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PRELIMINARY RESULTS OF A GALACTIC BACKGROUND SURVEY AT 45 MHz

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RESUMEN

Se presentan los resultados preliminares de la exploración del fondo galáctico en 45 MHz iniciada recientemente en el Observatorio Radioastronómico de Maipú. El instrumento es de tránsito y consiste en una formación rectangular de 528 dipolos con una resolución angular de 2.1° en declinación y 4.6° en ascensión recta. Estas primeras observaciones cubren la región comprendida entre declinaciones de −30° a −37° y se han obtenido con un sistema de haces múltiples.

ABSTRACT

Preliminary results of a survey of the galactic background at 45 MHz recently carried out at the Maipú Radio Astronomy Observatory are shown. The radiotelescope is a transit instrument that consists of a rectangular filled array of 528 dipoles with an angular resolution of 2.1° in declination and 4.6° in right ascension. These first observations cover the region of the sky between declinations from -30° to -37° and they have been obtained with a multiple beam system.

Key words: SYNCHROTON RADIATION – GALAXIES-THE MILKY WAY

I. INTRODUCTION

The study of the galactic background radiation is an important source of information on galactic structure.

As has been pointed out by Landecker and Wielebinski (1970), extensive surveys of the galactic radiation made with aerials of adequate sensitivity and resolution are the starting point in understanding the distribution of emitting regions in the galaxy.

In particular, metre wavelength observations provide the best range to study the galactic nonthermal radiation (Wielebinski *et al.* 1968).

In spite of the importance of this kind of observations, few works of this nature have been carried out, especially in the Southern Hemisphere, where regions as important as the galactic centre, the south galactic pole and the galactic radiation minimum are located.

This is probably due to the large collecting areas required to obtain good resolutions and sensitivities and to the severe interference of terrestrial origin that affects observations at these frequencies.

A survey of the galactic background radiation at 45 MHz (6.66 m) has been started at the Maipú Radio Astronomy Observatory of the University of Chile.

The resolution of the instrument is 2.1° in declination and 4.6° in right ascension.

The data acquisition has been automatized and is performed "on line" by a digital computer which is also used for data reduction.

In this work, preliminary results of observations of the Southern sky between declinations of − 30° and − 37° and between 19^h and 11^h of right ascension are presented.

The results obtained in this preliminary survey are shown in ecuatorial coordinates with isophotes that represent antenna temperature. The countour unit used is 500° K.

II. THE INSTRUMENT

The 45 MHz radiotelescope (May *et al.* 1979) is a transit instrument. The antenna is a rectangular filled array of 528 full-wavelength dipoles electrically steerable in declination within ±40° from the zenith.

The array consists of 6 groups of 88 dipoles and each group is fed to a low noise and high gain preamplifier. The 6 preamplified signals are interconnected by a Butler matrix of 12 hybrid rings (Butler 1966).

A multiple beam (8 beams separated by 1.8°) is thus generated in the meridian plane, allowing simultaneous observations at various declinations with the sensitivity of the whole array and the resolution of the Butler matrix (1.8°).

The receiver is a modified total power telemetry receiver with two channels. The detector output is recorded on paper chart using an automatic offset (Aparici *et al.* 1981*a*) and is simultaneously processed "on line" by a digital computer. Direct measurements of side lobes level are − 13 db with regard to the main beam (Reyes 1977).

The noise temperature of the system was measured to be 563 °K.

III. THE OBSERVATIONS

The observations consisted of constant declination scans performed mainly at night for approximately 15 hours during the months of October and part of November 1980.

Each night, 2 adjacent declinations were observed simultaneously with the antenna pointed toward the zenith ($\delta = -33.^{\circ}5$). Approximately 10 observations were made for each of the 4 central lobes of the matrix.

The receiver was operated with a bandwith of 1 MHz and a time constant of 3 seconds, however a final integration time of 1 minute was obtained with the computer. The observations were registered both in analog (paper chart) and digital form (punched paper tape).

IV. THE CALIBRATIONS

Automatic calibrations were performed every 30 minutes. The calibrator used is a programmable noise generator of saturated diodes controlled by the computer (Aparici *et al.* 1981*b*).

To cover the dynamic range of the observations, 12 one db steps were used in each calibration.

The calibrator was connected to the preamplifiers input; for this purpose, the noise generator was provided with 6 coherent noise outputs.

Phase shifters made of coaxial cable allowed simulations of different wavefronts giving to the calibration noise the desired phase relationships.

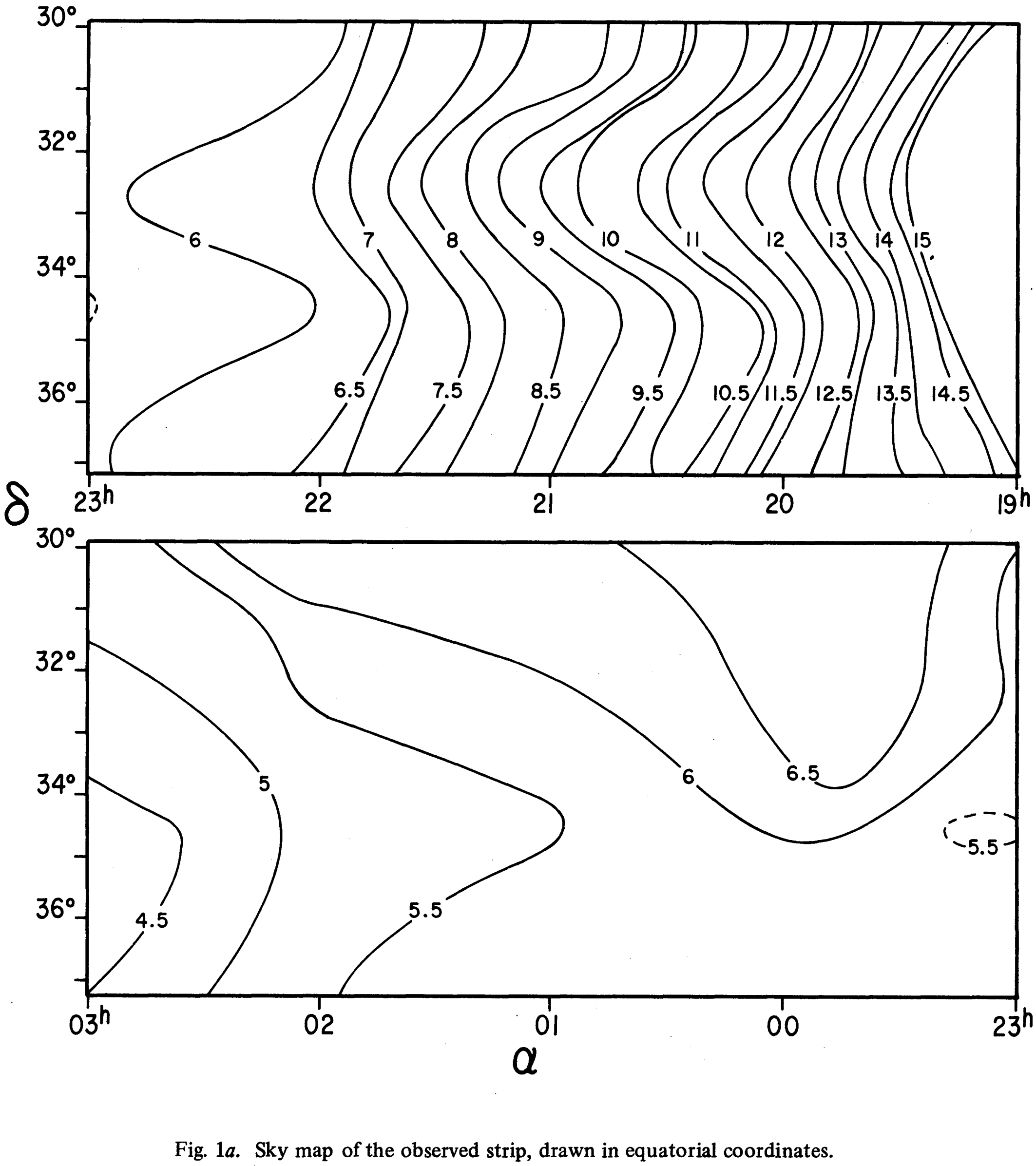

Fig. 1*a*. Sky map of the observed strip, drawn in equatorial coordinates.

V. ANALYSIS OF THE OBSERVATIONS AND RESULTS

The digital records of all observations were transformed to antenna temperature with a computer program.

Antenna temperature profiles for each declination were plotted by means of a digital to analog converter controlling a servo ink plotter.

The scans recorded in the best conditions of ionospheric activity and interference were selected to be averaged after removing the remaining interference.

Based on the averaged profiles, a sky map of the observed strip was drawn in equatorial coordinates as shown in Figure 1.

The antenna temperature contour unit is 500° K with an error of ± 20%. A base level error of ± 1 db is estimated for the observations.

No corrections for secondary lobes were made.

VI. DISCUSSION

Comparison of the map with known results is not straightforward due to the differences in frequency and resolution.

Nevertheless, the general features of the map agree reasonably well with maps at similar frequencies, namely the 55 MHz map of Rohan and Soden (1970) made with a resolution of 14° X 14° and the 30 MHz map of Mathewson *et al.* (1965) with a resolution of 11° X 11°.

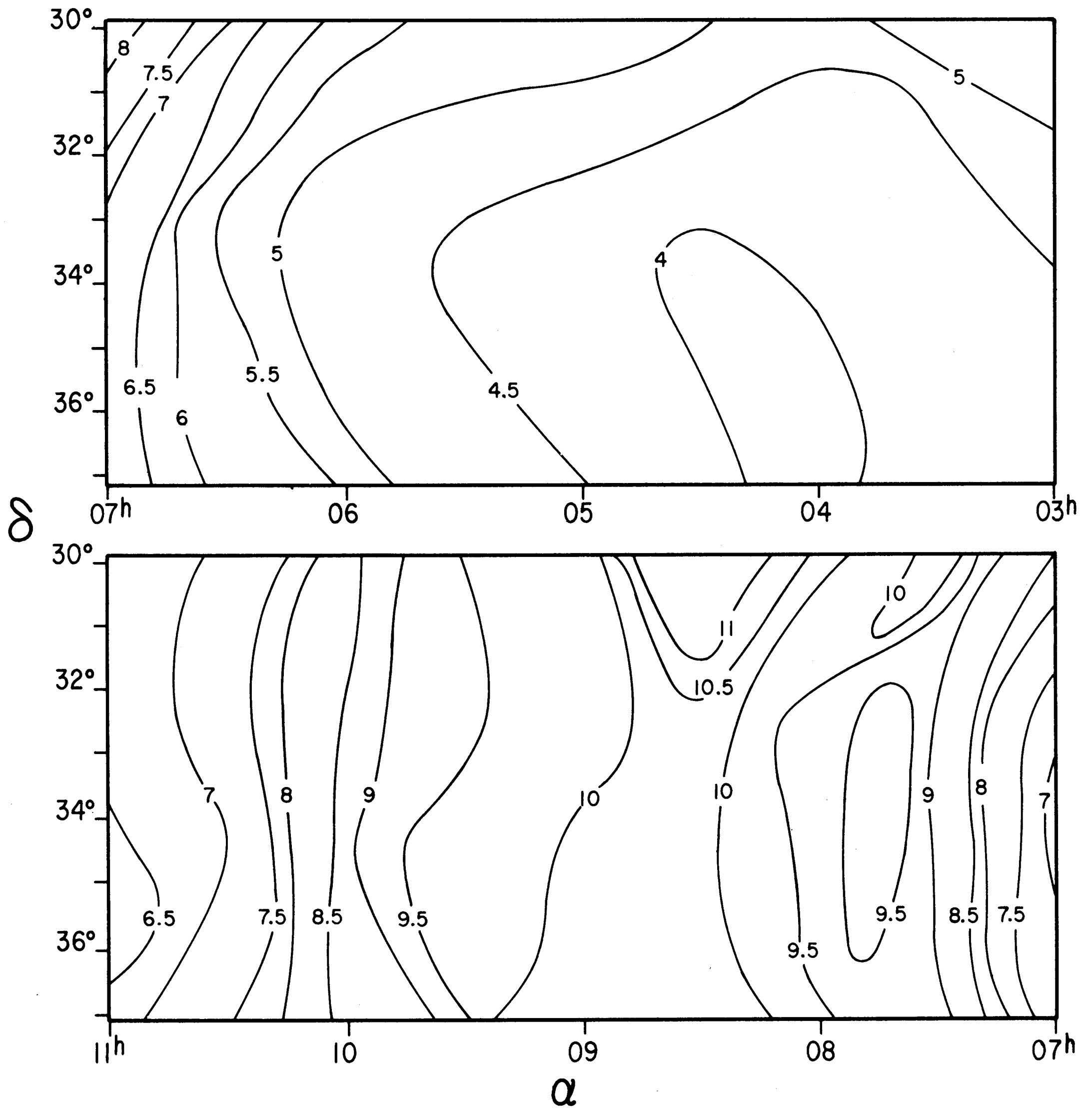

Fig. 2*a*. Same as Figure 1*a*.

Other works like the 85 MHz map by Yates *et al.* (1967) and a 10 MHz map by Hamilton and Haynes (1968) are at frequencies too diferent to enable a proper comparison.

A 30 MHz map by Cane (1978) is based on data of Mathewson *et al.* (1965) and Hamilton and Haynes (1968) which has already been discussed.

The minimum of the galactic emission has been measured at 48.5 MHz (Yates and Wielebinski 1965) and used to determine the spectra of the south galactic polar region by Cane (1979). This value is 5140 °K at $\delta = 34°$ and $\alpha = 4^h00^m$ and was obtained with resolution of 75° E-W and 115° N-S.

A temperature of 3792 °K and a location of $\delta = -36.2°$ and $\alpha = 03^h59^m$ has been determined for the minimum galactic emission at 45 MHz. This result is not contradictory with the value obtained at 48.5 MHz due the large difference in resolution.

Other interesting feature of the map is the anticentre region which shows an extended maximum between 7.5 and 10^h rising to a temperature of 11 000 °K.

The base level of the observations is poorly determined (± 1 db); this uncertainty is hoped to be removed in further observations, nevertheless, the relative values of the features in different scans are very consistent.

The method used has proved to be adequate to carry on a complete survey in the sky attainable by the instrument.

Due to the integration time used (1 minute), an additional scan with a shorter time constant will be useful to detect the scintillation of weak point sources; this additional scan can also be used to study pulsars.

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DISCUSSION

Campins: ¿Cuál es el mecanismo de producción de esta radiación?
Bitrán: La explicación aceptada es que se trata de radiación no térmica emitida en procesos sincrotrónicos.
Rosado: ¿Qué posibilidades existen de estudiar la polarización de esta radiación sincrotrónica?
Bitrán: Debido al diseño, la antena sólo detecta líneas en el sentido E-W, por lo que no podemos medir polarización circular.
Peimbert: ¿Cómo varían la declinación? y ¿Qué posibilidades hay de observar en otras frecuencias?
Bitrán: Hay dos sistemas para variar la declinación: la matriz de Butler permite observar simultáneamente en 8 declinaciones distintas; y, variando la fase entre los elementos de la antena, éste se puede orientar a cualquier posición entre ± 40° del zenith. Se puede observar en otras frecuencias dentro del ancho de banda de los pre-amplificadores que es de aproximadamente 8 MHz.

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