Determining the Distances to Infrared Point Sources

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Abstract

We present analysis of the first six square degrees of the Milky Way Galactic Ring Survey (GRS), a ^{13}CO molecular line survey of the inner Galaxy. Extended infrared emission correlates well with extended ^{13}CO emission (see Fig. 1) Many compact infrared sources identified by MSX and IRAS are also often coincident with ^{13}CO clumps. These sources are probably embedded young stars and protostars. By associating infrared point sources with ^{13}CO emission, we estimate their kinematic distances. We resolve the near/far distance ambiguity using HI self-absorption data from the BUAO survey. Using the estimated distances, we calculate luminosities and ZAMS spectral types. Once the distances to enough faint young stars and protostars have been estimated, we will determine their luminosity functions and spatial distributions throughout the inner galaxy.

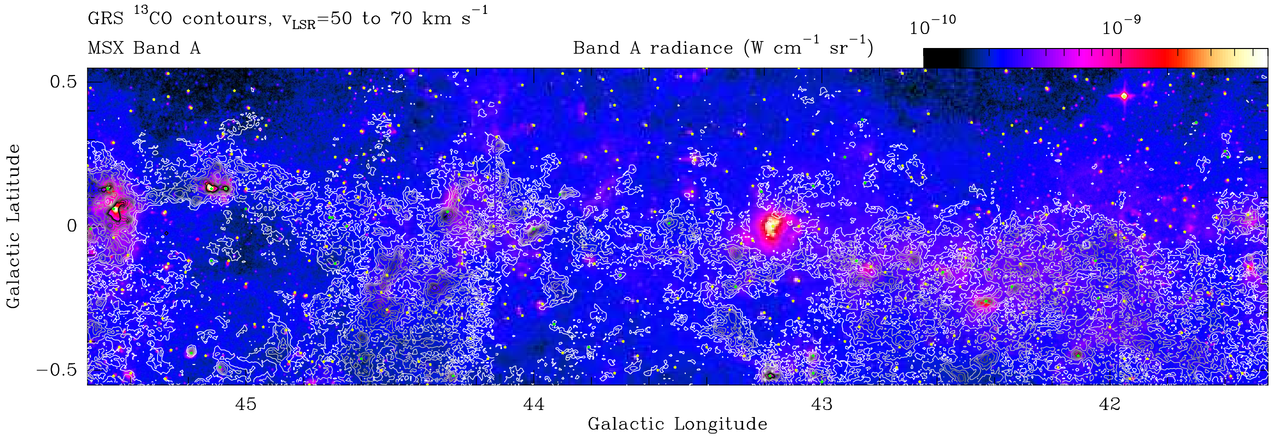

Fig. 1: Overlay of contours from the GRS ^{13}CO channel map for emission between 50 and 70 km s^{-1} on a false color infrared image obtained with the MSX satellite (Band A, 6.8-10.8 μm). The image h… background subtracted which removes both Zodiacal and very large scale Galactic emission. The angular resolution of the infrared image is $6''$ compared with the $46''$ resolution of the GRS. Darker cont… ^{13}CO correspond to intensity peaks. IRAS point sources are mrked with yellow stars, and IRAS point sources associated with ^{13}CO clumps are marked with green stars.

Investigation

- How well is the ^{13}CO emission correlated with infrared emission?
- How many IRAS point sources are obviously associated with ^{13}CO clumps?
- Is the association sample large enough to measure its luminosity function and spatial distribution?

Analysis

We superpose contours of ^{13}CO emission on MSX images to look for correlation (Fig. 1).

After resolving the near/far distance ambiguity using the HI data, we assign distances and LTE masses to all ^{13}CO clumps assuming the Clemens rotation curve (REF). Of roughly 400 IRAS point sources coincident with ^{13}CO features, 116 are clearly associated with bright, isolated ^{13}CO clumps. For these unambiguous cases, we assign the clump distances to the point sources. We estimate the total far infrared luminosity from the IRAS 60 and 100 micron fluxes (Fig. 2).

We estimate the ZAMS spectral type of each point source as if it is a single star (Panagia ref).

Future Work

We find distances and luminosities for the most obvious 116 correlations between IRAS point sources and ^{13}CO clumps. Roughly 1/3 of the remaining IRAS point sources are coincident with morphologically complex ^{13}CO emission, or multiple ^{13}CO clumps along the line of sight at different velocities. We plan to compare GRS data with high resolution infrared data (MSX, 2MASS, ISO) to convincingly associate these point sources with some of the more complex ^{13}CO features.

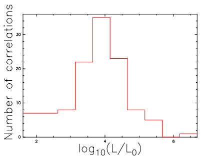

Fig. 2: Luminosity histogram for IRAS point sources associated with bright isolated ^{13}CO clumps. $log_{10}(L/L_\odot)$ ranges from 1.6 to 6.68 with an average of 3.7.

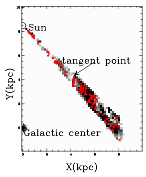

Fig. 3: The shading is proportional to ^{13}CO LTE mass. The red stars represent IRAS point sources, and their sizes are proportional to $log_{10}(L)$. The ^{13}CO shows clear concentrations and gaps, and the distribution of infrared sources is different.

Conclusions

- There is remarkable correlation between extended emission in ^{13}CO and the infrared.
- We find distances and luminosities for 25% of IRAS point sources coincident with ^{13}CO emission in the GRS region.
- Large scale Galactic structures, as well as a difference between the molecular gas and infrared source distributions are already apparent.
- We can begin to determine the luminosity function for infrared sources in the inner Galaxy.

REFERENCES

Clemens, D.P., Sanders, D.B., Scoville, N.Z., 1988, ApJ, 327, 139

Panagia....

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