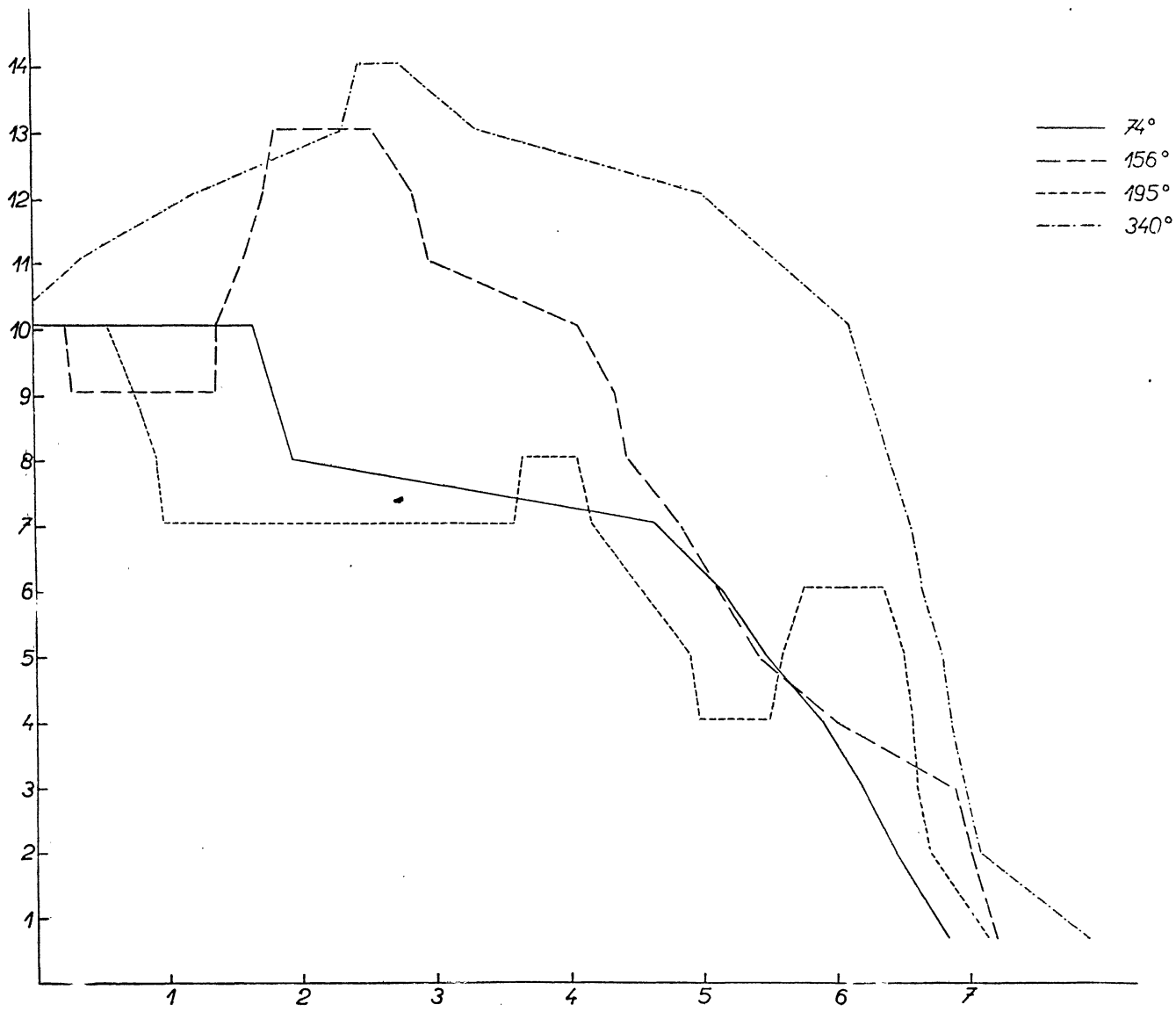


Figure 9.

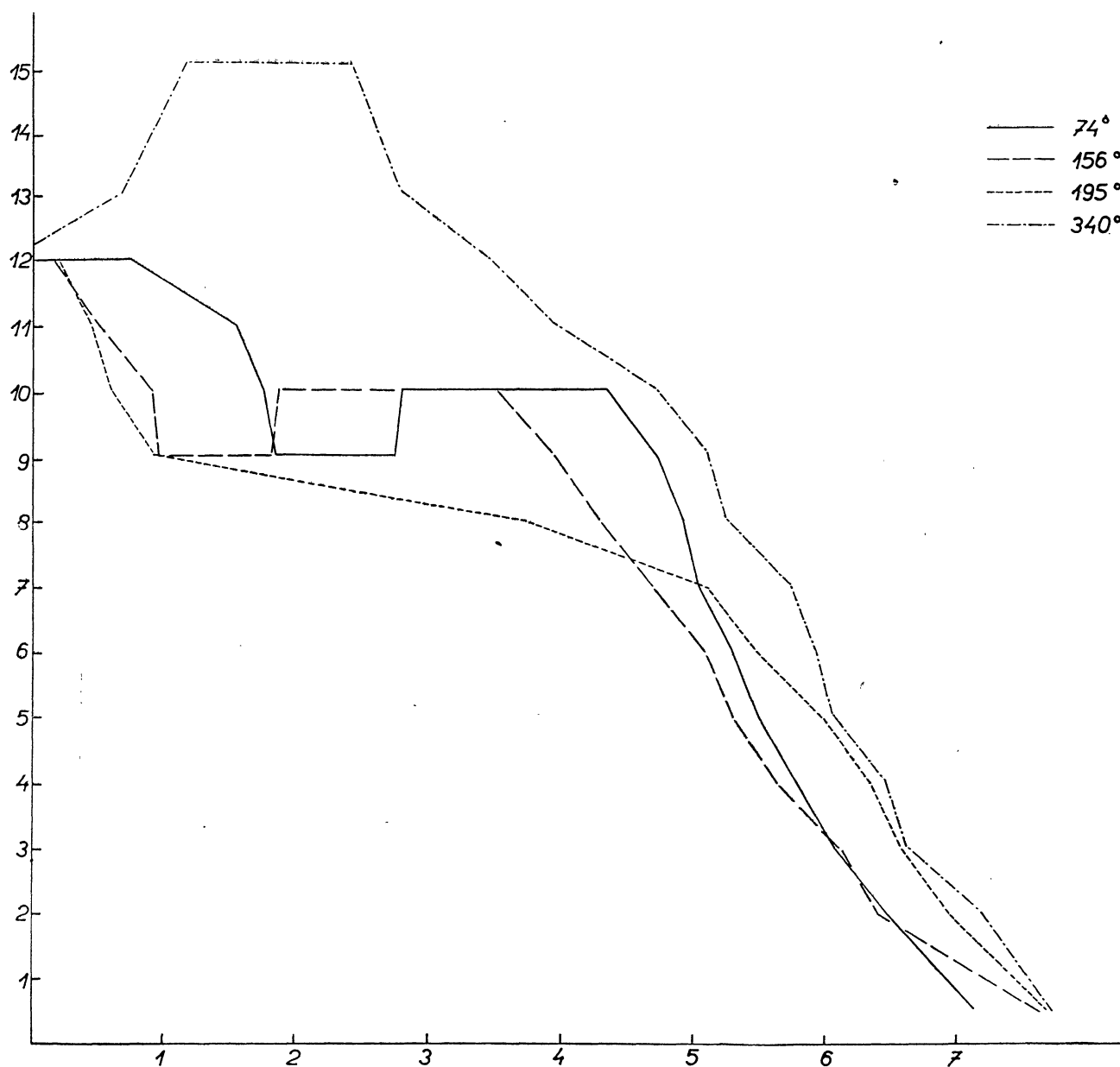


Figure 10.

REFERENCES

- [1] B. A. Voroncov-Veljaminov: *Gazovyje tumannosti i novyje zvezdy*, Moskva 1948.
- [2] H. Curtis: *Studies of the nebulae*. Publ. of the Lick Observatory Vol. XIII, 1918.
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- [4] L. Bermann: *Bulletin Lick Observatory* 18—57, 1937.
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МИКРОФОТОМЕТРИЧЕСКИЕ ИЗМЕРЕНИЯ NGC 3587

Работа приводит фотометрические измерения планетарной туманности NGC 3587 (M 97); эта туманность принадлежит к самым ярким объектам этого типа. Координаты этой туманности

$$AR_{1900} 11^h09^m00^s \text{ Decl}_{1900} + 55^\circ 35',7$$

размеры $199'' \times 203''$; расстояние 2290 парсек.

Микрофотометрические измерения мы сделали регистрирующим микрофотометром на пластинках, которые получили 60 см астрографом Астрономического обсерватория САН на Скальнате Плесе. Список пластинок приведен в

табл. 1. При получении негативов употреблялись светофильтры Шотта BG 1 и GG 11.

Изофоты туманности с помощью фильтра BG 1 приведены на рисунке 3 и изофоты с GG 11 на рисунке 4. Остальные рисунки представляют изофоты в различных углах направления (рис. 5, 6, 7 и 8). Наконец на рис. 9 приведено сравнение изофот в направлениях 74° , 156° , 340° в BG 1 и на рис. 10 изофоты в тех же направлениях в GG 11.

MIKROFOTOMETRICKÉ MERANIA NGC 3587

Práca prináša mikrofotometrické merania planétárnej hmloviny NGC 3587 (M 97 — Sovia hmlovina), ktorá prinálieži k najjasnejším objektom tohto druhu na oblohe. Jej ekvatoreálne súradnice sú

$$AR_{1900} 11^{\text{h}}09^{\text{m}}00^{\text{s}} \text{ Decl}_{1900} 55^{\circ}35',7$$

Rozmery hmloviny sú $199'' \times 203''$, vzdialenosť 2290 parsekov.

Mikrofotometrické merania boli urobené zo snímkov získaných na Astronomickom observatóriu

SAV na Skalnatom Plese. Zoznam použitých negatívov je uvedený v tab. 1. Pri expozíciách boli použité farebné filtre fy Schott BG 1 a GG 11.

Izofoty hmloviny, získané pomocou filtra BG 1, sú na obr. 3 a izofoty s filtrom GG 11 sú na obr. 4. Ostatné grafy znázorňujú izofoty v rozličných pozičných uhloch (graf. 5, 6, 7 a 8). Konečne graf 9 zachycuje vzájomné porovnanie jasnosti v pozičných uhloch 74° , 156° , 195° , 340° vo filtre BG 1 a graf 10 porovnanie jasnosti v týchže pozičných uhloch vo filtre GG 11.