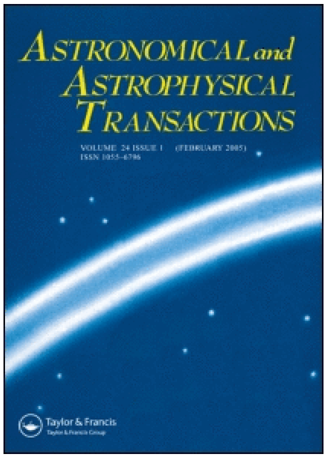

Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

Derived scale detecting on the angular distribution of radio sources from the RATAN-600 surveys analysis

M. G. Larionov [a]
[a] Sternberg Astronomical Institute, Moscow

Online Publication Date: 01 August 1999
To cite this Article: Larionov, M. G. (1999) 'Derived scale detecting on the angular distribution of radio sources from the RATAN-600 surveys analysis', Astronomical & Astrophysical Transactions, 18:1, 47 - 52
To link to this article: DOI: 10.1080/10556799908203033
URL: http://dx.doi.org/10.1080/10556799908203033

Astronomical and Astrophysical Transactions, 1999, Vol. 18, pp. 47–52
Reprints available directly from the publisher
Photocopying permitted by license only

DERIVED SCALE DETECTING ON THE ANGULAR DISTRIBUTION OF RADIO SOURCES FROM THE RATAN-600 SURVEYS ANALYSIS

M. G. LARIONOV

Sternberg Astronomical Institute, Moscow, 119899, Universitetskii prospect 13

(Received December 20, 1996)

Sources in the RATAN-600 deep and Z2 surveys have been investigated by the method of number counts per areas with different quantities of sources in them. Our previous data which detected the existence of a pronounced scale departure from a random distribution of sources in the sky on values near 0.5° were confirmed. The real distribution of sources is narrower than Poissonal. The local periodic supercluster – void structure of the Universe for the rich clusters and the regular structure manifests itself for our survey sources and allows us to connect the scale departure for radio sources with an angular period not far from 1° and the linear extent for the optical superclusters of galaxies is found to be 130 h^{-1} Mpc.

KEY WORDS Large-scale structure of universe, statistics, surveys

1 INTRODUCTION

The existence of a mosaic scale for the spatial inhomogeneity of the Universe has now been established. The largest scales of superclusters and voids reach about 150 h^{-1} Mpc. The optical data for rich clusters of galaxies show the presence of the characteristic scale (100–130) h^{-1} Mpc in the regularity of the supercluster – void network (Broadhurst *et al.*, 1990; Mo *et al.*, 1992; Einasto *et al.*, 1994).

Extragalactic radio sources are thought on the other hand to be associated with giant elliptical galaxies from rich clusters in a high-density environment. It may be possible to use them as "skeleton" indicators for the large-scale structure of the Universe (Shaver, 1991). The extensive lists of radio sources from search surveys gave the hope of detecting a visible departure from the Poisson source distribution through out the celestial sphere. The multi-year searches of distortions for sources, however, did not reveal this reliably. The spatial homogeneity on large scales is given as the result of the very broad luminosity function of radio sources and as a consequence of the presence of weak and strong objects in the ray line-of-sight, simultaneously. But the structure of the local supercluster has been confirmed by radio astronomical data (Shaver, 1991).

Besides reasons connected with the radio luminosity function of galaxies and quasars there may be circumstances where negative results came out: the poor statistical material that was used (Koleman and Saslow, 1990) and the insufficient depth of the surveys (Condon, 1988). Codiman, Burns and Klypin (1995) has detected differences from a Poisson distribution of the sources with angle sizes less than 2° at three standard deviations based on the angular correlation function in the 876B survey. However, the method used by Codiman *et al.* (1995) did not wark' effectively because of increasing statistical errors while the dimensions are small.

2 ANALYSIS

We have published, at the level of four standard deviations, the result of revealing the isolating scale $\sim 0.5^\circ$ departure from a Poisson distribution for the Z2-survey (Amirkhanyan *et al.*, 1989) sources (the limiting flux being about 50 mJy) by the method of a sample surface count with a different number of sources in them (Larionov, 1987). The different areas of the survey had the same characteristics of departure and there was evidences of the presence for regular structures in the source distribution. An equatorial deep survey to 20 mJy in the declination reange from 0° to -1° has been conducted in the last few years to confirm the result by using the more highly resolve configuration of RATAN-600. This survey removed some suspicion about the possible selection effect for the limited relation (~ 20) between the area of the minimal surface element and the square beam width, by analysing the Z2 list. We additionaly studied a strip of the Z2 survey so that the statistical conditions for both surveys would be equal. The selected region was located from 0° to $1^\circ 30'$ in declination for any right axension except the regions close to the Galactic plane.

The statistics of the number of areas with a different quantity of objects in them were submitted to a Poisson distribution and it determined the probability of an occurrence of some event for the random quantity.

$$p(m) = \frac{\alpha^m e^{-\alpha}}{m!} \tag{1}$$

where α is the average number of sources in the area of a certain dimension; and m is the number of sources in the area (the number of degrees of freedom). The method works with a maximum effect when α and m are not too large. This situation was realized in our investigation.

The check for a random distribution was made with the test

$$U = \sum_{i=0}^{m} \frac{(E_i - Np_i)^2}{Np_i} \tag{2}$$

where p_i are calculated by equation (1), but N is the general number of areas on the analysed zone survey.The statistics U obey by χ^2 distribution with $(m-1)$ degrees

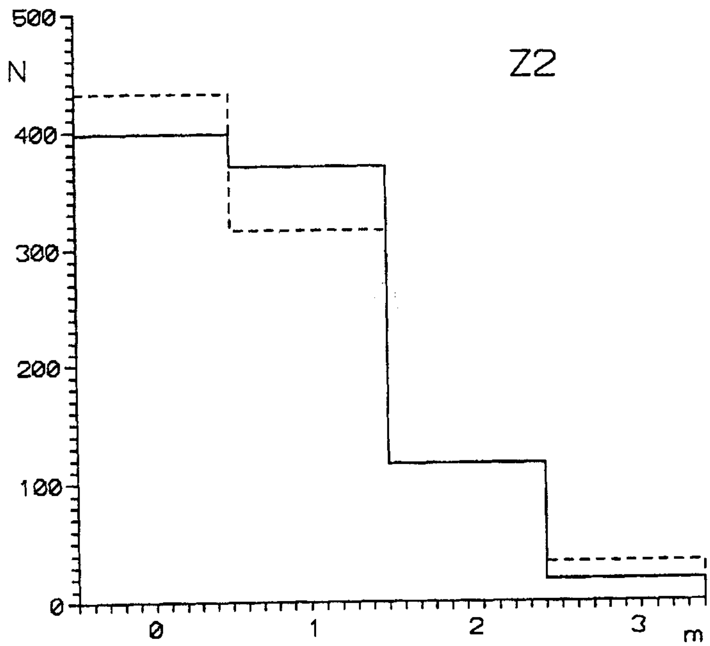

Figure 1 The area statistics for the Z2 survey.

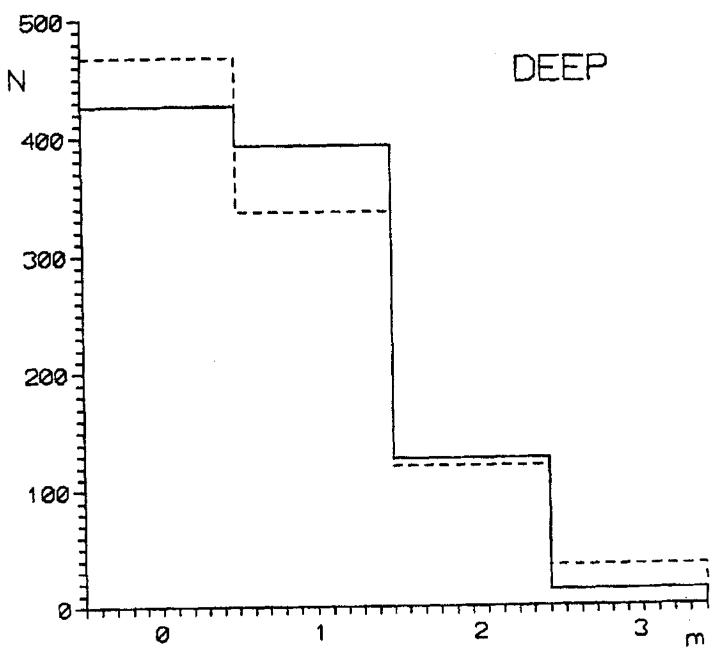

Figure 2 The area statistics for part of the deep survey.

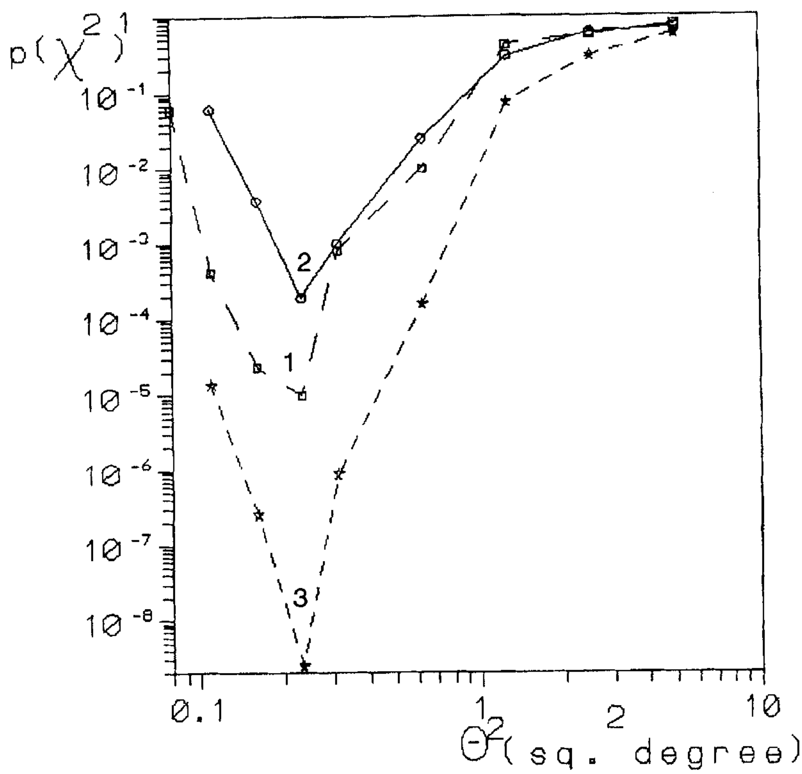

Figure 3 The probability of the random realization in the distribution of sources for the deep survey, the Z2 survey and for unified data of both surveys (curves 1, 2, 3 respectively).

of freedom for large N. The value of N was about 1000 in our case. The single parametrical distribution function is

$$f(\chi^2) = \frac{1}{2^{\nu/2}\Gamma\left(\frac{\nu}{2}\right)} \left(\chi^2\right)^{\frac{\nu}{2}-1} e^{-\frac{1}{2}\chi^2} \tag{3}$$

where $\nu = m - 1$ is the number independent degrees of freedom. This function enables us to determine the probability of the Poisson distribution

$$p(\chi)^2 = \int_{\chi^2}^{\infty} f(x)\, dx \tag{4}$$

where $f(x)$ is the distribution function of χ^2.

By this means the whole zone of the deep survey (α from 0° to $24^{\rm h}$ and δ from 0° to -1°) was divided into areas of dimension from 10 to 0.08 square degrees. A numbers of each sized area for different degrees of freedom have been calculated. The theoretical Poisson distribution was found by equation (1), where the density of the probability on one area was presented. For each sized square χ^2 was found by using equation (2) and the value of the random realization was calculated by integrating of equation (4). The hypothesis of a random distribution of sources through out the celestial sphere was adopted.

The area statistics for the part of Z2 survey and for the deep are plotted in Figures 1 and 2 according to the surface of 0.25 square degrees. The random distribution of objects in zone surveys is represented by dotted lines. The tendency for distortions of the Poisson distribution in two surveys is identical. There is a scarcity of areas that do not contain sources and areas with multiple structures. Besides this, there is an abundance (16–18)% of areas with one source in them. The real distribution is narrower than Poissonal. This may testify to the presence of quasiregular structures of sources. The probability of a random realization in the distribution of sources $p(\chi^2)$ is plotted in Figure 3 for the deep survey and the Z2 survey (for the declination range $0°$–$1°30'$) also with unified data for both surveys (curves 1, 2, 3 respectively). The sharp scale of departure $\sim 0.5°$ for both surveys may be the result of sources in supercluster galaxies with the linear extent a distance of 130 h^{-1} Mpc.

3 CONCLUSION

The analysis of the visible source distribution for the deep and the Z2 surveys have confirmed our previous data:

(1) there is a clear scale departure for the distribution of sources existing al. values near $0.5°$;

(2) the real data are represented by a narrower distribution than Poissonal;

(3) the behaviour of the departure from a Poisson distribution may indicate the existence of regular structures of sources with an angular period of about $1°$;

(4) the last circumstance and the periodic character for the superclaster–void structure of the Universe allow us to connect the angular scale deflection $1°$ for radio sources with the linear extent for optical superclasters of galaxies of 130 h^{-1} Mpc for further astrophysical investigations.

References

Amirkhanyan, V. R., Gorshkov, A. G., and Larionov, M. G. (1989) Moscow State University, sep., issue.

Cooiman, B. L., Burns, J. O., and Klypin, A. A. (1995) *Astrophys. J.* **448**, 500.

Condon, J. J. (1988) In: G. L. Werschuur and K. I. Kellermann (eds.), *Galactic and Exstragalactic Radio Astronomy*, Berlin, Springer, 641.

Broadhurst, T. J., Ellis, R. S., Koo, D. C., and Szalay, A. S. (1990) *Nature* **343**, 726.

Einasto, M., Einasto, J., Tago, E., *et al.* (1994) *Mon. Not. Roy. Astron. Soc.* **269**, 1.

Koleman, P. H. and Saslow, W. C. (1990) *Astrophys. J.* **353**, 354.

Komberg, B. V., Kravtsov, A. V., and Lukash, V. N. (1996) *Mon. Not. Roy. Astron. Soc.* **282**, 713.

Larionov, M. G. (1987) Tallinn, XIX All-Union radio astronomy conference **10**.

Larionov, M. G., Parijskij, Yu. N., and Zhuravlev, V. I. (1994) *Astron. Astrophys. Suppl. Ser.* **106**, 119.

Mo, H. J., Deng, Z. G., Xia, X, Y., *et al.* (1992) *Astron. Astrophys. J.* **257**, 1.

Shaver, P. A. (1991) *Austral. J. Phys.* **44**, 759.