26. CONTRIBUTION TO THE STUDY OF THE DISTRIBUTION OF NEUTRAL HYDROGEN IN THE REGION $230° \leqslant l^{II} \leqslant 280°$

D. GONIADZKI and A. JECH

Instituto Argentino de Radioastronomía, Buenos Aires, Argentine

Abstract. A sky survey of the 21 cm hydrogen line has been made with the 100-foot Radiotelescope of the I.A.R.-C.I.W. Radio Astronomy Station in the region $230° \leqslant l^{II} \leqslant 280°$, $-15° \leqslant b^{II} \leqslant -3°$.

We study the distribution of the local hydrogen and that in the Orion, Intermediate and Perseus arms. We find a new structure that starts at $l^{II} = 265°$. We also study the concentrations which lie far below the plane; some of them seem to be related to Lindblad's G arm.

1. Introduction

A sky survey has been made in the 21 cm emission line of neutral hydrogen covering the region with the galactic coordinates (new) $230° \leqslant l^{II} \leqslant 280°$ and $-3° \geqslant b^{II} \geqslant -15°$. The spacing was of 5° in longitude and of 1° in latitude. A total of 143 points in the sky were observed, each of them three times at different moments.

These data have been analyzed by means of contour diagrams which give the antenna temperature as a function of latitude and radial velocity for a given galactic longitude. Some of the graphs obtained are shown in Figures 1a, b, c.

In order to study continuous structures we made schematic plots using as radial velocity for each concentration the one corresponding to maximum temperature; their connection has been studied following the work of Lindblad (1967).

For some concentrations it was possible to separate the corresponding component by Gaussian analysis and in such cases N_H was evaluated from the formula given by Van de Hulst *et al.* (1954). A value of 135 K has been taken for the kinetic temperature, since this was the highest value found in our scale. Velocity dispersion was taken as the width at $T_b = 0.5\, T_{b\,max}$. Distance estimates were based on Schmidt's (1965) model of the Galaxy.

2. The Observed Features

We have adopted the notation used previously by Höglund (1963) and Lindblad (1967). For $l^{II} > 180°$ Lindblad found mainly four features.

(a) *Structure A* or local hydrogen whose typical characteristics are a very narrow velocity dispersion and great spread in latitude. The concentrations have velocities near zero. Figure 2 shows the mean value of those found in each latitude studied. The velocity of the local hydrogen appears to be negative at $l^{II} = 280°$, near the plane. This is due to the effect of an overlapping of the local hydrogen, the Orion arm and a contribution of the Carina arm (Garzoli, 1969). Beneath the plane the concentrations have velocities more nearly zero, as it is shown by the contour diagrams corresponding to that longitude.

At low latitudes we are in a region of great hydrogen concentration, due to the effect

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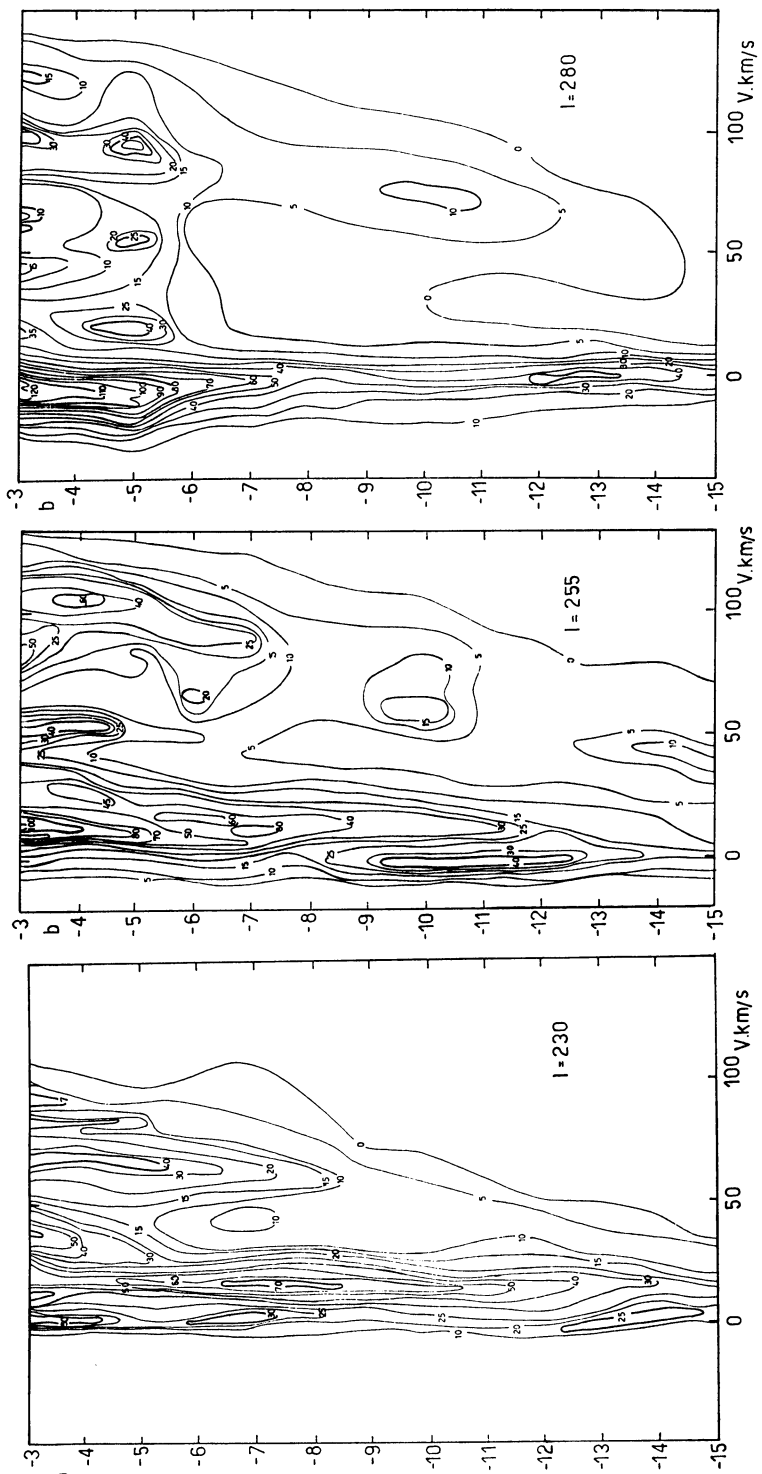

Fig. 1. Contour maps of antenna temperature as function of galactic latitude and radial velocity at longitudes, $l^{II} = 230°, 255°, 280°$.

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of the local structure or spiral arm which goes through the sun. For this reason local concentrations are the ones identified at most negative latitudes. On the basis of the circular galactic rotation model local hydrogen should become negative at $l^{II}=270°$; since it is positive for $270° \leqslant l^{II} \leqslant 280°$, these local concentrations are probably affected by peculiar motions.

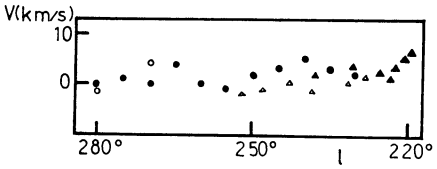

Fig. 2. Radial velocity – longitude diagram for the maximum temperature of the local hydrogen. Open circles represent Garzoli's data, open triangles are from the Kootwijk survey and full triangles are from the Dwingeloo survey. Full circles correspond to the present work.

Lindblad has suggested a theoretical model of a shell in expansion. The predictions of this model agree with our observations.

A full analysis into Gaussian components has not been made and consequently the mean values for velocity dispersion and the average number of atoms observed along the line of sight are not given. Typical average values are:

$$\sigma \approx 2\text{–}5 \text{ km s}^{-1}, \quad N_H \approx 6 \times 10^{20} \text{ at cm}^{-2},$$

which agree quite well with Lindblad's results.

(b) *Structure H or Orion arm.* Figure 3 shows radial velocities found for each longitude for structure H. The contour diagrams show that at $l^{II}=230°$ the maximum intensity falls below the plane, around $b^{II}=-7°$, and approaches it sharply as longitude increases. At $l^{II}=260°$ it is entirely on the plane and then it seems to dip down again.

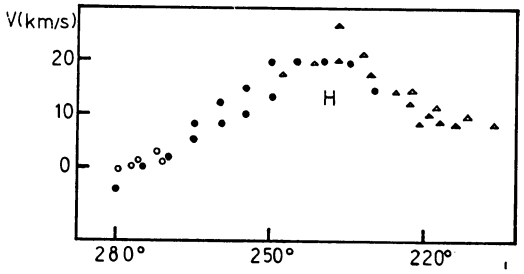

Fig. 3. Radial velocity – longitude diagram for the local arm (feature H); the symbols are the same as in Figure 2.

At $l^{II}=230°$ this structure is quite separated from the local hydrogen, but near $l^{II}=265°$ it overlaps with the local gas. Typical values for σ and N_H are 10 km s^{-1} and 4×10^{21} at cm^{-2} respectively; both are considerably greater than the corresponding values found by Lindblad because the analysis into Gaussian curves has not been done.

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As we can see, if circular motion is admitted, the most intense concentrations seem to be located behind the sun, with respect to the galactic center, and go away from it following an approximately ring-shaped path as l^{II} increases. This is shown in Figure 5.

(c) *Structure I or intermediate arm.* It is a very continuous structure located on the plane, with little spread in latitude. For this reason it has not been found by Lindblad at longitudes near ours, since he only observed intermediate latitudes with the Dwingeloo 25 m telescope. The only data available for $210° \leqslant l^{II} \leqslant 235°$ are those obtained at Kootwijk with the 7.5 m antenna. The values found are shown in Figure 4,

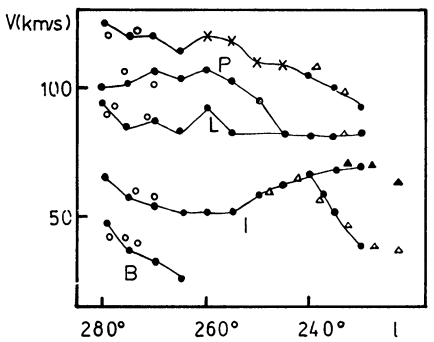

Fig. 4. Radial velocity – longitude diagram for the structures B, I, L and P. The symbols are the same as in Figure 2.

which also shows the agreement of our observations with those made by Lindblad and Garzoli. The latter refers to it as structure C. Typical values for σ and N_H are 13 km s^{-1} and 2×10^{21} at cm^{-2} respectively. For $203° \leqslant l^{II} \leqslant 212°$ Lindblad finds a value of 13×10^{21} at cm^{-2} for N_H. He also finds that the data for structure I are more similar to those found in the other hemisphere for the external arm, but he thinks it is doubtful that both belong to the same structure.

(d) *Structures P and L or Perseus arm.* Raimond's (1966) opinion is that the Perseus arm consists of both structures. He calls L the structure with greatest intensity and lowest velocity and he refers to the minor components as P. Structure L is the one with greatest spread in b; for this reason it is the only one measured by Lindblad with the 25 m telescope in a region overlapping ours. Figure 4 shows the data obtained and gives a comparison between them with those of Lindblad and Garzoli (the latter refers to these structures as F and G). To ascertain if the different concentrations are interconnected it is necessary to make a finer mesh in longitude and observe closer to the plane. The values of N_H and σ are likely to be highly variable and are affected by big errors due to the presence of many mingled structures.

(e) *Structure B.* For longitudes between 265° and 280° we observe a structure which does not appear at lower longitudes and consequently has not been studied by Lindblad. We call it B following Garzoli. It is located on the plane and we cannot say if it is related or not to the structure studied before. Its behaviour is shown in the radial velocity vs. longitude diagram of Figure 4.

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Figure 5 shows the general diagram of galactic structure for all observed features on the basis of Schmidt's rotation model.

3. Concentrations at Intermediate Latitude

All concentrations found are shown on Figure 6. The crosses are concentrations with little spread in latitude near $b^{II} = -5°$. It is impossible to determine σ without analysis into Gaussian components since they are mixed with other arms.

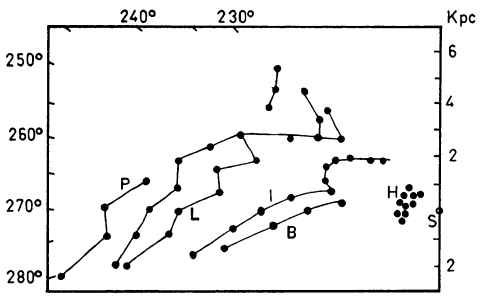

Fig. 5. General diagram of galactic structure (distances are based on Schmidt's model of the Galaxy).

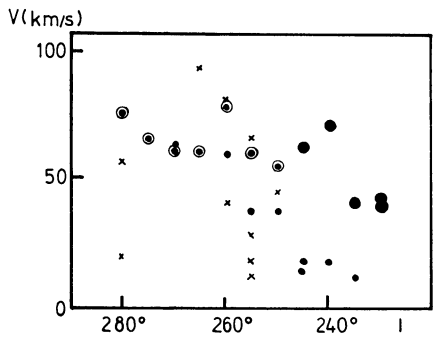

Fig. 6. Radial velocity – longitude diagram for the concentrations at intermediate latitudes.

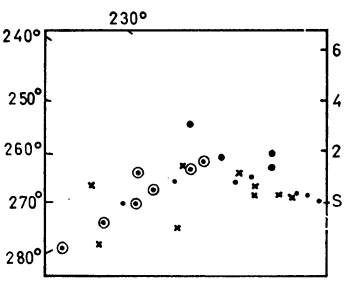

Fig. 7. Location of the concentrations at intermediate latitudes projected on the galactic plane.

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At latitudes between $-7°$ and $-8°$ and longitudes between 230° and 245° there are concentrations denoted by big dots, with $\sigma = 14$ km s^{-1}. Velocities correspond to the intermediate arm. These concentrations seem to be continued by the ones that start at $l^{II} = 250°$ which have a rather higher velocity dispersion and are located at $-10° \geqslant b^{II} \geqslant -11°$. The velocities are similar to those corresponding to structure L and this structure may affect the width. These concentrations are denoted by circled dots. This whole feature is very likely a continuation of feature G of Lindblad.

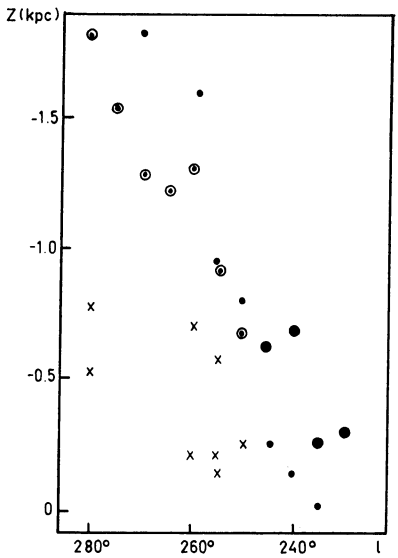

Fig. 8. Vertical distribution of the concentrations at intermediate latitudes.

Other concentrations of very low intensity are found at more negative latitudes, between $-13°$ and $-15°$ with σ of approximately 15 km s^{-1}; they are denoted by small dots.

4. Conclusions

The distribution of the structures found near the galactic plane shows good agreement with that found by Lindblad at $230° \leqslant l^{II} \leqslant 240°$ and that found by Garzoli at $270° \leqslant l^{II} \leqslant 280°$. They tend to be extended in latitude.

Those concentrations located below the plane which seem related to Lindblad's arm G, appear as extensions of the Intermediate arm away from the plane. The angular extent in latitude of this arm is lower than that of the Perseus arm. More observations at both negative and positive latitudes and at every degree in longitude are needed to test these conclusions.

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