Reprinted from the paper by R. Simon, R. Y. Shah, J. M. Jackson, T. M. Bania, D. P. Clemens, & M. H. Heyer

**Abstract**

Recent high resolution surveys with the ISO and MSX satellites have revealed a large number of Galactic dark clouds with significant extinction in the mid-infrared. The infrared dark clouds are characterized by their high column densities and low temperatures. Little is known, however, about their origin and distribution in the Galaxy.

The BU-FCRAO Galactic Ring Survey (GRS), a high resolution survey of $^{13}$CO emission in the inner Milky Way, makes it possible to derive physical parameters of IR dark clouds and their parental molecular clouds, such as sizes and masses, by spectroscopically determining their kinematic distances. Based on morphological correlation of IR extinction and GRS $^{13}$CO emission in velocity channel maps, we assign radial velocities to the IR dark clouds throughout the first Galactic quadrant and, assuming they are at the near kinematic distance, determine their location in the Galaxy. We find that the majority of the IR dark clouds are concentrated in the Galactic Ring at a Galactocentric radius of 5 kpc. We suggest that the most massive IR dark clouds represent high mass proto-clusters, or OB-associations in the making.

**GRS and MSX datasets**

The Milky Way Galactic Ring Survey (GRS), described in the introduction (Shah et al. 2003) is designed to probe the star-forming and quiescent molecular gas comprising the 5 kpc thick Galactic Ring.

The Midcourse Space Experiment (MSX) surveyed the entire Galactic plane within $|b| \leq 5^\circ$ in four mid-infrared spectral bands between 6 and 25 μm (Price et al. 2001, AJ 121, 2819).

<table>
<thead>
<tr>
<th>Survey</th>
<th>Wavelength</th>
<th>Coverage</th>
<th>Angular Resolution</th>
<th>Sensitivity</th>
<th>λ [μm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRS</td>
<td>3 mm</td>
<td>$-1^\circ$ to $+1^\circ$</td>
<td>$18''$ to $52''$</td>
<td>Spectral Res. 0.25 km s$^{-1}$</td>
<td>0.4 K</td>
</tr>
<tr>
<td>MSX Band</td>
<td>A: 6.8-8.9 μm</td>
<td>-1° to +1°</td>
<td>$20''$ to $6''$</td>
<td>Most sensitive Band, PAH</td>
<td></td>
</tr>
</tbody>
</table>

**Dark cloud identification**

Out of the 375 dark clouds selected, 318 have clean morphological matches with GRS molecular line emission in distinct velocity channels. The remaining dark clouds are either low contrast clouds, have only weak GRS 13CO emission or are probably holes in the MSX emission. To convert the assigned radial velocities into distances, we assume a flat rotation curve with (R$_0$, v$_{LSR}$) = (8, 220) km s$^{-1}$ and that the dark clouds are located at the near kinematic distance.

**Distributions and distribution**

The GRS 13CO map for 4° to 6° is shown in the left panel of the figure. The individual dark clouds are identified as IRDCs and their locations are plotted as circles. The sizes of the circles correspond to the approximate contrast value found for a given object. Higher contrast means larger 13CO opacity.

**Acknowledgements**

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**References**


For more information and available data, visit the GRS web page at www.bu.edu/GRS
The MSX data are available at irsa.ipac.caltech.edu/applications/MSX/