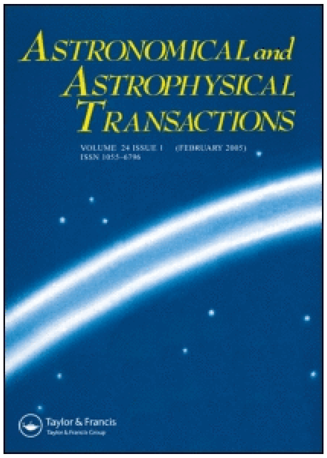

Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

Statistical characteristics of radio sources connected with high latitude galactic population of objects

M. G. Larionov [a]; V. N. Sidorenkov [a]; L. N. Larionova [a]; L. S. Ugol'kova [a]
[a] Sternberg Astronomical Institute, Moscow

Online Publication Date: 01 August 1999
To cite this Article: Larionov, M. G., Sidorenkov, V. N., Larionova, L. N. and Ugol'kova, L. S. (1999) 'Statistical characteristics of radio sources connected with high latitude galactic population of objects', Astronomical & Astrophysical Transactions, 18:1, 53 - 59
To link to this article: DOI: 10.1080/10556799908203034
URL: http://dx.doi.org/10.1080/10556799908203034

Astronomical and Astrophysical Transactions, 1999, Vol. 18, pp. 53–59
Reprints available directly from the publisher
Photocopying permitted by license only

STATISTICAL CHARACTERISTICS OF RADIO SOURCES CONNECTED WITH HIGH LATITUDE GALACTIC POPULATION OF OBJECTS

M. G. LARIONOV, V. N. SIDORENKOV, L. N. LARIONOVA, and L. S. UGOL'KOVA

Sternberg Astronomical Institute, Moscow, 119899, Universitetskii prospect 13

(Received July 10, 1997)

An investigation of the average spectral characteristics for the source sample of the Ohio survey, connected with the fine structures of the galactic high latitude background, has been carried out. This investigation was based on the RATAN-600 observations at 3.9 GHz and data was in the frequency range from 0.3 GHz to 5 GHz. Observed values of the fluxes at centimetre wavelengths turned out be lower than expected. This may indicate indirectly high-frequency variability on outburst-like type of objects. Other reasons for the contradictions are also examined. The possible nature of the objects is discussed in terms of galactic membership for the part of the sample.

KEY WORDS Galaxy-sources

1 INTRODUCTION

Large-scale formations are known to exist at high galactic latitudes and are named "loops". This follows from continuum radiation surveys at different frequencies over a wide range. The brightest regions of "Loop I" is called the North Polar Spur (NPS). Large-scale structure in the form of small circles on celestial sphere have a fine scale shape which consist of narrow ($< 1^\circ$) extended "ridges" of radiation and abrupt drops (steps). Steep gradients of brightness temperatures exist at the outer site of the loops. Many of these were not resolved with the $20'$ beam width at low frequency (Holden, 1969).

Correlation of high hydrogen enhanced formations in ultra-compact "clouds" which have a turbulent structure was pointed out. The relation between increasing hydrogen concentration with high velocity dispersion and position of step thermal gradients of distributed radiation was established (Vershuar, 1970; Berkhuijsen *et al.*, 1970). It was pointed out that these phenomenon were closely connected to each other. These formations are a result of interaction between non-thermal electrons and magnetic fields, stretching out from certain regions of the galactic plane, with their environment. In other words, we are observing a situation where cosmic rays, while there are moving along magnetic fields, can push out an interstellar gas up to higher galactic latitudes (Parker, 1970). The symmetry of the loops relative to the plane of the Galaxy and the estimation of the distance to these galactic formations indicate that we are observing the closest (20–200 pc) galactic objects (Lozinskaja, 1964).

The visible distribution sources analyzed in the sky using the surveys, conducted at low frequencies (to 1.5 GHz), revealed the excess of high-latitude extended radio sources (on a scale of about squares degree). This may indicate the multicomponent structure of these formations (Miln and Scheuer, 1964). In addition Ehman *et al.* (1970) found for the Ohio survey a large number of extended details with growing NPS concentration. Detailed investigations of the Ohio list of sources at 430 MHz with the enhancement in Arecibo has shown that part of the radio sources ($\sim$ 30%) have a tendency to form complex structures at an angular scale about one square degree (Stull, 1973).

We showed (Larionov, 1975) that a certain portion of the radio sources in the surveys can be connected with the fine shaped formations of the background radiation. Under this conclusion there are in high galactic latitudes, a population of galactic sources. These sources gave a possible sharp ($\sim$ 0.5) (Larionov, 1975) decrease of the temperature spectral index $\beta(T_b \sim \nu^{-\beta})$ for the brightness temperature of the background radiation; this was pointed out by Berkhuijsen (1971) based on the analysis of the background survey. This behaviour of β may be a consequence of hitting the radio sources with flat spectra in the telescope beam. The developing investigation of a possible connection between certain discrete sources from the radio survey and the fine structured detail of the background radiation has been done by us (Larionov and Sidorenkov, 1978). It was established that 7% of the Ohio radio sources with fluxes from 0.4 Jy to 1 Jy may belong to the galactic source population. For the sources with low values of the spectral indexes ($\alpha < 0.5$) this part has grown. Two possible mechanisms of emission – thermal and synchrotron radiation of disk accretion on to a "black hole" – were pointed out concerning the nature of the objects. The low rate of energy emission is the reason for the lowest requirements to the exciting star source or of the mass of the "black hole".

The purpose of this work consisted in the further study of galactic population objects and the gathering of additional information about spectral characteristics, time flux variations and optical identification of the sample radio sources, supposedly belonging to the population of high latitude galactic radio sources.

One has to take into account that the galactic source population effect was important for the counting of radio sources in cosmological applications.

2 CALCULATION AND RESULTS

In our investigations we used the part of the source sample provided by Stull (1973) from the Ohio survey in the declination rage 0–20°. Objects of the sample have a flux density in the rage of (0.4–1) Jy and had not been seen in the low-frequency survey below 1.4 GHz, at the survey epoch, but as a consequence they have low values of the spectral indexes α. The sources (50 objects from the first list, Stull, 1973) were found in zones of the high latitude formations "Loop I, Loop II" and they correlated with ridges of "loops" already established by us (Larionov, 1975). About 40% of the sources of the sample were found to be connected with the fine structures of the background radiation. It was suggested that analyses of the spectral characteristics, and flux variables of the sample, would let us confirm the hypothesis of their galactic localization on the basis of their parameter differences from extra-galactic sources.

We used the ideology of two or more surveys of sources at the same frequencies. If these conditions were not satisfied, we used data at close frequencies. The names of all the surveys used in this work and their characteristics are shown in Table 1. In addition to this material two observational sets at 3.9 GHz on RATAN-600 were done in 1989 and 1991. Because of source weakness, there are no additional frequencies for the radio telescope RATAN-600.

Table 1. Characteristics of all surveys and observations, used in this work

Arecib	*Texas*	*Molonglo*	*Ohio*	*Z2*	*Re-observ.*	*87GB*	*MG(I-III)*	*GB1.4*
f 430	365	408	1415	3900	3900	5000	5000	1400
S 100	250	700	250	40	25	25	40–60	150

The observations were made using the North sector RATAN-600 at the meridian with the standard SAO devices. The data reduction was done in the standard regime. Each source was observed about three time for improvement of the reliability of the data.

In order to find the spectral parameters we calculated the mean magnitudes α for sources of the sample α (365–430) MHz, α (430–1415) MHz, α (1415–3900) MHz and α (3900–5000) MHz. The average spectral indexes is shown in Table 2 together with the frequency intervals where they were determined. The mean spectrum on the basis of the denumerable data are shown in Figure 1. The spectra in the low frequency and the high frequency range obviously contradict each other. The extrapolation of the data spectrum at 1415 MHz (dotted lines in the figure) give a flux value difference of about 5 times the experimental ones and this needs to be explained.

The average values of the fluxes at high frequencies turned out to be considerably lower than those assumed in low-frequency data observations. This is possible when

Table 2. The average spectral indexes of the sample

Δf *(MHz)*	*365–430*	*430–1415*	*1415–3900*	*3900–5000*
α (MHz)	0.03	0.02	1.61	0.21
$\pm\Delta\alpha$	0.35	0.10	0.12	0.40

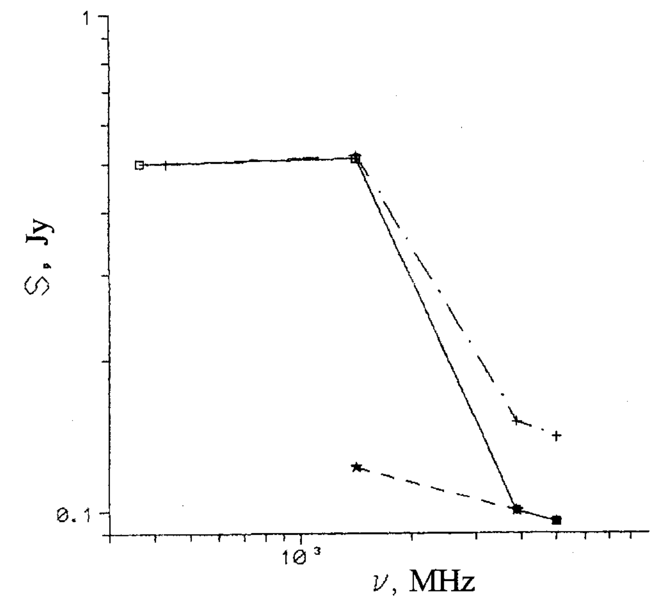

Figure 1 The average spectral characteristics for the sources of the sample.

the index of variability $(S_{max} - S_{min})/S_{min}$ at centimetre wavelengths is much higher than that at decimetre and metre wavelengths. This situation may be realized when the amplitude of variability $(S_{max} - S_{min})$ is increased to lower frequencies. It is surprising that the fluxes are changing by up to 5 times. This value is not typical for the variability of extragalactic radio sources as an average magnitude. We studied information about sources in the Z2, 87GB, and MGI–MGIII catalogues with data for those in the two observational sets at 3900 MHz for clarifying the situation of the flux change range at centimetre wavelengths.

Two sources were not found at centimetre wavelengths. The fluxes at the 5 standard deviations level was lower than 20 mJy, although these had been about 0.5 Jy at 1415 MHz earlier. These sources had still been visible at least once in the low-frequency surveys. The source fluxes were lower than the extrapolating data by nearly 20 times. One of them had a flux at 365 MHz of about 1 Jy. Three sources of the sample, which already consisted of 10% of the general observable quantity, are characterized by the same flux variability. It is necessary for 40% of the sources to have about 8 times the change of flux on basis of an explanation of the spectral behaviour. This percentage is in agreement with the estimation of the composition for the sources of the sample and correlates with the fine structure of the galactic background. Only about 30% of sources satisfied the values $\alpha_{(1415-5000)} \leq 1$ (dotted-broken line in the figure).

The variability investigation of individual objects at 3.9 GHz gave the following results. 20% of sources had an amplitude of flux variation of no more than two times at an interval of a few years. Each third source has a constant flux in the limits of the errors. The othes are changing by about two times. The change of flux at 5 GHz was analysed, which led us to the following conclusions.

(1) The variable can be explained on the assumption that sources are in conditions of increasing fluxes in a very short period of time and they are then not registered by re-observations.

(2) The real values of the fluxes of objects at decimetre wavelengths was lower than estimated, and there are distortions by the sharp gradient of the background radiation with the low spectral index in the beam of the radio telescopes that which contribute at decimetre wave lengths relatively more than at metre wavelengths. Objections against such explanations is the difference between beams sizes of the radio telescopes used but the basic agreement of fluxes in the Arecibo, Molonglo and Texas surveys at the very nearest frequencies.

(3) The GB survey at 1.4 GHz indicates an average lower flux for our sample of sources in comparison to the Ohio data. Near 25% of the objects of our sample were not visible in the GB 1.4 GHz list and it is not possible to compare the data of both surveys.

(4) There exist compact complexes of sources, connected with galactic structures blending at low frequencies and making fluxes higher. The large number of blending sources of about 35% was reported by Stull (1978) on his analyses of a sample of Ohio sources. The existence of more compact groups of sources can explain the visible picture. Our observations of the sample at 3.9 GHz revealed examples of such a group. Additional investigations and experiments are necessary to resolve this problem.

The optical identification of these objects together with the radio observations have been made using the data bank and plates (for weak objects) of the Palomar sky survey. The exact coordinates have been taken from the Texas survey at 365 MHz with a positional accuracy of better than one second of are. About 30% of the sources have been identified with an optical counterpart in the range of 5″. That was some lower than these at this frequency, but with higher fluxes. The identifications were made using red Palomar plates. This result is not confirmed but is not rejected by the galactic nature of a considerable number of the sources in the sample.

3 THE NATURE OF THE INVESTIGATES SOURCES

There is a large number of astrophysical objects in our Galaxy showing a mass loss with velocity of outflow from hundreds to thousands km/sec. In the last case are relativistic objects like SS433. The such sources is not possible spreading through the Galaxy disk on mass. Compact binary systems, where the phenomenon of instability is less pronounced, may be located at distances of hundreds of parsecs from us in the vicinity of our solar system. Stars on the pre-main sequence, like T Tau, is the other type of object, where matter is flowing out with high velocity. This list would be complemented with recurrent novae stars.

The brightest representative of flaring binary systems in the radio range is the object HR 1099 (V7II Tau); the radio flux from this object is changing by dozens of times. It was established that the nature of this sources is not thermal. The bipolar structure of flowing matter is observed in numerous objects like T Tau which lead to an interaction with their environment and the forming of sweeping gas clouds in the presence of magnetic fields. The dynamics of the system is usually such that the energy of outbursts may exceed the bolometric luminosity of the star. Some stars of the Orion population, such as Ae, Be, T Tau, show clear signs of matter accretion which may indicate the complex character of the matter interacting inside the system. The existence of an accretion disk in binary systems and the strong angular momentum may be due to the energy sources for bipolar ejections and as a result radiation in the radio and other ranges.

Assuming the local nature of the sources, the observable fluxes cannot have very high luminosity; the estimations give $L = 10^{29}$ erg/sec. This luminosity furnishes the thermal cloud with the size of 5–10 are seconds, $M = 5 \times 10^{-4} M_{\odot}$ and $n_e = 10^3$ cm^{-3}. Such a cloud, for example, of the T Tau type, formed for 10 years, as mass losses reached $5 \times 10^{-5} M_{\odot}$ per year.

If one takes into account an all types of galactic variable objects and the spreading of binary systems it is possible to consider an identical mode of operation for the "central engine". We observed accretion on the disk, which "replenishes" the energy sources for bursts of fast rotating compact objects. The magnetic field plays the role of a valve for energy accumulation; the variety configurations of companions rotating around each other is the escapement mechanism of flares.

4 CONCLUSIONS

The investigation of average spectral and time variability characteristics for a sample of sources from the Ohio survey gave the following results.

(1) The values of radio fluxes at the high frequency part of the spectrum turned out considerably lower than expected from low frequency data.

(2) As sequences of this situation the extrapolated data spectrum at the middle frequency 1425 MHz between the low and high part of the frequency range gave results that differ for each other by about five times.

(3) For an explanation of this effect one needs to suppose a very wide spread range of types of sources of the sample.

(4) The other explanations lay in the region of observational and selection effects.

(5) The optical identification of the sample gives a lower percentage than expected from the data which was obtained previously at higher fluxes.

References

Berkhuijsen, E. (1971) *Astron. Astrphys.* **14**, 1.
Berkhuijsen, E., Haslam, M., and Salter, C. (1970) *Nature* **225**, 364.
Ehman, J. *et al.* (1970) *Astron. J.* **75**, 351.
Holden, D. (1969) *Mon. Not. R. Astron. Soc.* **145**, 67.
Larionov, M. G. (1975) *Astron. Tsirk.*, No. 884, 1.
Larionov, M. G. and Sidorenkov, V. N. (1978) *Astron. J. Rus.* **55**, No. 2, 299.
Lozinskja, T. A. (1964) *Astron. Tsirk.*, No. 299.
Miln, D. and Scheuer, P. (1964) *Austr. J. Phys.* **17**, 106.
Parker, E. (1970) *Cosmical Gas Dynamics I.A.U. Symp.*, p. 393.
Stull, M. (1973) *Astron. J.* **78**, 285.
Vershuar, G. (1970) *Astrophys. J.* **6**, 215.