A CONTINUUM SURVEY OF THE SOUTHERN MILKY WAY AT 1410 MHz

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Summary

This paper presents a contour map of the Southern Milky Way at 1410 MHz obtained using the 210 ft radio telescope at Parkes.

I. Introduction

Shortly after the commissioning of the 210 ft radio telescope at Parkes, simultaneous surveys of the Southern Milky Way at frequencies of 408 and 1410 MHz were commenced. The results of the 408 MHz survey have already been described by Komesaroff (1966), and the present paper describes in part the results of the 1410 MHz survey.

The survey described here was intended to fulfil two objectives. Firstly, the beamwidth of 14 min of arc at 1410 MHz was more than a factor of three smaller than that used in the previous surveys of the region by Hill, Slee, and Mills (1958) and by Mathewson, Healey, and Rome (1962). Accordingly, the higher resolution study could be expected to reveal considerably more structural detail in the distribution of galactic radio emission. The second reason for the survey was that it provided an opportunity to obtain experience with the newly installed digital recording system designed by M. Beard, as well as with digital computer processing of radio astronomical data.

This paper presents the contour map of the aerial temperature distribution derived from the observations. A subsequent paper will list radio data concerning the sources found and enumerate optical identifications and, where possible, provide contour maps of the individual sources.

II. Observations

The observations were carried out in March–April, June–July, and September 1962, with the assistance of M. M. Komesaroff and M. Beard. The area surveyed was between new galactic longitudes 281° and 356° and latitudes of about ±5° or ±6°. Scans were made in declination using drive rates of between 2 and 2·5 deg/min. The spacing between scans was about 3′·5 arc; this corresponds to about one-quarter beamwidth, which theoretically (see Bracewell and Roberts 1954) means that there is much redundancy in the observations. However, the theory makes no allowance for the occurrence in real data of receiver drifts, or other forms of equipment instability, or for the presence of interference. To enable the detection of these effects, the redundancy was thought worth while. The usefulness of the redundancy was enhanced by scanning an area of sky on one night with half-beamwidth spacing,

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and then on another night making a further series of scans of the same area at the same spacing but positioned midway between the previous set of scans.

The feed rotator at present installed on the telescope was not available at the time of these observations and this made it impossible to maintain constant position angle over the whole area surveyed during the time available for the survey.

Two receiver front-ends were used for these observations. During the first observing period March–April 1962, a crystal-mixer system described briefly by Cooper (1963) was used. In the two subsequent periods the parametric receiver built by Gardner and Milne (1963) was used. In all observations the time constant was 1 sec. At all times the receiver output was recorded digitally on paper tape and monitored with analogue recordings. Subsequently, all the processing was done using the digital records, the analogue records being used primarily to select which digital records to process.

In addition to the survey scans in declination, a series of zenith-angle scans and another series of reference scans were made. The zenith-angle scans were made in regions of the sky well away from the galactic plane. Here the variation of cosmic radiation is negligible so that observed variations measure the change with zenith angle of ground radiation entering the system. Two sets of reference scans were made, both sets running roughly parallel to the galactic plane, one set near the northern declination limit of the survey, the other near the southern limit. Every survey scan was thus intersected twice by these reference scans. The purpose of these scans was to provide two points for the baseline of each survey scan. Temperatures were determined along the reference scans relative to the south celestial pole and the effects of zenith angle were removed on the basis of the information derived from the zenith-angle scans. Since the survey scans were made at zenith angles where this effect was linear, this reduction procedure removed the effects of varying zenith angle along each survey scan and, incidentally, the effects of any other disturbances (such as receiver drifts) that varied linearly along the scans.

The observing procedure during each night included, in addition to survey scanning, frequent gain calibrations by recording the output of a noise source which was itself checked against a reference radio source.

III. Analysis

The reduction procedure adopted for this part of the work is identical with that developed in conjunction with M. Beard and outlined by Beard (1966) and need not be repeated here. The only difference is that the present results are expressed as aerial temperatures rather than brightness temperatures. The temperature scale used is based on a value of 53°K for the source 13S6A provided by B. F. C. Cooper.

IV. Contour Map

Contours plotted in Figure 1 are those of aerial temperature referred to the south celestial pole as 0°K. Generally the levels plotted are

2, 3, 4, 6, 8, ... 20, 25, 30, ... 50, 75, 100, ... °K.

In some regions, however, where such contours crowd together too much, only a selection of these levels has been plotted. The coordinates are new galactic, l^{II}, b^{II}.

The error in the temperatures quoted on the contour map is considered to be in the vicinity of 10–15%. This error arises principally from the assumed aerial temperature of the reference source and variations in the gain and linearity of the receiving system. The failure to maintain constant position angle for the aerial feed during the observations is expected, on the basis of available polarization measurements in this part of the sky, to introduce only small errors.

V. Acknowledgments

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