CO SURVEY OF THE SOUTHERN MILKY WAY

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When the Columbia Southern Millimeter-Wave Telescope on Cerro Tololo, Chile, began operation in January 1983, one of the main goals was to make the first extensive out-of-plane survey of 2.6-mm CO emission in the Southern Milky Way. Because this telescope, a 1.2-meter Cassegrain, is a close copy of the Columbia telescope in New York -- with nearly identical antenna, feed, and calibration -- it will be very easy to join our northern and southern surveys to make the first homogeneous radio survey of the entire Galaxy. The Chile telescope does have one important improvement over the New York system: a liquid-nitrogen-cooled receiver with a single-sideband noise temperature of 385 K. Details of the telescope are given in Cohen (1983).

The basic galactic survey, a mirror image of the survey done with the New York telescope, will be completed in early 1984. It will run at least from $\ell = 300^{\circ}$ to 348° and from $b = -1^{\circ}$ to $+1^{\circ}$. Points will be spaced at most every two beamwidths over the entire range, and every beamwidth from $b = -0.5^{\circ}$ to $+0.5^{\circ}$, the latitudes containing the most intense CO emission. Because Cerro Tololo is such a good site for the galactic survey both in terms of weather and location (the galactic center transits 2° from the zenith), and because our liquid-nitrogen receiver is so fast, the final coverage will probably be somewhat better: we will extend the survey to higher latitudes and will increase the sampling. In addition, by late 1983 we will connect the northern and southern surveys with the first well-sampled survey of CO in the region of the galactic center.

To trace out the inner arms of the Galaxy as Dame (1983) did in the Northern Hemisphere -- by identifying the large molecular clouds and locating them in the Galaxy with respect to the classic spiral arms -- requires the full latitude coverage that is not yet available. Some interesting features are however already clearly apparent in our preliminary results. Figure 1 (these Proceedings, page 2) is a longitude-velocity map of the entire galactic equator from $\ell = 300^{\circ}$ through the center to $\ell = 60^{\circ}$. The most prominent feature is the well-known peak at the galactic center. The classic "4-kpc expanding arm" is visible as the line

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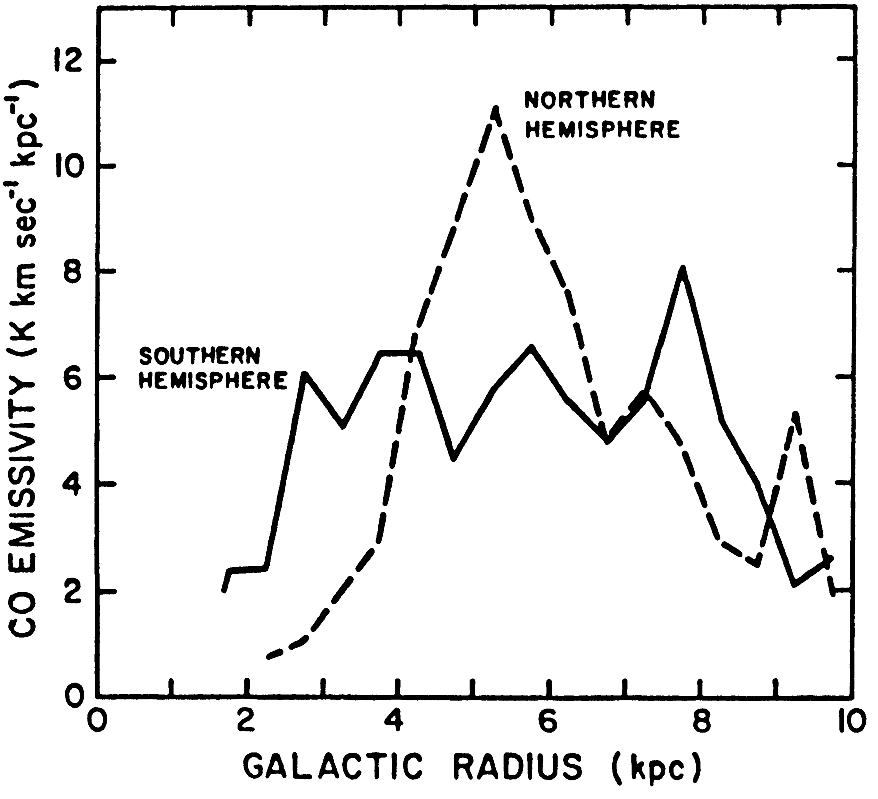

Figure 2. Emissivity of CO as a function of distance from the galactic center. The Northern Hemisphere data are from our New York survey. The sampling of the Southern data is still somewhat irregular, and the Southern Hemisphere curve should be considered preliminary.

of emission crossing $\ell = 0^{\circ}$ near v = -50 km s^{-1}. Further from the center, both north and south, the CO is organized into giant molecular clouds which in turn are clearly organized into larger structures on the scale of galactic spiral arms.

From the data available in May, 1983 we made a preliminary analysis of the distribution of CO as a function of galactocentric radius using a simple axisymmetric model of the Galaxy (Cohen et al., 1980). The results (Figure 2) are in general agreement with early Australian results (Robinson et al., 1983), and show that the galactic distribution of molecular clouds is plainly not axisymmetric. The well-known "molecular ring" -- the band of intense CO emission between 5 and 7 kpc from the galactic center -- has broadened into a wide band that begins, like the HI, abruptly at 4 kpc and then trails off by the solar radius. Because CO is a good tracer of spiral structure (Cohen et al., 1980), this is just what we would expect: the spiral model of Georgelin and Georgelin

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(1976) based on HII regions shows that in the Northern Hemisphere the spiral arms are close together and lie in the molecular ring, while in the Southern Hemisphere they spread apart in galactic radius.

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DISCUSSION

(There was no Discussion after Cohen's paper. The following comments were made later in the Symposium, in Section II6, after the papers by T.M. Dame and D.B. Sanders, but fit best here. - Editor)

A. Blaauw: A comment to the diagrams shown by Cohen and by Sanders. The surveys made by both are restricted to latitudes 0°±1°. This means that the material must be very incomplete at low velocities, where one deals with small distances. I never see in these beautiful diagrams any warning of this incompleteness. For instance, Orion sits about 100 pc below the plane; at a distance of 1000 pc, it would still be at 6° latitude and hence missing in the surveys by Cohen and by Sanders. One should either indicate this incompleteness due to latitude limits, or suppress the low velocities from the diagrams; otherwise the diagrams are misleading.

T.M. Dame: Indeed, the local emission may go up to very high latitudes. At velocities above 20 km/s we miss very little emission.

R.S. Cohen: Dame has done a wide-angle survey going 5° or 10° out of the plane to map nearby objects. But the local region is irrelevant to the problem of spiral structure.

F.J. Kerr: Still, Blaauw has given us an important warning.

(The spiral-structure implications of these surveys are discussed in Section II5 of these Proceedings. - Editor)

H. van Woerden to Sanders: What is your estimate for the total amount of molecular hydrogen in the Galaxy?

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D.B. Sanders: About 3 x 10^9 solar masses.

M.L. Kutner: What is your estimate for the H_2 mass inside the solar circle?

Sanders: About 85% of the total, hence about 2.5 x 10^9 $M_\odot$.

Kutner: That seems high compared to Hermsen's estimate based on the γ-ray observations.

Sanders: The γ-ray group derive a conversion factor from CO to H_2 of about 3 × 10^{20} molecules cm^{-2} K^{-1} $(km/s)^{-1}$; our number is 3.6 × 10^{20}, hence there is good agreement. And high-resolution observations of individual clouds, giving virial masses and column densities from ^{13}CO, do not show any evidence for a lower conversion factor.

Cohen presenting his CO survey CFD

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