AN OUT-OF-PLANE CO SURVEY OF THE FIRST GALACTIC QUADRANT

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We are undertaking at Columbia University an out-of-plane survey of 2.6 mm CO emission from the first quadrant of the galactic disk with a 1.2 meter telescope. With the 8' beamwidth of this instrument at 2.6 mm (about that of the largest existing steerable instruments at 21 cm) it is possible to completely map the first quadrant in only a few hundred days of observation.

The first systematic out-of-plane survey (Cohen and Thaddeus 1977; Cohen 1978), consisting of 179 spectra taken with the 1.2 m telescope, confirmed the findings of two previous in-plane surveys (Gordon and Burton 1978; Scoville and Solomon 1975) that galactic CO emission is concentrated in a ring 6 kpc in radius. A fit of a cylindrically symmetric galactic model to this data provided the first systematic determination of the thickness of this molecular ring as a function of distance from the galactic center, and showed that the ring lies roughly 40 pc below the b=0° plane.

Since this first survey was made, several significant improvements have been made in the 1.2 m telescope. A fast drive now allows rapid position switching over large angles. The spectral resolution has been improved from 2.6 km s^{-1} to 0.65 km s^{-1}, and the spectral range of the backend has been increased from 104 km s^{-1} to 166 km s^{-1}. The single sideband system noise temperature of the uncooled front end has been lowered from 1200°K to 860°K.

A new galactic survey was undertaken with this improved system during the past winter (1977-8). To date, about 1600 spectra have been obtained of the CO disk at longitudes from 12° to 60°, and latitudes from -1.25° to +1.25°. Specifically, b=0° has been sampled every beamwidth (0.125°) in longitude, b= ±0.25° and ±0.50° have been sampled every 0.25°, b= ±0.75°, ±1.00°, and -1.25° have been sampled every 0.50°, and some observations have been made at b=+1.25°. The LSR velocity range covered was from -13 to 153 km s^{-1} for l<55°, and from -55 to 112 km s^{-1} for $l \geq 55°$. Integration times were adjusted to give a 3σ noise level of 0.8°K per 0.5 MHz spectral channel. Base-

W. B. Burton (ed.), The Large-Scale Characteristics of the Galaxy, 53–56.

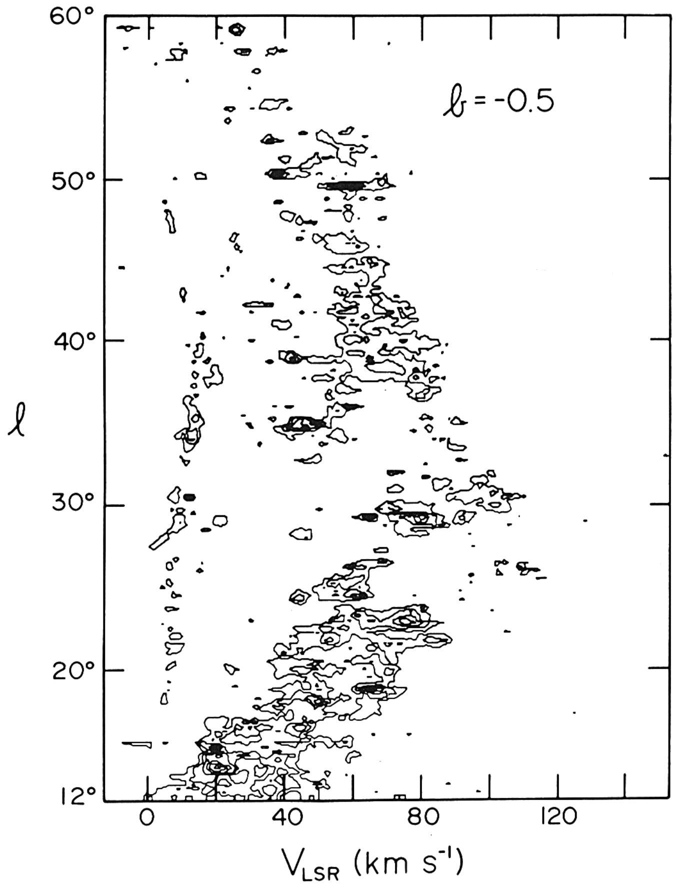

Figure 1. Longitude-velocity diagram of CO emission at b = -0°.5. The contour interval is 1 K of antenna temperature corrected for beam efficiency and atmospheric absorption.

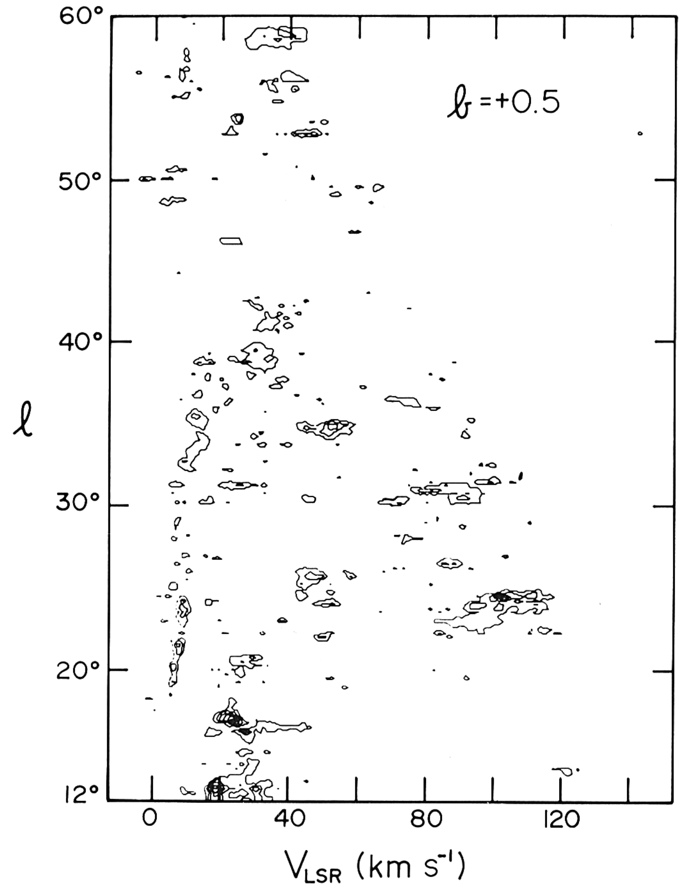

Figure 2. Longitude-velocity diagram of CO emission at b = +0°.5.

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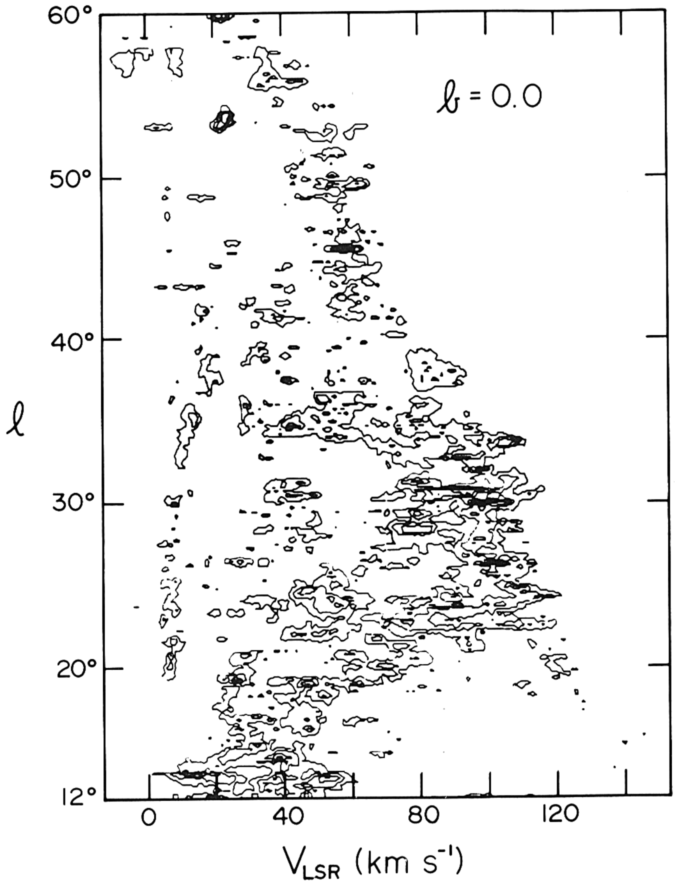

Figure 3. Longitude-velocity diagram of CO emission at b = 0°.

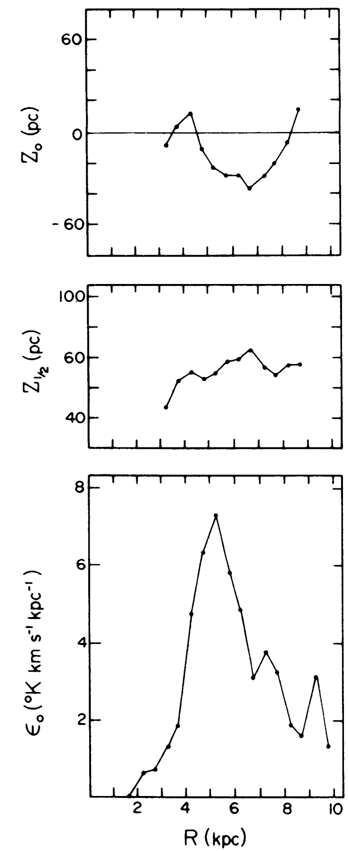

Figure 4. Displacement (top), half-thickness at half-maximum (middle), and centroid emissivity (bottom) of the CO disk as functions of galactic radius.

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lines were linear to within the 1σ noise level.

Longitude-velocity diagrams for the galactic plane and for b=±0.5° are shown in figures 1, 2, and 3. (Figure 3 is preliminary and represents only half the existing in-plane data.) These figures corroborate the main features of the galactic distribution of CO obtained in our previous survey. The most intense emission comes from the roughly triangular area with corners at l=12°, v=20 km s^{-1}; l=22°, v=110 km s^{-1}; and l=33°, v=100 km s^{-1}. When transformed to galactocentric coordinates using a circular rotation model of the Galaxy, this area corresponds to the region of the molecular ring. The displacement of CO emission with respect to the b=0° plane is immediately apparent on comparing the b=+0.5° and b=-0.5° diagrams.

The new survey has been analysed quantitatively in terms of the cylindrically symmetric galactic model described previously (Cohen 1978; Cohen and Thaddeus 1977). The half-thickness of the CO plane, its displacement, and the emissivity of CO, all as functions of galactic radius, are shown in figure 4. These new results are generally consistent with those reported before; an apparent but statistically uncertain rise in the thickness of the CO disk for R between 7 and 8 kpc in the first survey is now absent. Near the peak of the molecular ring at R=5.2 kpc, the ring is 50 pc thick, and is 23 pc below the b=0° plane.

With the large amount of CO data now available, large scale features of the Galaxy in addition to the molecular ring are starting to appear. For example, on the b=0° map, there appear to be two roughly parallel ridges, one running from l=12°, v=10 km s^{-1}, to l=30°, v=80 km s^{-1}; and the other from l=12°, v=20 km s^{-1} to l=25°, v=90 km s^{-1}. From l=24° to l=27°, these ridges are separated by a large hole. There is another ridge extending almost vertically at v≈60 km s^{-1} from l=34° to 53°. There is an approximate correspondence between these features and some of the features identified with spiral arms by Burton and Shane (1970) and Shane (1972).

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