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BRIGHTNESS OF MAIN GALACTIC RADIO LOOPS AT 1420 MHz

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Abstract. In this article we calculated the mean temperatures and surface brightness of main galactic radio loops at 1420 MHz. We computed the mean temperatures of the major radio loops I, II, III and IV using the data taken from the northern sky radio continuum survey. We also compared our results with results obtained at other wavelengths. The results showed good agreement when reduced to 1000 MHz.

1. INTRODUCTION

It is well known that some radio spurs can be joined into small circles. The set of spurs belonging to the same small circle is named a loop. Four major loops were recognized in the early seventies. They were discovered and studied in this order: Loop I (Large et al., 1962; Haslam et al., 1964; Large et al., 1966; Salter, 1970), Loop II (Large et al., 1962; Quigley and Haslam, 1965; Salter, 1970), Loop III (Quigley and Haslam, 1965; Salter, 1970) and Loop IV (Large et al., 1966; Salter, 1970). The most precise determination of parameters of these circles was performed by Salter (1970) and published by Berkhuijsen et al. (1971). Salter used the best data available then at 408 MHz, 404 MHz, 240 MHz and 178 MHz. A detailed review of the subject was published by Salter (1983). It was noticed by Milogradov-Turin (1970, 1997) that some other spurs could be connected into loops.

Small circles' positions for main radio loops in Galactic coordinates at 1420 MHz are given in Fig. 1. (Milogradov-Turin and Urošević, 1997). An all-sky map of the radio continuum brightness, in Galactic coordinates, is presented in Fig. 2.

2. DATA

The survey at 1420 MHz (Reich and Reich, 1986) provided a new base for recomputation of small circles for major loops. These data were obtained with the Stockert 25 – m telescope. The effective sensitivity is about 50 mK T_b. The angular resolution is 35'. These data are available on MPIfR's Survey Sampler ("Max – Planck – Institut für Radioastronomie", Bonn). This service is connected to the Internet (http://www.mpifr-bonn.mpg.de/survey.html) which allows users to pick a region of the sky and obtain images at a number of wavelengths.

3. ANALYSIS

In order to determine the temperature and surface brightness of these four loops, we used the radio continuum survey at 1420 MHz (Reich and Reich, 1986) as the best available. The 1420 MHz has a resolution of $35'$.

The background radiation was subtracted in the following way: the temperature of the loop with the background added was determined at first. After that the temperature of the background near the loop was determined. Finally, the difference of these two values was calculated. For Loop I average temperature was sampled at 26 362 points, for Loop II at 66 250, for Loop III at 32 649 points and for temperature of Loop IV it was sampled at 2 289 points. Average brightness temperatures for loops are presented in Table 1. Surface brightnesses are presented in Table 2.

Temperatures at 1 GHz were calculated by use of the spectral indices given by Berkhuijsen (1973). We calculated the surface brightness by the following relations:

$$T_{1\mathrm{GHz}}/T_{1420\mathrm{MHz}} = (1000/1420)^{-\beta} \tag{1}$$

$$\Sigma_{1\mathrm{GHz}} = 2kT_{1\mathrm{GHz}}(1\mathrm{GHz}/c)^2 \tag{2}$$

4. RESULTS

The results are presented in Tables 1 and 2. Table 1 shows the calculated temperatures and temperatures obtained by Berkhuijsen. In Table 2 are presented brightnesses of radio loops at 1420 MHz and the same brightnesses recalculated at 1000 MHz.

These results for temperatures may be compared with values calculated earlier (Berkhuijsen, 1973) at different frequency, when all results for temperatures are estimated at 1420 MHz.

When comparing with Berkhuijsen (1973), it is obvious good agreement of these results. The good agreement of our results with those of Berkhuijsen (1973) is obvious.

Table 1: Temperatures of radio loops (1420 MHz)

label of the loop	temperature (K)	T(K) at 1420 MHz (Berkhuijsen, 1973)
Loop I	0.27 ± 0.05	0.27 ± 0.33
Loop II	0.22 ± 0.05	0.25 ± 0.12
Loop III	0.30 ± 0.05	0.30 ± 0.11
Loop IV	0.08 ± 0.05	0.07 ± 0.05

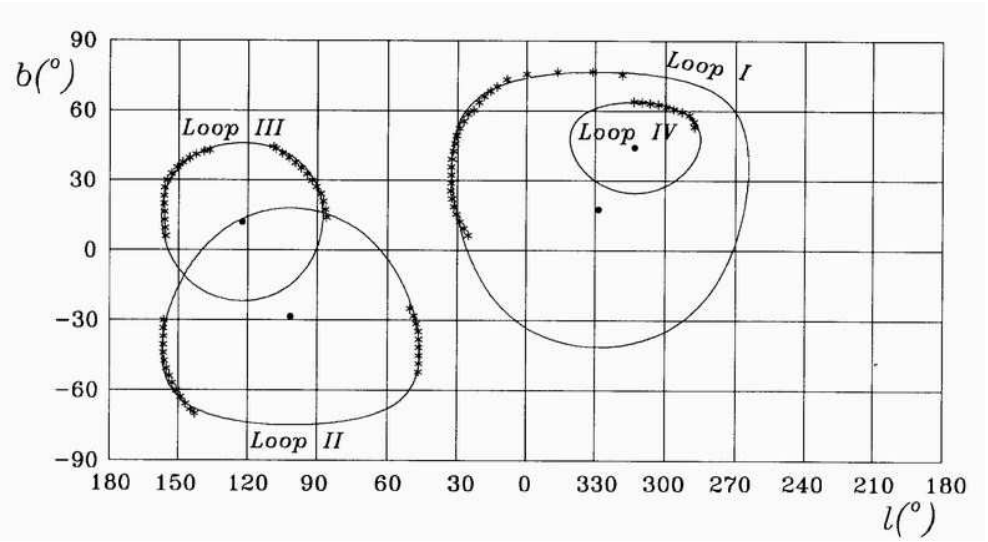

Figure 1: The small circle geometry of the Galactic loops. The crosses mark the measured ridge positions used to compute the small circles (Milogradov-Turin and Urošević, 1997).

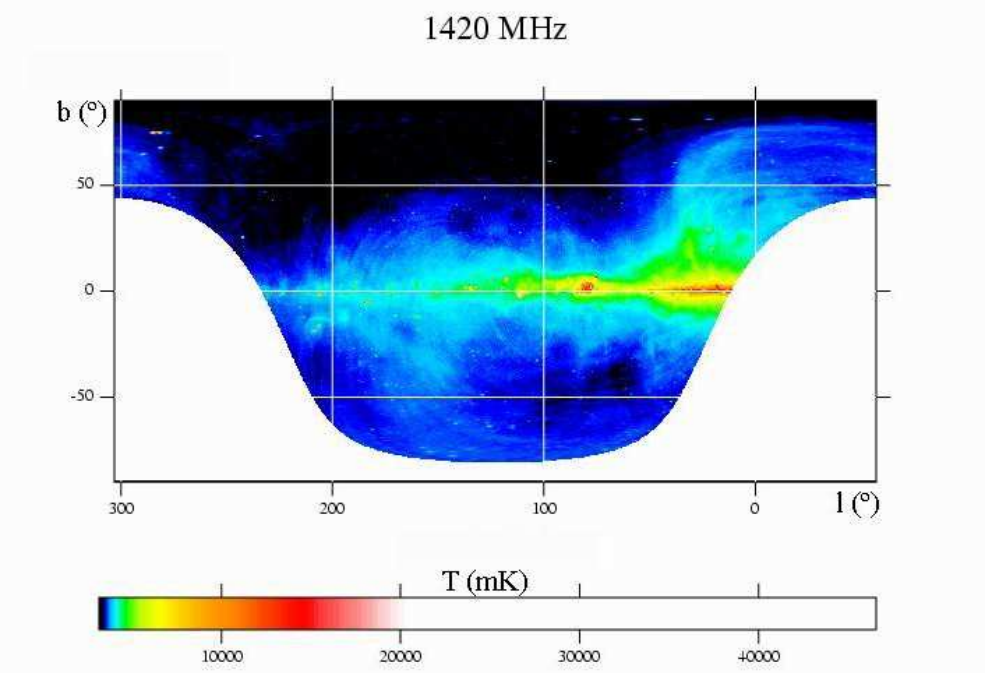

Figure 2: A 1420 MHz all-sky continuum survey.

Table 2: Brightness of radio loops

label of the loop	brightness at **1420 MHz** (10^{-22} W/(m^2 Hz Sr))	brightness at **1000 MHz** (10^{-22} W/(m^2 Hz Sr))
Loop I	1.69 ± 0.30	2.16 ± 0.54
Loop II	1.37 ± 0.30	1.76 ± 0.51
Loop III	1.84 ± 0.30	2.29 ± 0.45
Loop IV	0.49 ± 0.30	0.62 ± 0.45

5. DISCUSSION

In this paper we calculated the temperatures and surface brightness of the main galactic radio loops at 1420 MHz. Temperatures of main galactic radio loops are calculated from a radio continuum survey at 1420 MHz (Reich and Reich, 1986). For this frequency it is a first time that we calculated temperature from experimental data.

The effective sensitivity of the brightness temperatures is 50 mK, and we calculated absolute errors for surface brightness'. Temperatures of radio loops at 1420 MHz are in good agreement with the results for other wavelengths (Berkhuijsen, 1973).

Possibilities for further investigations: we can suppose all radio loops to be SNRs (Berkhuijsen et al., 1970; Berkhuijsen, 1971; Shklovskii and Sheffer, 1971; Salter, 1983) and we can calculate distances of radio loops at 1420 MHz using Σ – D relations (Shklovskii, 1960; Urošević, 2002) compared with values calculated earlier (Berkhuijsen, 1973).

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