PAPER 2

21-CM. OBSERVATIONS IN SYDNEY

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The primary project in the current 21-cm. hydrogen-line work in Sydney is a study of the southern Milky Way by F. J. Kerr, J. V. Hindman, and the author. Earlier observations* made at the Radiophysics Laboratory during 1954 yielded a tentative picture of spiral structure in the southern portion of the conventional galactic plane. That picture, slightly modified by more recent results, is shown in Fig. 1.

The observational programme now in progress covers the portions of the sky which are indicated in galactic co-ordinates in Fig. 2. Observations are made simultaneously on a number of fixed-frequency channels as the aerial beam sweeps across the sky. A receiver which will have enough channels (~ 50) to delineate the whole line profile simultaneously is under development, but the present receiver has only four channels, each with a band-width of 40 kc./s. A profile is built up by repeating a given run an appropriate number of times, each time displacing the channels to a new set of frequencies. Calibration checks are made at low levels by moving the aerial to the south pole between successive galactic crossings, and at high levels by the observation of standard regions near the beginning, middle, and end of each observing period.

A 'long-run programme', in which an 8° band of galactic latitude is covered at relatively few longitudes, is alternated with a 'short-run programme' which covers a narrower band of latitude at more closely spaced longitudes. The latitude range of approximately 8° was selected in order to permit a study of features of distant spiral arms which are centred well to the south of the conventional galactic plane. Moreover, from observations of the angular widths of spiral features, important information concerning their distances may be expected.

For each track a diagram showing constant-intensity contour lines with respect to galactic latitude as the vertical co-ordinate and radial velocity as the horizontal co-ordinate is being derived. The more familiar line

* Reported to U.R.S.I. August 1954.

https://doi.org/10.1017/S0074180900048774 Published online by Cambridge University Press

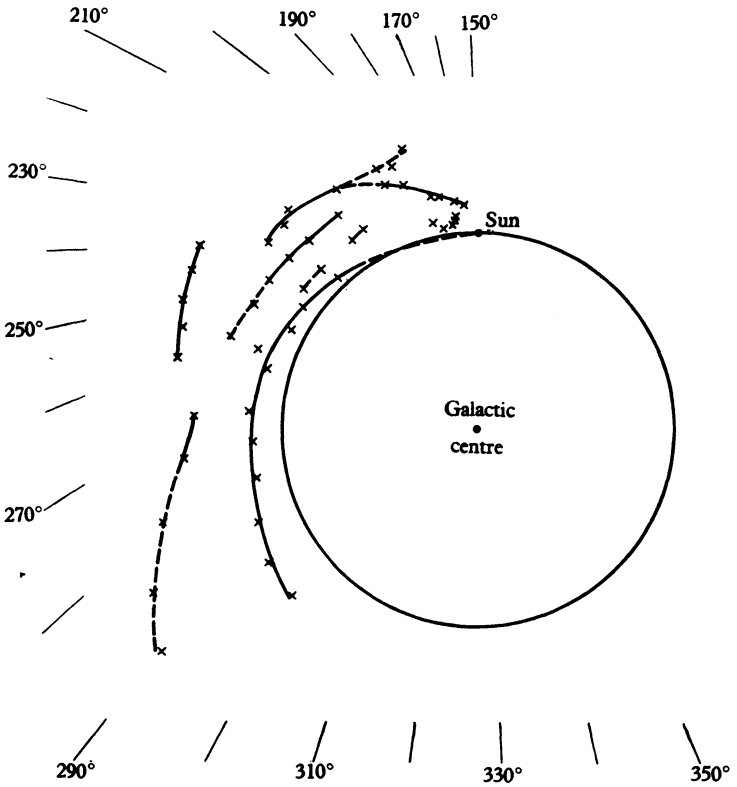

Fig. 1. Provisional diagram of galactic spiral structure based on southern observations and the rotational model of *B.A.N.* no. 452.

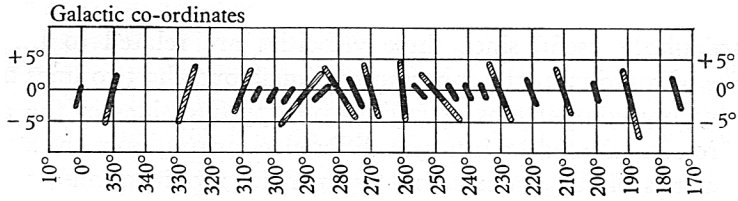

Fig. 2. Tracks followed in 21-cm. survey of southern Milky Way. Black: 'short-run' programme; hatched: 'long-run' programme.

profiles correspond to horizontal sections through the contours. This form of diagram is, for our method of observation, a direct presentation of observational data. Since the velocity scale is related to the distance scale, a series of such diagrams at successive longitudes leads to a three-dimensional picture of the hydrogen distribution. At present, however, distances

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are ambiguous inside the circle joining the sun with other points at the same distance from the galactic centre. They also depend in all regions on the galactic model chosen.

Fig. 3 gives provisional contour diagrams for the tracks which cross the galactic circle at longitudes 260°, 270°, and 275°. The corresponding scales of distance, deduced on the basis of a recent model [1] derived by Oort, are indicated. In each case at least three spiral arm peaks appear, one lying inside, the other two outside, the circle through the sun. The vertical ridge near zero velocity in the diagram for $l = 270°$ coincides with the Coalsack, but further observations at nearby longitudes are needed to confirm this identification.

Consideration of the positions of the maxima with respect to galactic longitude and distance from the galactic centre shows that each of the two outer arms tends to shift outward from the centre with increasing longitude, i.e. in this range of longitude they trail as the Galaxy rotates. All three arms indicated in Fig. 3 show in addition a strong tendency to shift southward in galactic latitude with increasing distance from the galactic centre. The outermost arm is, in fact, barely visible if we consider only the three profiles in the galactic plane. It is of interest that the Magellanic Clouds are located near these longitudes and may therefore be producing some distortion of the structure of our galaxy in this region.

Edmondson has recently suggested [2] that the directions of the mean motions in the Galaxy may be inwardly inclined by about 4° with respect to circular motions. This hypothesis can be tested by making a number of comparisons of observed radial velocities along pairs of lines of sight which lie in the galactic plane and are symmetrically placed with respect to the galactic centre. Comparisons of the *extreme* velocities in two such directions are particularly useful since these velocities are related to the actual velocities of rotation at the innermost points along the two lines of sight. However, any comparisons of regions on opposite sides of the galactic centre are complicated by inherent differences arising from the structural characteristics of the Galaxy and by artificial modifications of the line profiles due to the different aerial beam-widths with which the observations in the northern and southern hemispheres have been obtained.

A sample comparison is shown in Fig. 4, which gives part of a Sydney profile, together with two Leiden profiles for which the signs of the velocities have been reversed. The Sydney profile is for longitude 311°2, which, on the assumption that the galactic centre is at longitude 327°8, is symmetrical with the mean of the longitudes at which the two Leiden profiles were obtained. Edmondson's theory predicts that, for $\phi = 4°$, the numerical

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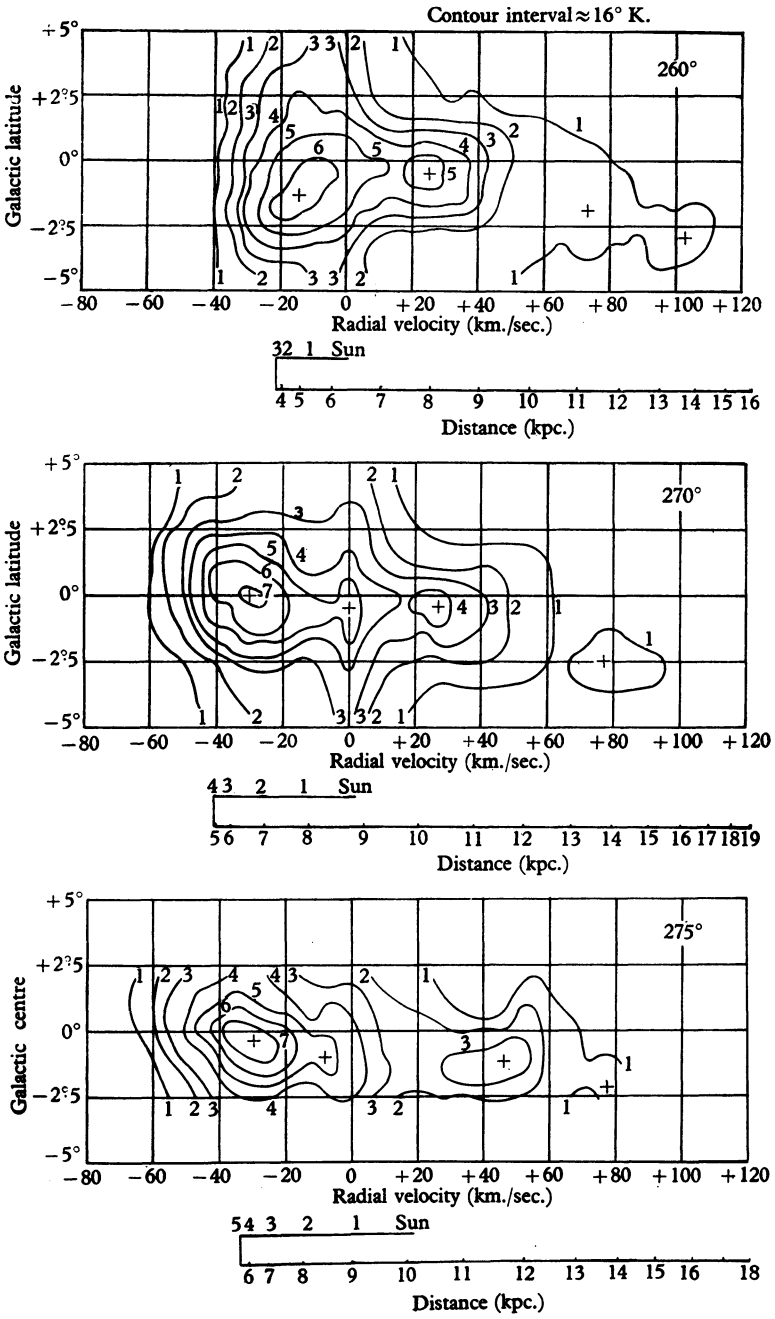

Fig. 3. Sample contours obtained at longitudes 260°, 270° and 275°. The distance scales are based on the model of *B.A.N.* no. 452.

https://doi.org/10.1017/S0074180900048774 Published online by Cambridge University Press

value of the southern 'cut-off' velocity should in this case be 29 km./sec. greater than that of the northern, but no such difference appears. Other comparisons have also failed to show the predicted differences. Conclusive evidence for or against the hypothesis awaits, however, a systematic comparison over a wide range of longitudes. This would amount to a rotational determination of the apparent direction of the galactic centre.

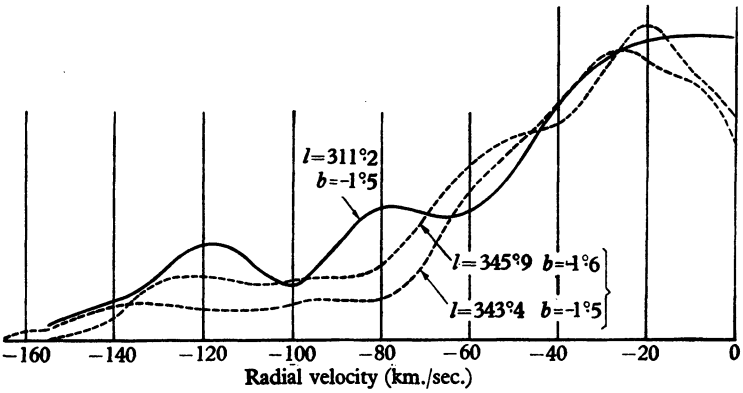

Fig. 4. Comparison of portions of line profiles referring to inner part of the Galaxy. The Sydney profile at $l=311°2$ is compared with the Leiden profiles at $l=345°9$ and $343°4$ plotted on a reverse velocity scale.

The author is indebted to the Commonwealth Scientific and Industrial Research Organization for a research grant in support of her participation in this programme over the past year.

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[1] van de Hulst, H. C., Muller C. A. and Oort, J. H. *B.A.N.* **12**, 117–49, no. 452, 1954.
[2] Edmondson, F. K. *P.A.S.P.* **67**, 10–11, 1955.

https://doi.org/10.1017/S0074180900048774 Published online by Cambridge University Press