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A Correlation Between the IRAS Infrared Cirrus at 60 or 100 μm and Neutral Atomic Hydrogen in the Outer Galaxy

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ABSTRACT

We find a linear correlation between the infrared cirrus at 100 or 60 μm and neutral atomic hydrogen near the galactic plane. IRAS Sky Brightness images were compared to the 0.5° resolution Weaver-Williams HI survey in two regions of the outer Galaxy near l= 125° and l=215°. The dust temperature inferred is nearly uniform and in reasonable agreement with theoretical predictions of thermal dust emission.

INTRODUCTION

The IRAS Satellite Survey has given us a wealth of information on the diffuse galactic infrared emission, strongest in the 100 μm band, which has become known as the infrared cirrus (Low et al. 1984). Boulanger, Baud, and van Albada (1985) have found a correlation between the 100 μm cirrus and several high latitude HI clouds. Weiland et al. (1986) have found an association between the cirrus and several high latitude molecular clouds.

We discuss the properties of the infrared cirrus, and the physical conditions necessary for the observed emission. A more extensive discussion of the data can be found in Terebey and Fich (1986).

DATA

The two IRAS image fields are from the original release of the third HCON Sky Brightness Survey with central positions at (1.6h,60°) and (7.0h,0°) and linear extents of 16.5°. We smoothed the IRAS data to 0.5° resolution and subtracted a smooth zodiacal background from both the 60 and 100 μm data.

The HI data (Weaver and Williams 1973) have an angular resolution of 0.5° and galactic latitude range (-10°,10°). We constructed integrated brightness temperature maps from the HI data, then converted to neutral hydrogen column density assuming optical depth much less than one.

RESULTS

The 60 μm data show a linear correlation with the 100 μm data. Least squares derived values for the slope give 0.207 ± 0.022 and 0.205 ± 0.026 for the l = 125° and l = 215° fields, respectively. The small scatter in the correlation implies that the physical conditions leading to the infrared emission are very uniform in the outer Galaxy.

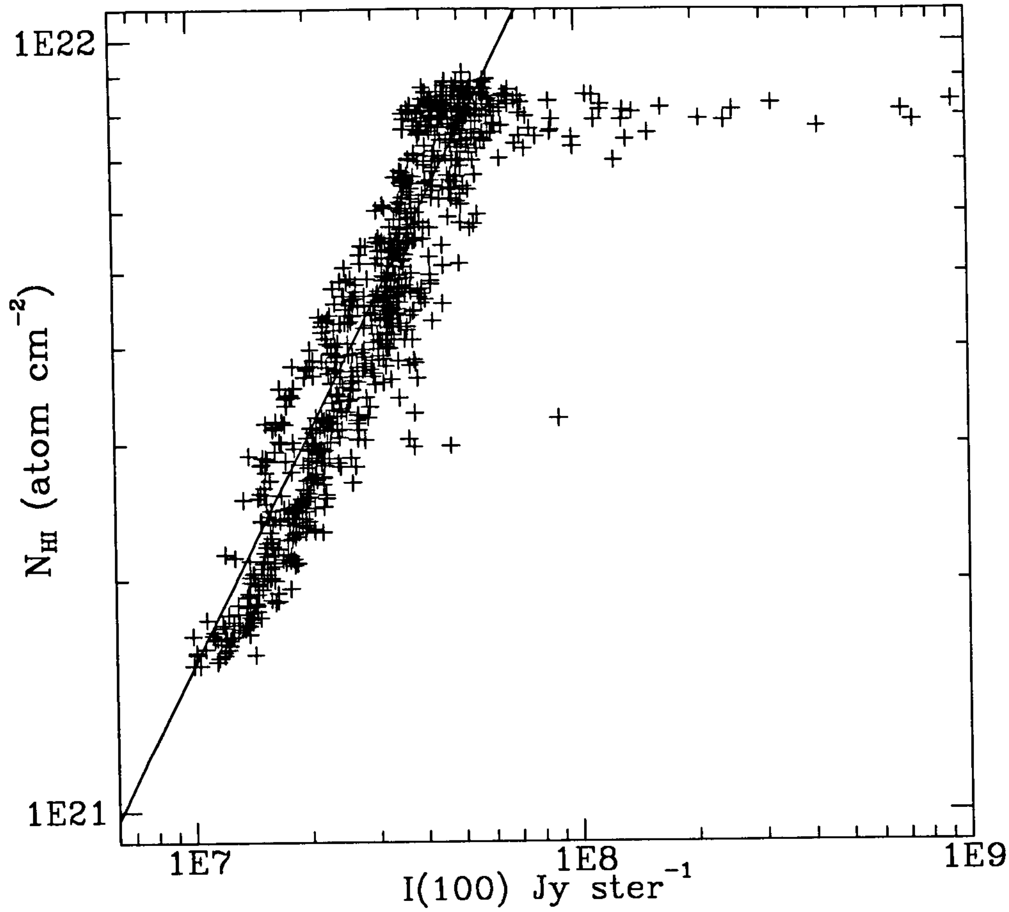

Figure 1. The HI column density is plotted against the IRAS 100 μm intensity in the $l = 125°$ field. Contamination by non-cirrus infrared sources produces the high intensity 100 μm points that don't follow the correlation. Solid line shows a least squares fit to the data (excluding non-cirrus sources).

If the infrared emission is due to thermal emission from dust grains, then galactic properties such as the dust to gas ratio and the interstellar radiation field are relatively uniform in these regions. The infrared emissivity is a strong function of dust temperature. If the dust temperature is uniform then we might expect a linear relationship between the infrared intensity, which would be proportional to dust column density, and the gas column density. In the outer Galaxy the interstellar medium is predominantly neutral atomic hydrogen suggesting there should be a correlation between HI and the infrared cirrus.

Figure 1 shows there is a strong linear correlation between the 100 μm intensity and HI column density. A least squares fit gives slopes of $6.4 \pm 1.1\ 10^{-15}$ and $4.2 \pm 0.8\ 10^{-15}$ Jy ster^{-1}/ HI atom cm^{-2} in the $l = 125°$ and $l = 215°$ fields, respectively. This can be compared with the value of $1.4 \pm 0.3\ 10^{-14}$ found by Boulanger, Baud, and van Albada (1985) for several high latitude HI clouds.

Assuming the emission is thermal emission from dust grains then the ratio of the 100 μm intensity to HI column density can be used to calculate the characteristic dust temperature. Following Hildebrand (1983) and using for illustrative purposes a dust opacity proportional to $\lambda^{-1.5}$ gives a dust temperature of 16.7 and 15.9 K for the $l = 125°$ and $l = 215°$ fields, respectively. These results are in reasonable agreement with average dust temperatures predicted by models of thermal dust emission from dust grains (de Muizon and Rouan 1985, Draine and Anderson 1985).

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