

COUNT OF GALAXIES ON PA83

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1. Palomar Atlas Sky Survey (PA) is perfectly irreplaceable for the investigation of the surface density of galaxies. All attempts made so far show that galaxies to $+20^m$ can be counted on the PA. This superior limit is of an exceptional importance for the investigation as it is for groups of galaxies as well as for clusters and the superclusters of galaxies, for example [1, 2]. Besides this, the PA may be used for a morphological investigation of galaxies (the known atlas of Vorontsov-Velyaminov is based only on the study of galaxies in the PA [3]).

As it is known, the count of galaxies up to stellar magnitude limit lies in the basis of many questions and problems of the extra-galactic research. The important investigation of Zwicky and his collaborators [4] can not be considered under any circumstances as having exhausted all possibilities, offered by PA.

In the present paper the results of a count of galaxies on the print No 83 (PA 83) are given.

2. The center of PA 83 has equatorial coordinates

$$\alpha_{1950} = 16^h 04^m 17^s,$$

$$\delta_{1950} = +17^\circ 44' 28''$$

and galactic coordinates (second system) by [5]

$$l^{\text{II}} = 31^\circ, 56,$$

$$b^{\text{II}} = +44^\circ, 19.$$

The count of galaxies was made only on the red print, E, on which we observed considerably more galaxies than on the blue print, O. We used the plexiglass reseau anew, which had been used for the determination of the total photographic absorption [6, 7]. The reseau has $6' \times 6'$ sides. With the help of the cross-wire eyepiece each separate square was divided into four equal parts, $3' \times 3'$ or $1/400$ sq. degr. All counts were made on the squares $3' \times 3'$ by magnification $13\times$ by the authors independently one of the other and after that the counts were grouped by squares $6' \times 6'$. These

values (number of galaxies for 1/400 sq. degr.) were used for plotting of contour map (Fig. 1), where the counts are calculated for 1 sq. degr. Analogous maps are used by the well-known Lick counts of galaxies [8—11], which is leading directly from astrograph's plates to stellar magnitude limit

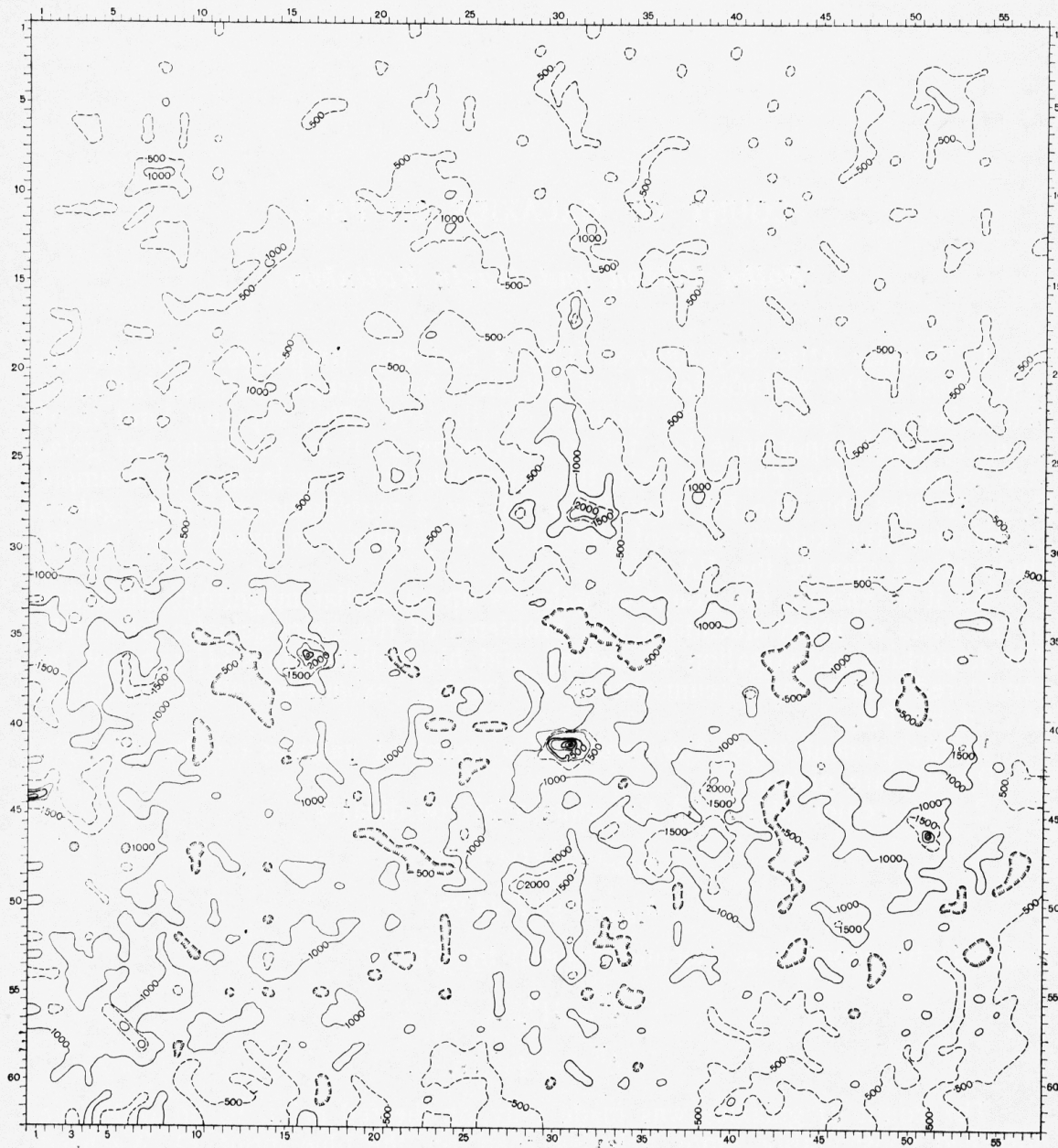


Fig. 1

of the order of $+18^m.4$. The authors have used running mean arithmetic values of four neighbouring surface densities, which constitute a square.

The contour map on Fig. 1 is plotted by the same method, but the scale is 10 times larger than the maps of Lick counts of galaxies,

Our contour map clearly shows the existence of groups of galaxies, clusters of galaxies, and groups of clusters also. The larger scale permits to investigate the structure in the surface density of galaxies in minute detail.

3. The errors of counts of galaxies are not well investigated, if we exclude the notes in [8—11], in spite of the fact that special attention has

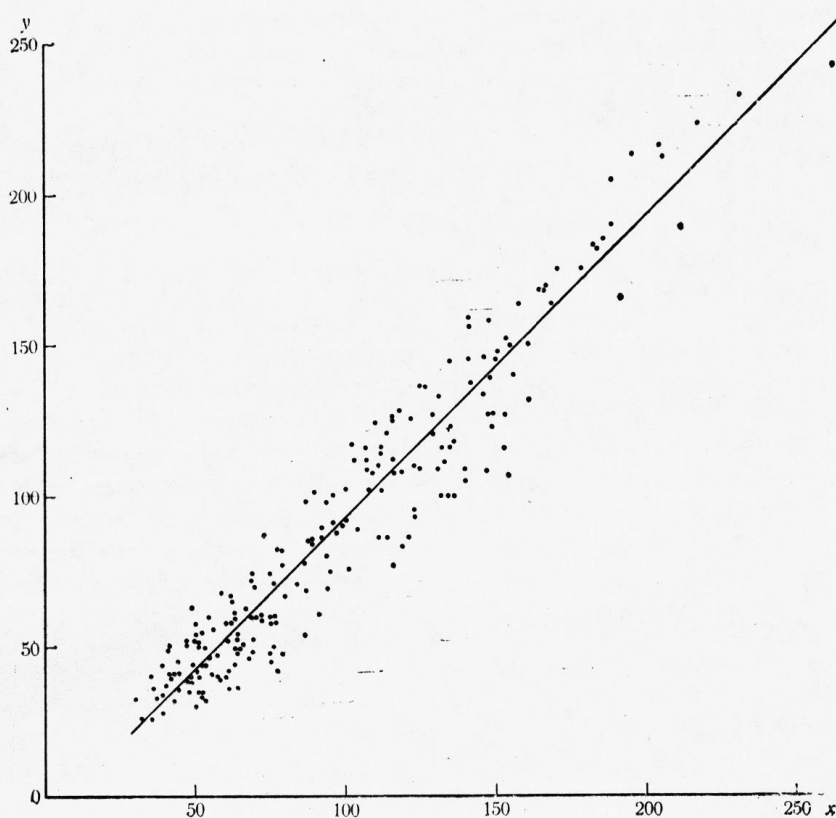


Fig. 2

been devoted to this question, for example [12—15]. We shall here mention that the errors in counts on prints of PA are of some other character, than those in direct plate counts. For example, a great part of the palest spots can be considered as belonging to groups of grains of photoemulsion, whose blackening is fluctuational.

In order to limit the errors in counts, we accepted the following criteria for selecting the galaxies:

- a) Objects, whose contours are not circles.
- b) Objects, which are diluted, with diffusive boundary parts.
- c) Objects, which are pale spots, but show certain peculiarities, typical for nonstellar objects.
- d) Objects, which are pale spots also, scarcely visible, but which are galaxies on O print (by blinking).

An additional criterion is the rejecting of all small spots, which are invisible by blinking on O print. However, this is the case, when the greatest error is made, as these objects may be galaxies. On the other hand, it

is clear, that a certain part of the counted galaxies are stars. Since these two errors have effects, acting in opposite directions, and we do not know which one is prevalent, there exists an uncertainty in the final result.

The number of galaxies to the 1 sq. degr. are plotted in Fig. 2. It has been attained from groups of 16 squares $6' \times 6'$ by the authors — Veleva (V)

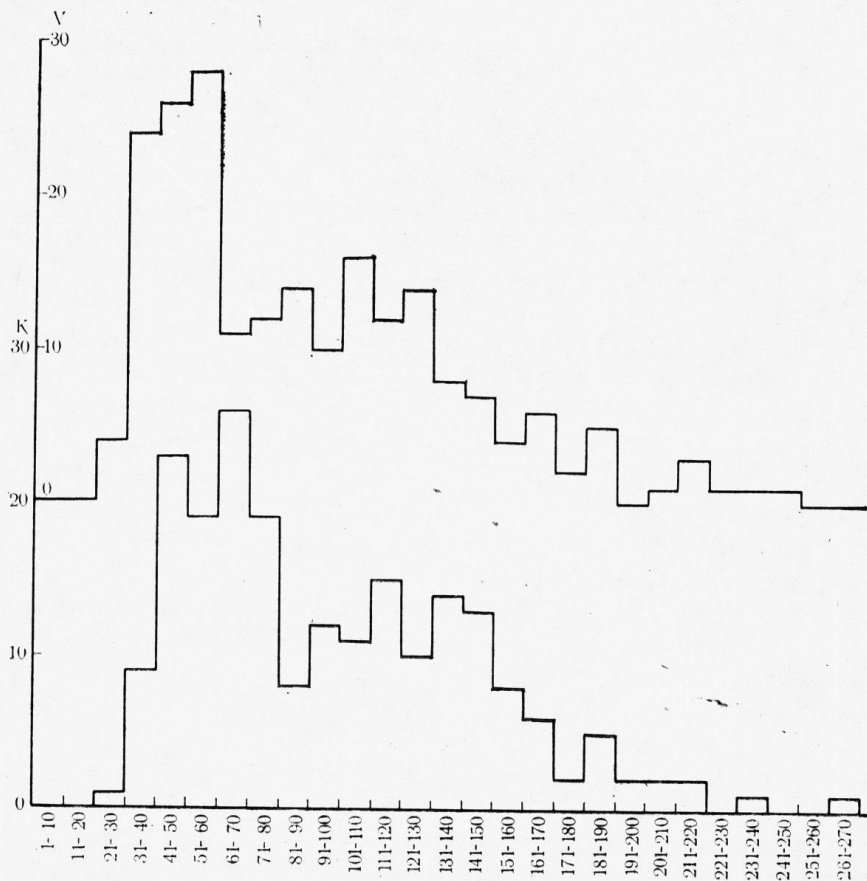


Fig. 3

and Kalinkov (K). The dependence between the values of the two observers is linear and the equalization by the method of least mean squares gives the straight line

$$y = -8.261 + 1.001 x,$$

where x are the values of K and y — of V, respectively.

The distributions of the various surface densities by counts of the two observers are plotted to Fig. 3.

4. The stellar magnitude limit up to which is carried out the count, may be determined by Hubble's relation

$$\lg N_m = 0.6 m - 9.12,$$

where N_m is the number of galaxies to sq. degr. [16]. The total area of our count embracing almost the whole print of PA 83, is 35.34 sq. degr. According to observers K and V the numbers of counting galaxies are 21,497

and 19,016 galaxies, respectively. Consequently, the average number of galaxies to sq. degr. $N_m = 573.05$, and then by Hubble we obtain the stellar magnitude limit of our count $\approx +19^m.8$. The error of this value is not larger than $\pm 0^m.1$, since for density 500 gal/sq. degr., $m = 19^m.7$, as for density 600 gal/sq. degr. $m = 19^m.8$. It may, therefore, be inferred, that the dispersion of the average number of galaxies for sq. degr. is approximately ± 20 galaxies. The above values refer to the number of galaxies and stellar magnitude limit, but under the condition that galactic absorption does not exist. If we use Hubble's relation

$$\lg N_{b,m} = \lg N_m - 0.6 \beta \operatorname{cosec} b$$

and for β we assume this value, which is the arithmetical mean from Hubble and oth., $\beta = 0.308$, then we obtain

$$\lg N_m = 3.023 \quad (N_m = 1055.3),$$

in which we must take into account a new correction — correction for the red shift, but for $+20^m$ this correction is negligible and moreover it depends on cosmological models.

5. The counts of galaxies on the print PA 83 permit to further establish, that there exist several dozens of groups of galaxies whose angle sizes do not exceed $8' - 10'$ and contain about 10—20 galaxies. It is impossible to establish whether there are fluctuations, or clusters of galaxies.

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REFERENCES

1. Abell G. O., *ApJ*, Suppl. **3**, 1958, 211.
2. Abell, G. O., *ApJ*, **66**, 1961, 607.
3. Воронцов-Вельяминов Б. А., Морфологический каталог галактики, I, II, III, Москва, 1961—1964.
4. Zwicky F., E. Herzog and P. Wild, Catalogue of Galaxies and Clusters of Galaxies. Vol. I, II, III, California, Institute of Technology, 1960—1965.
5. Rubin V. C., F. Martin and S. Y. McCarthy, *ApJ*, Suppl. **8**, 1963, 213.
6. Калинков М. и В. Добричев, *Известия на ФИ с АНБ*, **13**, 1965, 225.
7. Калинков М. и В. Добричев, *Известия на Секцията по астрономия при БАН*, **2**, 1967.
8. Shane C. D. and C. A. Wirtanen, *AI*, **59**, 1954, 285.
9. Shane C. D., *AI*, **61**, 1956, 292.
10. Shane C. D., C. A. Wirtanen and U. Steinlin, *AI*, **64**, 1959, 197.
11. Shane C. D., *Vistas in Astronomy*, Vol. 2, 2—NI, ed. by A. Beer, 1956, 1954.
12. Zwicky F., *Hand. Phys.*, **53**, 1959, 390.
13. Neyman J. and E. L. Scott, *Hand. Phys.*, **53**, 1959, 416.
14. Zwicky F., *Morphological Astronomy*, Berlin, Springer-Verlag, 1957.
15. Limber D. N., *ApJ*, **119**, 1954, 655.
16. Hubble E., *ApJ*, **79**, 1934, 139.

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ПОВЪРХНОСТНО РАЗПРЕДЕЛЕНИЕ НА НЯКОИ ГРУПИ ОТ ГАЛАКТИКИ

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(Резюме)

Върху копие от Паломарския атлас е проведено броене на галактиките до пределна звездна величина около $+19^m$. Преброяването е извършено независимо от двамата автори. Крайните резултати са представени като контурна карта на разглежданата област, на която са свързани точките с еднаква повърхностна плътност на галактиките. Графически е представена зависимостта между бройките, получени от двамата наблюдатели, която е изравнена по метода на най-малките квадрати.

ПОВЕРХНОСТНОЕ РАСПРЕДЕЛЕНИЕ НЕКОТОРЫХ ГРУПП ГАЛАКТИК

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(Резюме)

На копии Паломарского атласа произведен счет галактик до предельной звездной величины около $+19^m$. Счет велся независимо друг от друга обоими авторами. Крайние результаты представлены в виде контурной карты рассматриваемой области, на которой соединены точки с одинаковой поверхностной плотностью галактик. Графически представлена зависимость между числами, полученными обоими наблюдателями, которая уравнена методом наименьших квадратов.