INVESTIGATION OF THE IONIZED COMPONENT OF THE LOCAL INTERSTELLAR MEDIUM

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ABSTRACT. Based upon numerous observational data of variability in extragalactic radiosources of the southern sky at low frequences the possibility of obtaining information on ionized component structure in the Local Interstellar Medium (LISM) is investigate. The model of anisotropic structure of LISM developed by Bochkarev (1987) is compared with investigational results of extragalactic radio sources scintillation of the soutern sky at 80 and 160 MHz (Slee, Siegmen, 1988). In the direction where scintillation indices increase, regions of interaction of interstellar wind with large scale structure of LISM are located. Decrease region of scintillation indices are observed wherein on towards the third galactic quadrant (near $l = 240°$), there is a gas free tunnel. On the basis of the theory refraction scintillation the estimations of characteristic time of changes of flows of radiosources on frequency 100 MHZ for the mentioned above areas LISM are considered. In view of high importance of speed of movement inhomogenius of electronic concentration and their sizes for the given areas LISM, reaching 500 km/sec and 20-70 a.u., the characteristic times variability turn out equal 0.1-0.7 years, that will be coordinated to the data of supervision.

Key words: Interstellar medium: Local Interstellar medium: ionized component: interstellar radiosources scintillation.

1. Introduction

Interstellar scintillations of radio sources resulting from small-scale inhomogeneities of interstellar matter's refractive coefficient (Rickett, 1986) can yield information about plasma turbulence near shock fronts (Pikelner and Tsytovich, 1969). Here, the thin scattering screen approximation may be applied.

We used Culgoora (Australia) 1970–1984 array observations of extragalactic radio sources at 80 and 160 MHz (Slee and Siegman, 1988). During 15 years, 412 sources covering homogeneously most of the sky (with the exception of a northern sky section) were observed repeatedly, in two or more 4-week-long series. 190 sources proved variable at least at one frequency and only 27, at both frequencies. [?] give many arguments in favor of interstellar origin of the variations. They published measured scintillation variability indices m for the time scale of 1 month ($m1$) and from one to several years ($m12$). In all cases, the main maxima are present for the majority of the data combinations and conserve their positions within our angular resolution (about $20° - 30°$), with slight variations of sizes and positions of the mapped structures.

2. Results and interpretation

We found 3 clear maxima, virtually independent of the data combinations and ways of averaging, in the all-sky distribution of interstellar scintillation indices (Table 1). Three other maxima, though probably real, are not as definite as the three first ones. In all the cases, a minimum of m is present near the galactic longitude $l = 240°$ in the Southern hemisphere, but the data for this direction is too scarce to allow definite conclusions.

We assume that the revealed maxima of m can be identified with maxima of the soft X-ray background radiation distribution (B, C, and M bands in the survey by McCammon et al., 1983). The maxima 1 and 2 from Table 1 are overlapping a considerable part of the two brightest X-ray filaments in the M1 band (440–930 eV) map corresponding to Loop I, the old SNR expanding inside the coronal gas in a cavern formed around the Sco–Cen stellar association (Bochkarev, 1987b, 1990).

Another marked m maximum (number 3) obviously coincides with a soft X-ray background bright spot observed in the Southern hemisphere in B (130–188 eV) and C bands. According to Bochkarev (1987ab, 1990), the spot corresponds to the area of interaction of the outer part of the Local Cloud with the envelope surrounding the Sco–Cen association, namely to the position

Table 1: Galactic coordinates and possible identifications of the features in the map of interstellar scintillation index distribution

	Features	Identification
		Clear maxima
1.	$0° < l < 30°; 0° < b < 30°$	Loop I
2.	$300° < l < 330°; 0° < b < 30°$	Loop I
3.	$-20° < l < 20°; -60° < b < -40°$	Southern maximum of soft X-ray BG (B and C bands, McCammon et al., 1983)
		Other possible maxima
4.	$170° < l < 220°; 30° < b < 45°$	Northern maximum of soft X-ray BG (B and C bands, McCammon et al., 1983)
5.	$180° < l < 200°;\ -20° < b < 0°$	Orion star-formation region
6.	$l \approx 120°$ and $300°$ $b > 75°$	Soft X-ray BG filament near NGP (B and C bands, McCammon et al., 1983)
		Minimum of m
7.	$l \approx 240°$ low southern b	Tunnel free of interstellar extinction (Bochkarev 1987b, 1990)

where the line of sight meets the relatively dense coronal gas near the shock front boundaries of the Sco–Cen superbubble. A similar northern maximum of m probably exists (number 4), but there is insufficient data for its direction in the Culgoora survey.

The maximum 5 is uncertain because its position and shape vary with data combinations. It might be identified with the densest northern part of the Ori–Eri superbubble, namely with the Orion star formation region.

The minimum 7 corresponds to a very old bubble, spread by differential rotation of the Galaxy within the Galactic quadrant III.

3. Discussion of time scale of interstellar scintillations

In accordance with the interpretation discussed in Section 3, the distance L to the maxima 1,2 (Loop I) is about 150 pc (Cox and Reynolds 1987; Bochkarev, 1987b, 1990). The velocity of the shock wave is 530–580 km/s (Bochkarev, 1990). Adopting typical angular sizes of the point components of extragalactic radio sources at 100 MHz $\theta = 0.2 - 0.5$ arcsec (see Janardhan and Alurkar, 1993 and references in Slee and Siegman, 1988), we find, in accordance with [?], $\tau = L\theta/v = 0.1 - 0.7$ years, and the size of the scattering inhomogeneities $a = 20 - 70$ A.U.

For the maxima 3, 4, we assume the distance $L = 20 - 40$ pc (Bochkarev, 1987ab, 1990) and v equal to the thermal velocity in coronal gas with the temperature $T = 10^6$ K: $v = 130$ km/s. In this case, $\tau = 0.1 - 0.3$ year.

In both cases (for all most definite m maxima), the estimated time scale of refractive interstellar scintillations is considerably shorter than that of the average scattering screen in the Galaxy (Rickett 1986; Slee and Siegman, 1988) and is in good agreement with the observed radio-source variations.

3. Conclusions

A) Areas of the sky are found with intensified extragalactic radio-source interstellar scintillation at low radio frequencies (80 – 160 MHz), at time scales from months to years.

B) A correspondence between the areas mentioned in Conclusion A and soft X-ray background details of large angular size is found: two Loop I bright X-ray filaments; high Galactic latitude brightest spots in soft (B and C bands) X-ray background radiation. The direction of the "interstellar absorption-free tunnel" at the galactic longitude $l = 240°$ probably corresponds to a minimum of interstellar scintillation.

C) The estimated time scales $\tau = 0.1 - 0.7$ year at 100 MHz for interstellar scintillation in hot LISM structures are shorter than those for a typical scattering screen and correspond to Slee & Siegman (1988) observations.

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