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DOES CO TRACE H<sub>2</sub> AT HIGH GALACTIC LATITUDE?

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We have recently completed a CO survey of 342 Infrared Excess Clouds (IRECs) distributed uniformly across the sky. Following comparison of the integrated CO brightness  $W_{CO}$  ( $K km s^{-1}$ ) with the  $100 \mu m$  infrared brightness  $B_4$  obtained from the *IRAS* data, we have found evidence for a threshold in  $B_4$  of  $4 - 5 MJy sr^{-1}$  below which CO does not form.

In an attempt to find an unbiased method to determine the location of High Latitude Molecular Clouds, Désert, Bazell, and Boulanger (1988) (DBB) studied the correlation between the  $100 \mu m$  infrared brightness from the *IRAS* survey and the integrated HI column density from several HI surveys. They cataloged regions characterized by an excess of infrared radiation above what was expected from the local  $B_4-N_{HI}$  correlation, producing a list of several hundred statistically significant infrared excess clouds or IRECs. The physical nature of the IRECs was not totally clear. Hence, in order to determine whether they corresponded to molecular clouds we performed a CO survey of the DBB clouds.

The original correlation study by DBB had spatial resolution of  $1/3$  degree. To accurately determine the observational positions we made a  $2x2$  degree map at 2 arc min resolution from the  $100 \mu m$  *IRAS* Sky Flux plates centered on the peak of infrared excess for each cloud. The search position corresponded to the peak of  $100 \mu m$  brightness within a  $0.5$  degree box coincident with the center of the map, after subtracting a background equal to the lowest value in the  $2x2$  degree map.

In the figure we show the detection success rate  $R = No. det./No. obs.$  as a function of  $B_4$ . A clear cutoff or threshold is evident between  $4$  and  $5 MJy sr^{-1}$  in  $B_4$ . Above  $4 MJy sr^{-1}$  the average detection rate is  $71\%$ . Below  $4 MJy sr^{-1}$  the average detection rate is  $3\%$  (consisting of over  $100$  observations). Using the conversion  $B_4/A_V = 16 MJy sr^{-1}/mag$  the threshold value corresponds to about  $0.25 mag$  of visual extinction. Above  $5 MJy sr^{-1}$  a plot of  $W_{CO}$  vs.  $B_4$  shows no direct correlation. We will also present evidence that this threshold effect can be seen within an individual cloud, providing evidence for a phase transition between atomic and molecular gas.

While the main thrust of our observing program was to examine the CO content of the IRECs, we also attempted to detect CO toward a number of UV stars so we could correlate CO brightness with direct measurements of  $H_2$  column density and  $E(B-V)$ . We observed  $26$  stars selected from the list of Bohlin, Savage, and Drake (1978) which had been observed in the UV by the Copernicus satellite. Of the  $26$  observed stars in the sample we detected CO toward  $6$ . Excluding  $\epsilon Per$ , which appears to have a large amount of CO behind it, CO is detected only for those stars with  $E(B-V)$  above  $0.3 mag$ . corresponding to  $A_V = 0.9 mag$ . This is consistent with our results obtained using infrared data which would be expected to show a lower value for  $A_V$  because the smooth background and foreground component of the image has been removed.

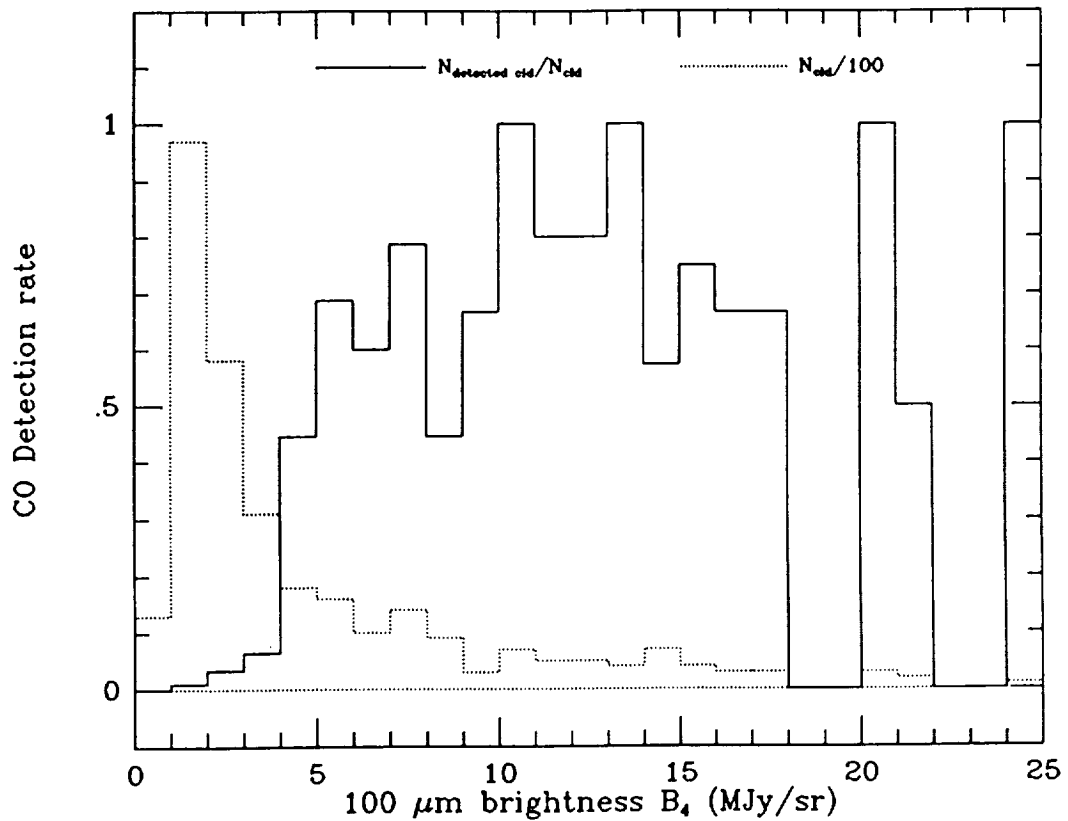
There are a number of ways to explain the excess infrared brightness observed in the clouds in which CO was not detected. The most interesting is that they are clouds containing  $H_2$  but not CO, indicating that CO is not necessarily a good tracer of the total gas content of the diffuse interstellar medium. It is possible that the clouds have an abnormally high dust to gas mass ratio, producing excess IR due to larger column density of dust. Finally, it may be that these clouds

are heated by some distant heating source that 'beams' its radiation in a certain direction due to inhomogeneities in the interstellar medium.

*References*

Bohlin, R.C., Savage, B.D., and Drake, J.F. 1978, Ap. J., **224**, 132

Désert, F.X., Bazell, D., and Boulanger, F. 1988, to appear in Nov. 15 issue of Ap. J.



*Figure Caption*

The solid line shows the detection success rate as a function of 100 μm infrared brightness, B<sub>4</sub>. Below the threshold value of 4 MJy sr<sup>-1</sup> the average detection success rate is about 3%. Above the threshold it is about 71%. The dotted line shows the number of clouds in each brightness bin divided by 100.