

CO₂ Ice in Cold Dense Dark Cloud Cores: Abundance versus visual extinction

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The ice mantle composition in cold dense cores may trace their chemical and physical evolution, and may be important for understanding the eventual chemical composition of solar nebula bodies. To study these issues we compare ice mantle column densities as a function of H₂ and dust column density, and radius in a number of cores. We use 2MASS colors to identify high extinction background stars, and to study the absorption spectrum in three cores. These cores show evidence for gas phase CO molecule depletion and are representative of quiescent prestellar cores. We use Spitzer IRS observations of the ice absorption features to determine the ice composition. We observed several target stars, with $A_v = 8$ to 50 mag, across each core. Our results for IC 5146 E & W and L694-2 suggest a clear correlation between the CO₂ absorption with increasing A_v .

Spitzer IRS Spectra of CO₂ Absorption Towards Background Stars

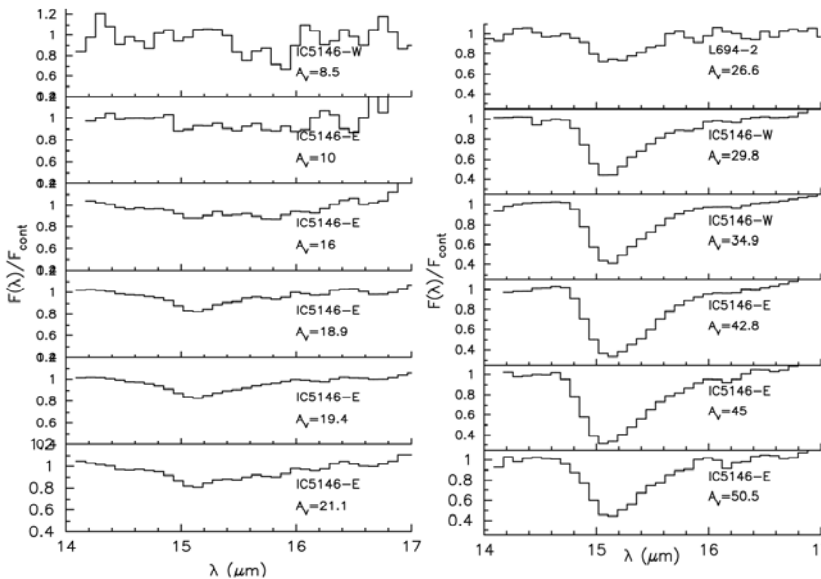


Figure 1. Spitzer IRS Long Low spectrum of CO₂ absorption at 15 μ m observed towards 2MASS stars. The intensities are normalized to the continuum flux at 15 μ m. The visual extinctions A_v shown for each line of sight through the cores were obtained using 2MASS colors.

CO₂ Absorption Versus Visual Extinction

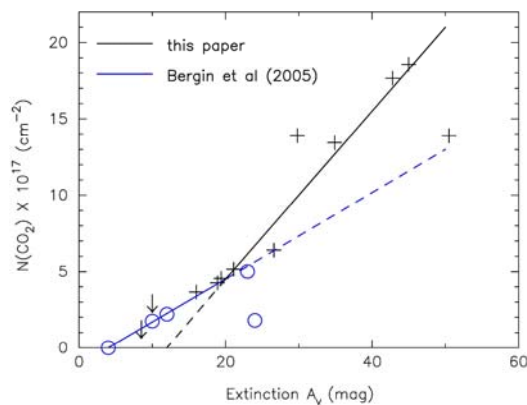


Figure 2. CO₂ ice column density against visual extinction A_v . The column densities were estimated using the integrated optical depth $\int \tau_\nu dv$ over the absorption profile between 14.8 and 15.8 μ m, (i.e the absorption profile area). The crosses denote the data from this paper. The open circles are data from Bergin et al (2005). The solid lines show the corresponding fits. Extrapolations to the fits are indicated by broken lines.

Figures 1 and 2 show strong correlations between extinction and CO₂ absorption up to 50 mag. For low extinctions (<25mag) Bergin et al (2005) suggest an extinction threshold $A_v = 4$ mag (Fig. 2) and our data for these A_v is consistent with this relationship. However, for $A_v \geq 25$ mag we find a steeper increase in CO₂ ice column density with A_v , as shown in Fig. 2. The increased CO₂ at higher extinction in our data can best be explained by time and density dependent effects in forming CO₂ ice deep in the cores.

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References:

Bergin et al. 2005 ApJ 627, L33