Properties of Interstellar Dust in the MBM 18-19 High-Latitude Cloud Complex

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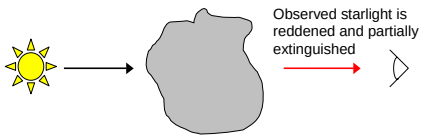
INTRODUCTION

Interstellar clouds are made up of gas and **dust particles**. Starlight passing through a cloud is either absorbed or scattered by the dust. These processes, collectively known as **extinction**, alter the magnitude and color of the light that reaches observers on Earth. Studying the extinction of starlight toward various lines of sight reveals much about the nature of the dust grains themselves.



Since new stars and planets are formed from interstellar clouds, understanding the properties of the dust helps us to better determine how these processes occur.

The MBM 18-19 cloud complex is a high galactic latitude cloud (-30°), which is located near the Taurus Dark Cloud Complex—one of the closest regions of new star formation in the Galaxy.

METHODS & CALCULATIONS

- **Photometric Data** (B, V, J, H, K bands) and **Spectral Types** for 238 stars were collected from the SIMBAD Astronomical Database (http://cdsweb.u-strasbg.fr/Simbad.html) and the 2MASS infrared archive (accessed through: http://irsa.ipac.caltech.edu/applications/Oasis/).
- **Visible and Infrared Color Excesses** were determined by comparisons to standard stars in the literature (Bessel & Brett 1988), (Wegner 1994)
  $E_{B-V} = (B-V) - (B-V)_{std}$
  $E_{V-K} = (V-K) - (V-K)_{std}$
- **Total visual extinction** was calculated using the relationship to infrared color excess
  $A_V \approx 1.1\ E_{V-K}$
- **Ratio of Total to Selective Extinction** (indicator of dust grain sizes in interstellar clouds)
  $R_V = A_V / E_{B-V}$

RESULTS

Map of Studied Lines of Sight

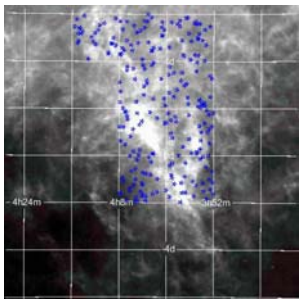


Figure 1. A map in Right Ascension (h,m,s) & Declination (degrees) of the lines of sight studied in this project (blue stars), plotted over a map of infrared dust emission at a wavelength of 100 μm (grayscale) from the *Infrared Astronomical Satellite* (IRAS).

A_V for Selected Sources

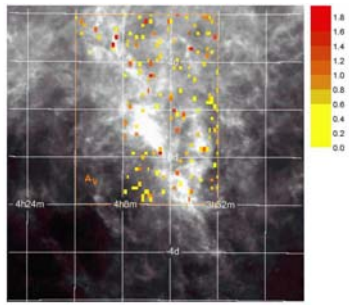


Figure 2. A_V for studied lines of sight mapped by the color scale given on the right over the 100 μm dust emission (grayscale). Higher values of A_V indicate denser regions of the cloud. Foreground stars are excluded from this diagram.

R_V for Selected Sources

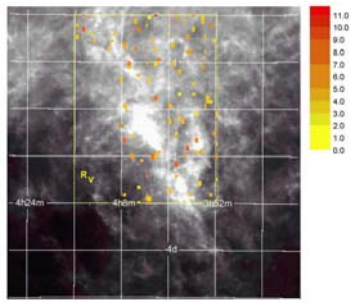


Figure 3. R_V for studied lines of sight mapped by the color scale given on the right over the 100 μm dust emission (grayscale). Higher values of R_V indicate the presence of relatively large dust grains. Stars with $E_{B-V} < 0.1$ have been omitted.

E_{B-V} vs. Distance for stars in the MBM 18-19 Region

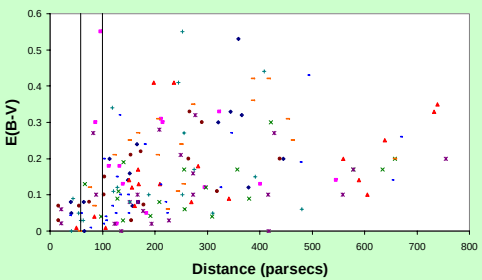


Figure 4. Reddening (E_{B-V}) vs. d (in pc) for lines of sight studied. Each symbol denotes a different 2º x 2º sub-region studied. From these data, we estimate the distance to the cloud to be 80±20 pc.

- Since spectral type information was found for each star, **distance to each star** (in parsecs) was calculated based on known luminosity in the V band (M_V) for stars of a given spectral type,

$$V - M_V - A_V = 5 \log d - 5$$

- **Distance to the cloud** was determined by plots of E_{B-V} **vs.** d for all stars. An abrupt jump in E_{B-V} values occurs at the distance of the cloud at 80 ± 20 pc.
- Due to uncertainties in spectral type and luminosity class, anomalously low distances were found toward many highly reddened stars (d < 50pc). When the luminosity class was assumed to be that of giant stars (class III), the problem was resolved.

Infrared Color-Color Diagram for Dwarf Stars

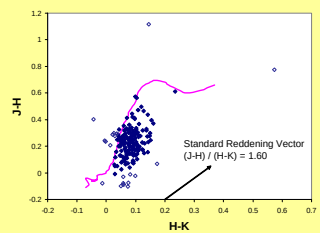


Figure 5. Plot of IR colors (J-H) vs. (H-K) for lines of sight studied (points). The solid curve represents the intrinsic colors of unreddened stars. The arrow represents the reddening vector, representing the predicted effect of reddening by interstellar dust. If a star cannot be traced back to the intrinsic color curve along the standard reddening vector, the star probably has circumstellar dust, indicating that it is a newly forming star (these are signified by open diamonds on the graph).

R_V vs. Total Visual Extinction

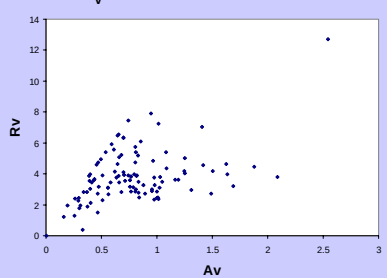


Figure 6. Plot of R_V (unitless) vs. A_V (in magnitudes). A trend toward increasing R_V with increasing A_V is generally expected, but we observed little correlation. Stars with E_{B-V} < 0.1 have been omitted.

SUMMARY

- The distance to the MBM 18-19 cloud complex was found to be 80 ± 20 pc, using the photometry measurements of 238 stars found in on-line archives, which greatly increased the data set for stars in this region (Fig. 4).
- 20 potential Young Stellar Objects were found in the new data set by examination of the infrared colors of these stars in comparison to standard stars and the normal effects of interstellar reddening (Fig. 5).
- As found in previous studies, R_V is only slightly correlated with A_V in the MBM 18-19 region (Fig. 6), although extremely low values for R_V were most often found in lines of sight with low A_V.
- Maps of A_V (Fig. 2) and R_V (Fig. 3) suggest that each parameter is higher along the brightest regions of the infrared emission map, where the density of interstellar dust is highest.

CONCLUSIONS

- Increasing the data set to 238 lines of sight toward the MBM 18-19 interstellar cloud complex has led to a better understanding of the distance to this cloud.
- Unlike other dense clouds, such as the nearby Taurus Dark Cloud Complex, little correlation between extinction and RV exists, suggesting a different cloud structure and processes that affect dust grain growth in MBM 18-19.
- The identification of Young Stellar Objects in MBM 18-19 demonstrates that it is an active region, ideal for the study of nearby new star formation.
- Future research will combine the parameters of both the extinction and polarization of starlight by the dust grains in MBM 18-19, but require further observations to be performed.

ACKNOWLEDGMENTS

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