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Since our original report of CO emission from outside the solar circle in the first quadrant (Kutner and Mead, 1981) we have extended the observations in two ways: (1) We have improved latitude and longitude coverage. Preliminary results on the latitude distribution were reported by Kutner (1983). (2) We have extended our cloud mapping, giving us at least partial CO maps of 55 clouds, along with ^{13}CO, $C^{18}O$, CO (2-1), and 2-mm H_2CO observations of some clouds.

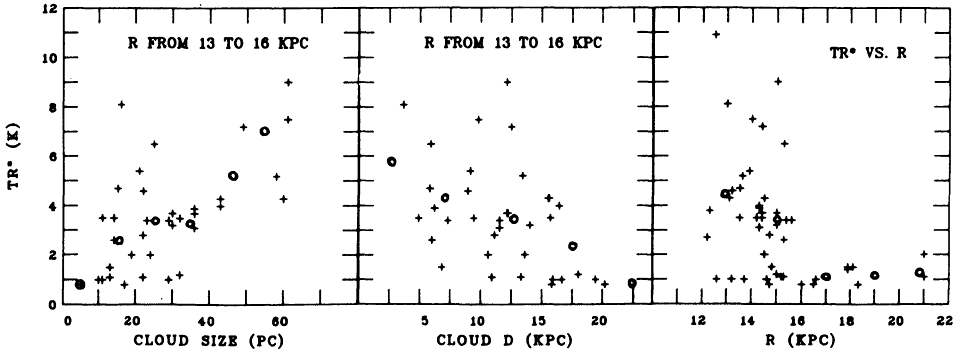
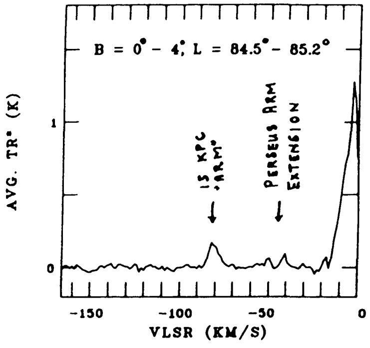


Fig. 1 presents statistics on clouds with sufficient mapping data. (Crosses represent data points and circles indicate binned averages.) (A) For clouds at the same distance, R, from the galactic center there is a correlation between peak temperature T_R^* and cloud size. (B) For clouds with similar R, we see a falloff in T_R^* with distance, d, from the Sun, suggesting that beam dilution becomes important in distant clouds. (C) There is a falloff in T_R^* with R, only weak clouds being seen beyond R ~ 16 kpc.

Using the CO and isotopic data, as well as CO (2-1) data taken at the Texas Millimeter-Wave Observatory (Dickman et al., in preparation), along with microturbulent radiative transfer models (Kutner and Leung, in preparation), we conclude that densities and column densities of GMCs in the outer Galaxy are essentially the same as in the inner Galaxy. However, GMCs in the outer Galaxy are cooler (6 K vs 13 K), probably due to a lower cosmic-ray flux.

H. van Woerden et al. (eds.), The Milky Way Galaxy, 209–210.



We have used a region of 0.8° in l by 4.0° in b, sampled at 0.1° intervals (for profiles see Kutner 1983) to get an idea of the radial distribution in the outer Galaxy. Fig. 2 shows the average of all 328 spectra. At -40 and -80 km/s it contains two features pointed out by Kutner and Mead (1981): an extension of the Perseus Arm into the first quadrant, and a feature about 15 kpc from the galactic center. The latter is also prominent in HI-data averaged over b (Blitz et al. 1981). The integrated intensity from -25 to -100 km/s in this average spectrum is 1.8 K km/s, corresponding to $N(H_2) \sim 7 \times 10^{20}$ cm^{-2}. If this slice is typical of the outer Galaxy, then the total mass of H_2 in the outer Galaxy would be 5×10^8 $M_\odot$.

The results of Kutner and Mead have been questioned by Solomon et al. (1983). We attribute the failure of Solomon et al. to reproduce our results to problems in calibration and sensitivity. In fact most of the disagreement is over the weak, small clouds that contribute little to the total mass. One must be careful in comparing integrated intensity along any given line of sight. First, the outer Galaxy subtends 6 times the solid angle of the inner Galaxy. Second, each galactic radius, R, contributes twice to each line of sight through the inner Galaxy. Finally, one must consider the variations with R in the conversion from CO intensity to mass (Kutner and Leung, in preparation). Despite all of the disagreement, Solomon et al. (using the same conversion factor from CO to H_2 as we did) get an estimate for the outer-Galaxy mass which differs by only a factor of two from ours. (This factor of two arises from their use of an assumed scale height vs our measured scale height). This supports the idea that most of the mass is in GMCs.

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