SPURS SYSTEM

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ABSTRACT. The system of nearby radioloops (spurs) is the screen to the remote objects and, perhaps, it distorts the real sky picture. But it is not due to the light absorption. Vise versa, the spurs system makes the objects brighter. Perhaps, it is the main reason for the fact that the majority of different scale objects, such as supernova, bright parts of Galactic spiral arms, main filaments of Local supergalaxy, etc are observed particularly through the spurs shells. Besides, the density of spiral structure' indicators, such as supergiants, Cepheids, and OB-associations, observed through the spurs, exceeds twice and more the same one in the neighbouring Milky Way regions. These facts can be explained either by making the objects brighter by spurs system, or by the existence of matter of higher density, contacting to spurs belts, or their combination.

Key words: Spurs, Radioloops, foreground, supernova, Local system, distribution

Radio Loops were discovered in the middle of 20th century. They are famous by strong radiation in radio continuum at different frequencies, in HI, in X-Rays, γ-radiation There is strong synchrotron radiation, strong magnetic field and polarization in spurs region (Page et al, [1]). Radio Loops are also interesting by their position: large angular dimensions and small distances (~>100 pc), spherical shape and large masses- 10^5 - 10^6 $M_{\odot}$ and other peculiarities.

More than a half of the sky is observed through these shells. The spurs region is considered transparent enough and they did not attract attention as the matter, rather distorting the real sky picture. We'll show, that Radio Loops take part in the formation of observed sky picture.

We have analyzed the influence of this foreground on the distribution of the different scale objects. And if the nearby and remote objects have the same peculiarities in their distribution, it means, that the observed picture is formed by the foreground.

We have analyzed a lot of objects of different scales:

- ✓ Stellar density –
  - the Supernova (SN Galactic extragalactic SNR)
  - the supergiants
  - the OB-associations
  - the Cepheids
- ✓ The supercluster of galaxies
- ✓ Local group of galaxies
- ✓ Light absorption

1. Supernova

1.1. Galactic Supernova

There were 12 very bright Supernova bursts from the beginning of our era. Their coordinates (l, b) and angular distances Δ from the nearest shell are given in Table 1. The angles Δ are obtained from

$$\Delta=\rho-\rho_s; \quad \cos\rho=\sin b \sin b_s + \cos b \cos b_s \cos(l-l_s) \qquad (1)$$

where ρ – the angular distance from the centre of s- spur, having coordinates (l_s, b_s) and ρ_s - the spur radius.

Table 1. Historical supernova, their coordinates (l, b) and angular distances Δ from the nearest shell

SN: year, name		l	b	Radioloop (s)	|Δ|(°)
1604	Kepler	4,5	6,8	I	
1408	CTB80	69	2,7	II, shell	0,3
1667	CasA	111,7	-2,1	(II, III)	3,0
902	CTA1	119,5	10,2	II, shell	1,1
1572	Tycho	120,1	1,4	(II, III)	2,7
369		129	-6	(II, III)	1,0
1181	3C58	130,7	3,1	II, shell	0,5
668	*	160	5,0	III, shell	4
		(156,2)	(5,7)		(0,5)
396		173	-22,0	V,VI;Eri,shell	
1054	Crab	184,6	-5,8	Ori-Eri	3
185	RCW86	315,4	-2,3	I	
1006		327,6	14,6	I,nucleus	3,2

The distance from the Loop I centre is $\Delta\equiv\Delta_c$ for SN1006. The Crab and SN396 are observed at the border of Orion-Eridan complex or at recently discovered loops V and VI [2].

The calculated Δ, Δ_p and Δ_c, between the share of degree and several degrees, are in the limits of the accuracy of parameters in table 2, or the shells thickness, having the same order.

It means that all 12 historical SN are observed through the spurs, through their shells, on the whole.

Table 2 shows the centre coordinates and the diameters of Radio loops over Berkhuijsen [3] and Heiles [4]. s is the number of spur in Roman numerals or the name. Number (II, III) in table 1 means, that the star is observed through the Lens, formed by the intersection of shells II and III, which have the mean plane along the Gould Belt (GB). The stars, having (II, III) $\Delta\equiv\Delta_p$ compared to p – the distance from GB, where

$$\sin p = \sin b \cos b^* - \cos b \sin b^* \sin (l-l^*) \qquad (2)$$

and parameters l* = 296°, b* = 21° over [5].

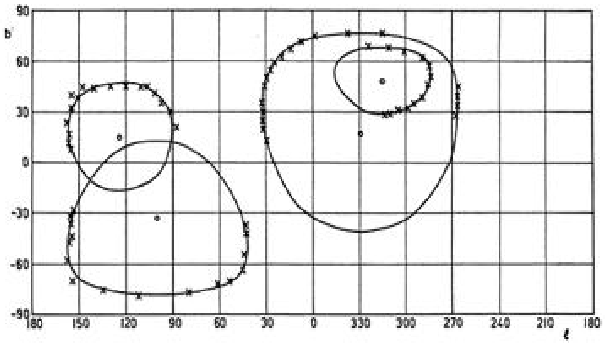

Fig. 1: The spurs, obtained theoretically from the equation (3)

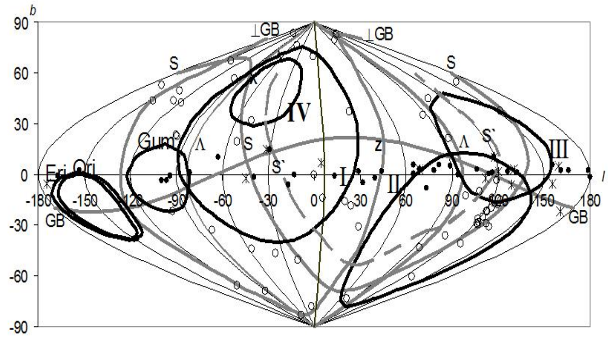

Fig. 2: Galactic SNR [7] and spurs, n=33(>1°)
l=207°-260° n=0

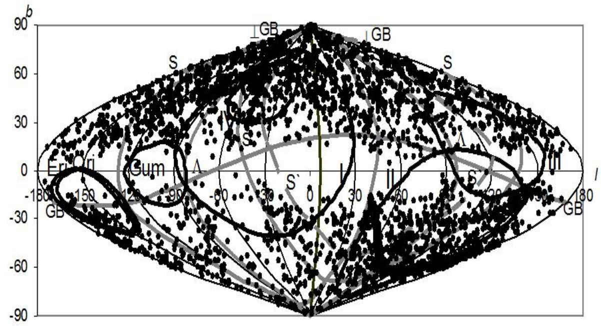

Fig. 3: SNR (out of Galaxy) [8] and spurs

Table 2. The centre coordinates and the diameters of Radio loops.

Spur	l_s	b_s	ρ_s
I	329°±1,5°	17,°5±3°	116°±4°
II	100°±2°	-32,°5±3°	91°±4°
III	124°±2°	15,°5±3°	65°±3°
IV	315°±3°	48,°5±1°	40°±2°
Ori-Eri	205°-209°	-19°	40°

The same results, presented in (Fig.1), we had obtained in [6] theoretically from the equation.

$$\rho_i = 2\pi/\kappa_i \quad \kappa_i – 3, 4, 6, 9, 10; \text{ multiple to } 3 \qquad (3)$$

1.2. Supernova remnants

The list of these observed young SN can be enlarged by the old supernova remnants (SNR). The most large SNR (>1°, n=33) over Green catalogue [7] are presented at Fig.2. Only 3 of them are situated between the spurs, and 3 more are situated on Loops V and IV, recently discovered [2]. Hundreds of SNR over whole catalogue [7] give the same picture – the absence of SNR between *l*= 207° and 260°, that is between Eri-Ori and Gum Neb complexes. There are about 20 SNR between Loops I and II, that is over Loops V and VI [2].

1.3. Extragalactic Supernova

All SN and SNR are located on the small latitudes *b* and can't show the correlation with the spurs, stretched to b≈±78°. Thousands of extragalactic Supernovas from several catalogues can be used, for instance, from [8], to present the map in the galactic coordinates together with spurs (Fig.3). There is almost empty wide zone at |b|<10 – 15° (the known zone of avoidance of galaxies and SN in them). The densest zone passes along the celestial equator, which shows the selection: SNs were searched more often here, than in other regions.

The next on density is zone S, passing through the spur centres I – IV especially visible at Loop IV, the southern part of Loop I, the middle part of Loop II and between the Loops. The Loop IV is only one of all, located completely out of zone of avoidance, and it is well outlined by dense SN groups. Along the borders of other Loops one can also see a lot of dense SN groups. And there are many arcs, consisting of SN, and there are many candidates to the shell structures, over Hu [9] and Heiles [10] lists. These arcs may be used to check these candidates. But also here may be random arcs and selection.

So, the real and visible effects are interlaced in this map, and it is difficult to separate them. But many elements of the map can be attributed to the foreground, connected to the spur system, and in the predicted places.

2. The indicators of spiral arms

We also analyzed different indicators of spiral arms, among them there were 669 supergiants, 78 OB–associations over Humphreys [11, 12], and 270 Cepheids, over Melnic et al map [13]. The histograms of their distributions are given in Fig.4. The longitude intervals tangential to the Loops I, II, III are marked at x-axis.

All three groups of objects show large jump in density distribution at the border of loops, which show the correlation with spurs. It can be explained either by the higher density of these different objects, or by making objects brighter in the spurs regions, or by their combination.

If the contrast in density is attributed entirely to the process of making objects brighter, one can determine its value Δm. In conditions of homogeneous environment Δm means the exceeding of the process of making objects brighter Δm_1 over the light absorption $A_v r$

$$\Delta m = \Delta m_1 – A_v r \qquad (4)$$

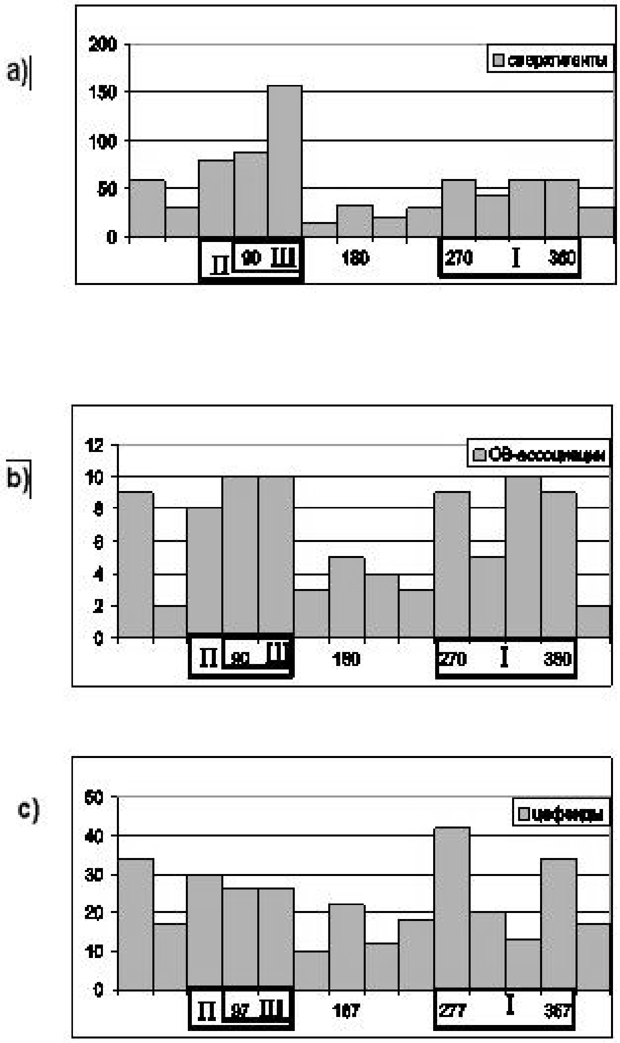

Fig. 4: The distribution of the objects number on longitude l

a) supergiants (669)
b) OB-associations (78) [11,12],
c) the Cepheids (270) [13]

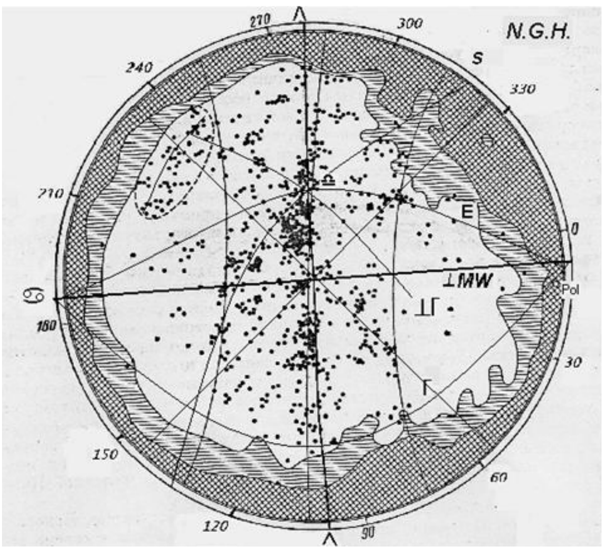

Fig. 5: Virgo supergalaxy [15] (NGH)

The more remote objects from the larger volume of radius r ($\sim r^3$) are as if displacing to the nearer volume of radius r_1 ($\sim r_1^3$) due to the process of making objects brighter and become visually nearer. The observed density increases in comparison to the real density in the same nearby (out of spur) volume ($\sim r_1^3$). The object (stars) numbers n(r) and $n_1(r_1)$ have the same sense.

On the one hand, for the identical absolute magnitudes

$$\Delta m = 5 \lg (r/r_1) \quad (5)$$

On another hand – $$\lg (n_1/n) = 3 \lg (r/r_1) \quad (6)$$

Excluding $\lg (r/r_1)$, we have

$$\Delta m = 5/3 \lg (n_1/n) \quad (7)$$

We determine $n_1/n \sim> 2$ for the spurs borders, using the histograms on fig.4. Only one case, for supergiants, gives the ratio about 11. There are shells of two loops (II and III) here at the same l, but having opposite sign of b, in projection to the Galactic plane. So, it can be attributed only a half to each loop (≈ 5). But it is also higher, than over the Cepheids, that can be the result of local peculiarities. We have $\Delta m \geq 0.^m5$, adopting $n_1/n \geq 2$. If the light absorption A_v at the same longitudes is in interval of $0.^m5$ to 2 m/kpc (over[14]), then the process of making objects brighter itself Δm_1 may be several stellar magnitudes. Just the same magnitudes are needed to understand the visibility of bright SN.

The second alternative case is attributed to $\Delta m_1 = 0$, when the contrast in number of stars is created by the belts of the higher density, passing near spurs border [5]. In reality we have the combination of these cases: the dense belts are combined with the process of making brighter the objects by spurs foreground.

3. The supercluster of galaxies (Vaucouleurs)

The Virgo supercluster of galaxies has the flattened filamentary shape. The whole Local group of the galaxies (and our Galaxy inside it) is surrounded by Virgo, but we are far from its centre. And the spurs system has also asymmetrical position over sky. One can see on Fig.5 over the Vaucouleurs map [15] (galaxies brighter 13^m) that a lot of filaments fit to the loops borders at $l_s \pm ½\rho_s$ or $b_s \pm ½\rho_s$ (table 2). The spurs system serves as a stencil to cut out in supercluster the regions of filament shape. And it means that this is not random, as we see this effect on all spurs. Hence, the real picture in supercluster rather differs from the visual one.

The individual galaxies from Local group over the lists [16,17], containing 65 nearby systems, were compared with the spurs. Their correlation is seen from Table 3 and Fig.2.

Table 3. Local group of galaxies (65), observed through spurs

Loop	Shell	SBelt	Loop Centre	Outside
I	11 (12)	4	2	
II	3 (4)	19		
III	9	-		
IV	1 ?	1 ?		
Gum Neb	2			
gap		5		
Outside				10

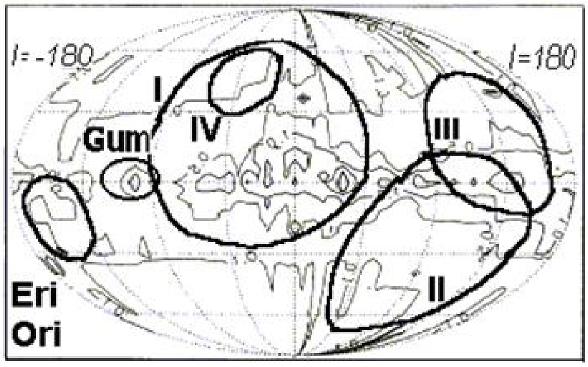

Fig. 6: Map of light absorption [14] and spurs

More than 80% of galaxies from Table 3 are projecting over the loops and s-belt ±20°wide, though their total area is smaller 40% of sky, except the part of Antlia group near the Galactic pole. The conditions of visibility differ for different loops and loops' parts.

4. The light absorption

The observed picture can't be explained by light absorption, as in the loops region the absorption is also larger than in the neighbouring region over [14] (Fig 6). So, taking into account the light absorption can only make the observed picture more contrast.

Conclusions

The spurs are screening more than a half of sky area from the distances of 100 – 200 pc and, perhaps, it distorts the real sky picture. The light absorption here rather slightly differs from its mean value at the same latitudes. Nevertheless, compact spurs are controlling the situation around. The spurs participate in the creation of visual sky picture, have the influence on the models of Galactic structure and even the large scale structures. The facts are:

The supernova and nearby galaxies projections coincide with spurs shells, spurs belt S and the spurs Lens

The indicators of spiral structure (the supergiants, the OB-associations, the Cepheids) have sharp density jumps at the longitudes of spurs borders

The coincidence of the spurs system map with the

- galactic distribution in the Local group
- filaments of Virgo supergalaxy
- CMB polarization, etc.

The large quantity of coincidences related to the objects of such different scales can't be random. Perhaps, being the foreground, the spurs create the conditions of visibility of such different structures, making them brighter for several stellar magnitudes.

We observe the objects brighter; and then what are they in reality?

And the Galactic spiral arm models were built over supergiants , OB-associations and the Cepheids. What will be the changes in the models, if we take into account the correlation of spiral indicators and the spurs (as foreground makes brighter the real objects)?

What will be the changes in the scale of distances?

What will be the changes in the luminosity function? The bright part becomes lower?

Resuming this theme, we can conclude, that many objects are rather more remote, than it is considered now.

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