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THE DISTORTION OF THE GALACTIC PLANE EMISSION IN THE ANTICENTRE REGION

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INTRODUCTION

Little study has been devoted to the interpretation of the radio continuum brightness distribution in the anticentre region. It is accepted that the major part of the radiation at decimetre and metre wavelenghts is synchrotron emission from relativistic electrons moving in partially organized magnetic field. The detailed structure of the magnetic field is not yet fully known and therefore the detailed interpretation of the galactic synchrotron emission has not been completed. Nevertheless, interpretation of large scale features has been attempted by Hanbury Brown and Hazard (1960) and Hornby (1966). Hanbury Brown and Hazard (1960) have suggested that magnetic lines of force are aligned along the spiral arms but not perfectly. According to them, the irregularities in the direction of field have an upper limit of 20°. Hornby (1966) has shown that the bulk of emission in the anticentre region can not originate in regions in which the field is completely disordered. He proposed that observed brightness distribution and radio polarization could be attributed to relativistic electrons moving in the helical magnetic field of the local spiral arm.

DISCUSSION

The analysis of the low latitudes galactic emission at 38 MHz, observed by the author with the Jodrell Bank Mark I radio telescope having the half power beamwidth of 8° at this frequency, has shown that the brightness distribution in the anticentre region (Figure 1) exhibits the following properties:

(i) A rather steady decrease in intensity from $l = 140°$ to $l = 240°$, except for steps near $l = 140°$, $l = 165°$, $l = 200°$ and $l = 240°$.

(ii) A general symmetry in respect to the line which lies about 2°.5 below the galactic equator.

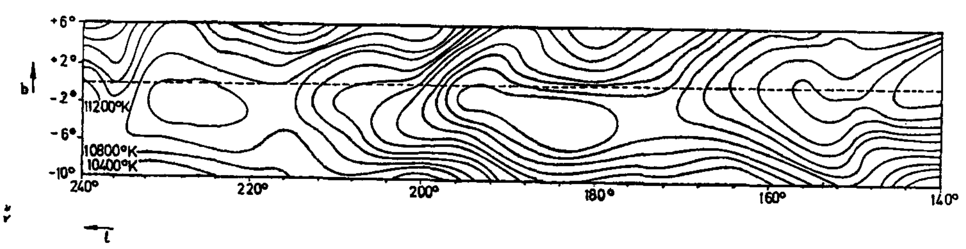

Fig. 1.

(iii) A distortion of contours such that after allowance for the influence of spurs and intense sources the greatest distance of any low latitude contour from the galactic equator is reached at lower longitude below the galactic plane and at greater longitude above the plane.

Comparison with other surveys, e.g. Pauliny-Toth and Shakeshaft (1962) at 404 MHz, Haslam et al. (1970) at 408 MHz and Berkhuijsen (1971) at 820 MHz, shows that the galactic emission has these properties over a large range of frequencies.

A rather steady decrease in intensity reaching its minimum near $l = 240°$ indicates, following the computations done by Hornby (1966), that the bulk of the 38 MHz radiation in the anticentre region does not come from randomly distributed arae in which the magnetic field is disordered. Nevertheless it seems doubtful to the author that the shape of contours and their displacement below the plane can be explained by the left-handed helical model of the magnetic field as proposed by Hornby (1966). Firstly, the shape of isophots computed by Hornby (1966) differs from the real ones. Secondly, recent results of Mathewson (1968), Mathewson and Nicholls (1968) and Mathewson and Ford (1970) show that the optical polarization data are best explained taking magnetic lines of force to be right-handed helices.

Simple analysis shows that even if only the sense of the helices is changed and all other parameters are kept constant the predicted distribution of the background will differ from that of Hornby (1966). If the lines of force were right-handed helices the greatest distance from the galactic equator of any contour should be reached at lower longitudes below the galactic plane and at higher longitudes above the plane. The difference between these longitudes is $2p$ where p is pitch angle of the helix (Figure 2). If $p = 7°$ as suggested by Mathewson (1968) this difference will be 14°. In the case of left-handed helices the greatest distance of the particular isophote from the galactic equator will be reached at lower longitudes above the plane. Comparison with the observed background distribution indicates that the contours have the shape which can be better explained by the right-handed helical model. Observed differences in longitudes of contour extremes at 38 MHz (Figure 1) go up to 12° what seems quite satisfactory considering the resolution of this map.

The fact that the maximum brightness is observed about 2°.5 below the galactic equator could be caused, as suggested by Salter (1970), by the contribution of an outer spiral arm running across the anticentre region from $l = 130°$ to $l = 210°$, having its closest distance to the Sun of about 3 kpc. This arm is presumably HI region at 3 kpc which was associated by Lindblad (1967) with the Perseus spiral arm. Salter (1970) interprets his disk component A which

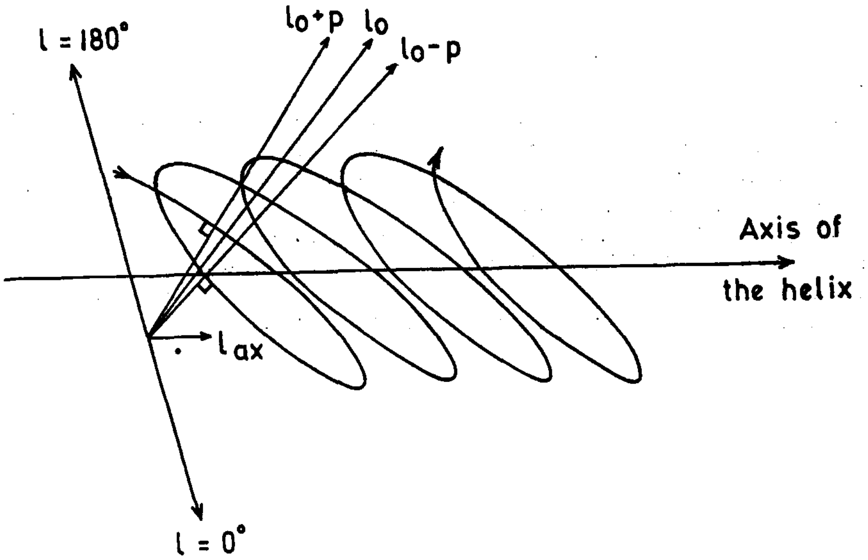

Fig. 2.

causes the displacement of the contours below the plane to originate in this spiral arm. The latitude of —1°.75 which he finds for the latitude of the peak of the component A coincides well with the value of about — 2°.5 observed at 38 MHz. This explanation sounds even more probable if it is recalled that Mathewson (1968) places the Sun 10 pc below the magnetic plane, which would make many difficulties if the interpretation of the emission in the anticentre region is based solely on the helical model of the local magnetic field.

SUMMARY

An attempt to interprete the radio continuum brightness in the anticentre region is made taking as the basis the right-handed helical model of the local magnetic field. It is shown that the shape of the contours of brightness distribution can be well explained by this model and the assumption that part of the radiation comes from the neighbouring region of the Perseus arm.

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