A STATISTICAL STUDY OF LOCAL INTERSTELLAR MATTER BASED ON THE NANCAY 21-CM ABSORPTION SURVEY

J. Crovisier and I. Kazès
Département de Radioastronomie, Observatoire de Meudon

The survey of 21-cm galactic absorption towards 819 extragalactic sources, recently carried out with the Nancay radio telescope (Crovisier et al. 1978) provides a sample of absorbing neutral hydrogen clouds which is an order of magnitude larger than those resulting from other available surveys (Hughes et al. 1971, Radhakrishnan et al. 1972, Lazareff 1975, and Dickey et al. 1978). A statistical study of this sample offers insight into the properties of local interstellar matter.

We will refer to the results of a kinematical analysis of nearby clouds, and present a preliminary analysis of the internal velocity dispersion of the clouds and of their 21-cm optical depths. In these studies, account must be taken of the observational bias caused by the blending of absorption features coming from clouds at nearby velocities, and by the presence of spurious features resulting from an incomplete elimination of 21-cm HII emission when measuring the absorption profiles. Hydrogen spin temperatures may in principle be derived from comparison of emission and absorption observations at the same direction. However, the small-scale structure of the hydrogen distribution, which is now indicated by several observations (e.g. Greisen 1976, Schwarz and Wesselius 1978), precludes accurate determination of emission profiles corresponding to the same clouds as those responsible for absorption along the line of sight. Up to now, the closest approach to real spin temperature is perhaps the one made with the Arecibo antenna by Dickey et al. (1978).

The kinematical analysis was made on 299 clouds detected in absorption at $|b| > 10°$(Crovisier, 1978). The main results are: (i) The systematic motion relative to the Sun of cold neutral local hydrogen is the same as that of nearby stars defined by the standard solar motion. (ii) It has been possible to separate statistically the local differential galactic rotation from random motion in the radial velocities of the clouds. This was done by assuming a plane-parallel distribution of local HI clouds, symmetrical with respect to the galactic plane. Although large discrepancies from this model exist (e.g. gas associated with Gould's Belt) it was possible to determine the average distance from the galactic plane of HI cold clouds: $<|z|> = 107 \pm 29$ pc. (iii) The

W. B. Burton (ed.), The Large-Scale Characteristics of the Galaxy, 253–256.

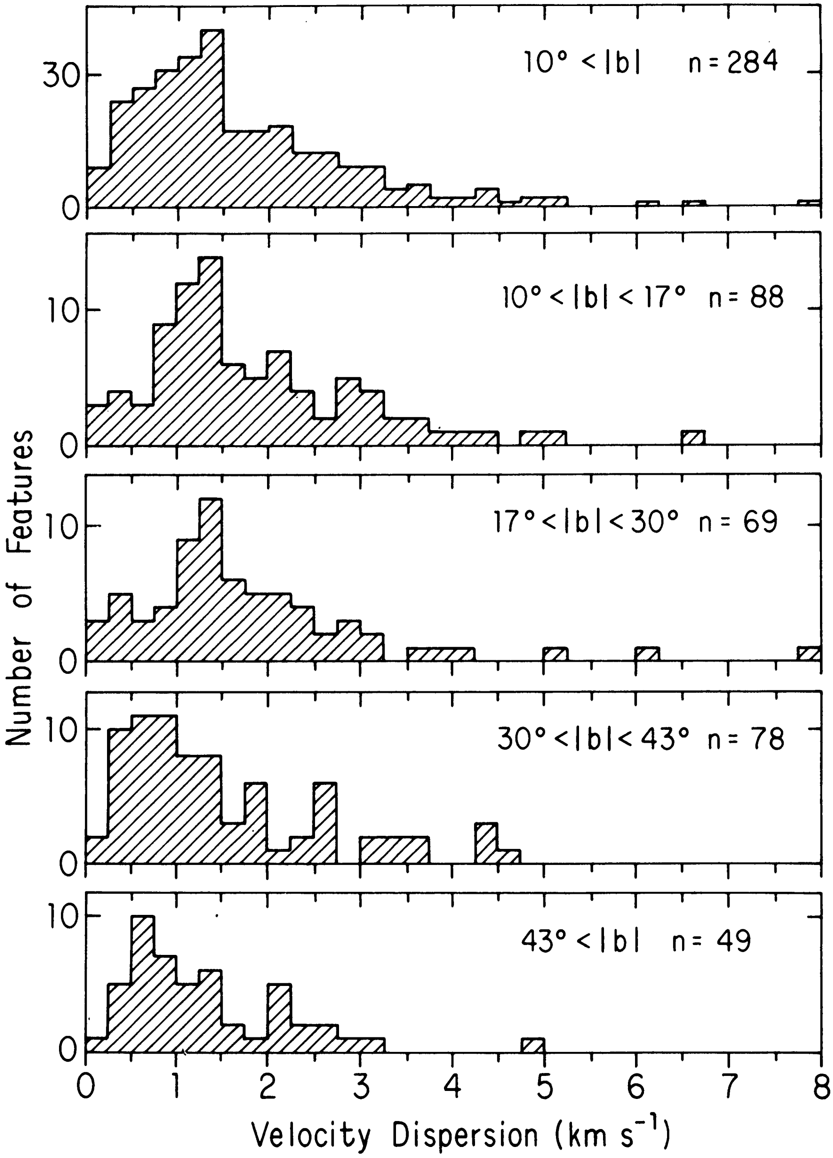

Figure 1. Histograms of the internal velocity dispersion of HI clouds for various latitude ranges. n is the number of clouds in each sample.

radial velocity dispersion, after subtraction of differential galactic rotation, is $<V^2>^{\frac{1}{2}} = 5.7 \pm 0.9$ km s^{-1} and corresponds to a three-dimensional velocity dispersion of about 10 km s^{-1}. No anisotropy greater than 30% was found in the velocity dispersion.

https://doi.org/10.1017/S0074180900014595 Published online by Cambridge University Press

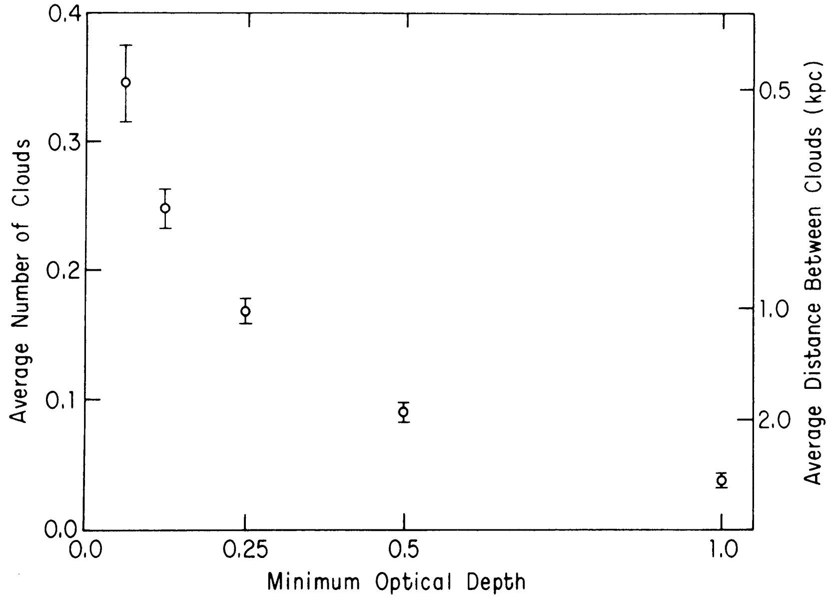

Figure 2. Average number P (left-hand ordinate) of clouds of optical depth at 21 cm greater than τ in a standard line of sight towards b = 90°, and average distance L (right-hand ordinate) between these clouds assuming a plane-parallel distribution of equivalent half-thickness equal to 170 pc.

Histograms of internal velocity dispersions, deduced from the observed widths of the absorbing features, are shown in Figure 1 for different latitude ranges. We do not think these histograms are biased against low velocity-dispersions owing to the spectral resolution of the Nancay survey (full half-power width of the channels was 1.3 km s^{-1}); they are, however, affected by blends which cause the feature widths to be overestimated. We believe that the difference between the histograms at $|b| < 30°$ and $|b| > 30°$ is due to the presence of blends, which are more liable to occur at low latitudes, and that the high-latitude histograms are closer to the real distribution of the internal velocity dispersions of the clouds. The distribution peaks around 0.6 km s^{-1}, but the average velocity dispersion is 1.7 km s^{-1}.

In order to derive objectively the distribution of 21-cm optical depths of HI clouds, it is necessary to take into account the sensitivity of each absorption spectrum, which depends on the intensity of the background source. We have calculated the average number per line of sight, $P(\tau)$, of features with optical depths greater than τ, reduced to the standard direction b = 90° using a consecant law (plane-parallel model). A correction was made to account, in a statistical way, for the presence of spurious features. $P(\tau)$ is shown in Figure 2. Note that with increasing τ, $P(\tau)$ decreases more rapidly than might have been expected

https://doi.org/10.1017/S0074180900014595 Published online by Cambridge University Press

from the exp ($-\tau$) distribution of optical depths assumed up to now on the basis of the observed histograms of optical depths (Clark 1965, Hughes et al. 1971, and Radhakrishnan and Goss 1972). $P(\tau)$ is related to the average distance L (τ) between clouds of optical depth greater than through $L(\tau) = H/P(\tau)$, where H is the equivalent half-thickness of the cloud distribution in a plane-parallel model. The right-hand ordinate in Figure 2 is scaled in L assuming a Gaussian distribution for clouds along the z-direction, and the average distance from the galactic plane found in our kinematical study. There is for instance one cloud of $\tau > 0.062$ every 500 pc, which may be compared with three clouds per kpc found by Radhakrishnan and Goss (1972)--who did not consider the limit of detection for τ--and one cloud of $\tau > 0.01$ every 80 pc derived recently from a smaller sample by Dickey et al. (1978).

REFERENCES

Clark, B. G.: 1965, Astrophys. J. 142, 1388.

Crovisier, J.: 1978, Astron. Astrophys. 70, 43.

Crovisier, J., Kazès, I., Aubry, D.: 1978, Astron. Astrophys. Suppl.32,20.

Dickey, J. M., Salpeter, E. E., Terzian, Y.:1978, Astrophys. J. Suppl.36,7.

Greisen, E. W.: 1976, Astrophys. J. 203, 371.

Hughes, M. P., Thompson, A. R., Colvin, R. S.: 1971, Astrophys. J. Suppl. 23, 323.

Lazareff, B.: 1975, Astron. Astrophys. 42, 25.

Radharkrishnan, V., Goss, W. M.: 1972, Astrophys. J. Suppl. 24, 161.

Radhakrishnan, V., Murray, J. D., Lockhart, P., Whittle, R. P. J.: 1972, Astrophys. J. Suppl. 24, 15.

Schwarz, U. J., Wesselius, P. R.: 1978, Astron. Astrophys. 64, 97.

DISCUSSION

Rubin: Did you adopt a value for Oort's constant A, or did you estimate a distance for each cloud?

Crovisier: I assumed the standard value A = 15 km s^{-1}.

https://doi.org/10.1017/S0074180900014595 Published online by Cambridge University Press