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Dark cloud DCld 256.1-09.3 distance determination

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Abstract. In this work, the distance of the dark cloud DCld 256.1-09.3 has been estimated. To achieve this, we have analyzed a circular area with a radius of 1° around the cloud, using Color Excess $E(b-y)$ vs. Distance Diagrams and Spatial Reddening Distribution Maps. The data were extracted from the StarHorse2 catalog (Anders et al., 2022). The analysis revealed two main structures. The first one, permeating the entire region, has $E(b-y)$ between 0.1 and 0.2 mag at a distance of (400 ± 50) pc, corresponding to the Gum Nebula. A second structure, seemingly more diffuse and also occupying the whole surveyed area, is located between 900 pc and 1000 pc. The studied cloud is found at a distance of (1000 ± 50) pc and is likely a condensation in this second more diffuse structure.

Resumo. Neste trabalho foi estimada a distância da nuvem escura DCld 256.1-09.3. Para isso, analisamos uma área circular com raio de 1º ao redor da nuvem, utilizando Diagramas de Excesso de Cor $E(b-y)$ por Distância e Mapas da Distribuição Espacial do Avermelhamento. Os dados foram extraídos do catálogo Starhorse 2 (Anders et al., 2022). A análise revelou duas estruturas principais. A primeira, que permeia toda a região, tem $E(b-y)$ entre 0.1 e 0.2 mag na distância de (400 ± 50)pc, que corresponde à Gum Nebula. A segunda estrutura é difusa e também permeia toda a região, situando-se entre 900pc e 1000pc. A nuvem estudada encontra-se à uma distância de (1000 ± 50) pc e provavelmente é uma condensação dessa estrutura difusa

Keywords. (ISM:clouds – dust, extinction – individual objects: DCld 256.1-09.3)

1. Introduction

This study is part of a broader effort to investigate the interstellar medium, focusing on molecular clouds, young open clusters and Bok Globules. Specifically, it aims to explore the origin and distribution of the interstellar structures, such as bubbles and dark clouds, within 2 kpc of the Sun. These investigations build on previous work by franco90, corradi,corradi2004, Santos et al. (2011) and reis that highlighted the importance of understanding the local interstellar features.

Dark clouds are dense objects, with number densities ranging from 10^4 to 10^6 particles per cm^3, and cold, with typical temperatures of 10–20K. They play a fundamental role in the star formation process, making the study of these objects highly relevant.

In this work, the distance to the dark cloud DCld 256.1-09.3 (Firgure 1) has been estimated. The object has been first cataloged by Hartley et al. (1986) and is located at the coordinates (RA= 07:42:49.0, Dec= -42:25:48). With an angular size of approximately 2×1.5 $arcmin^2$, the dark cloud is situated in the constellation Puppis.

(a) (b)

FIGURE 1: DSS2 images of DCld 256.1-09.3. (a) (2^ox2^o), with circles of radius 5' and 1°; (b) Zoom of (11'x11')

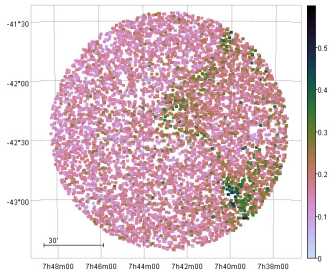
2. Methodology

Based on the method of Corradi et al. (1997) and Reis & Corradi (2008), we have used Spatial Reddening Distribution Maps and Color Excess $E(b-y)$ vs. Distance Diagrams to identify the components of the interstellar medium.

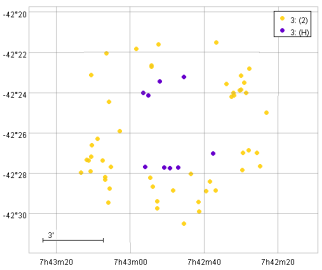
When light passes through the interstellar components, part of it is absorbed and scattered. Thus, we build Color Excess $E(b-y)$ vs. Distance Diagrams for a given region looking for an abrupt transition in the reddening. These transitions are characterized by a sudden increase in the mean value of the color excess to higher values, and the onset of a minimum value after the distance where the transition occurs.

To determine which transitions are caused by the dark cloud, we have analyzed regions surrounding it as well as one encompassing it. This approach is intended to discriminate the contribution of the cloud from the surrounding area.

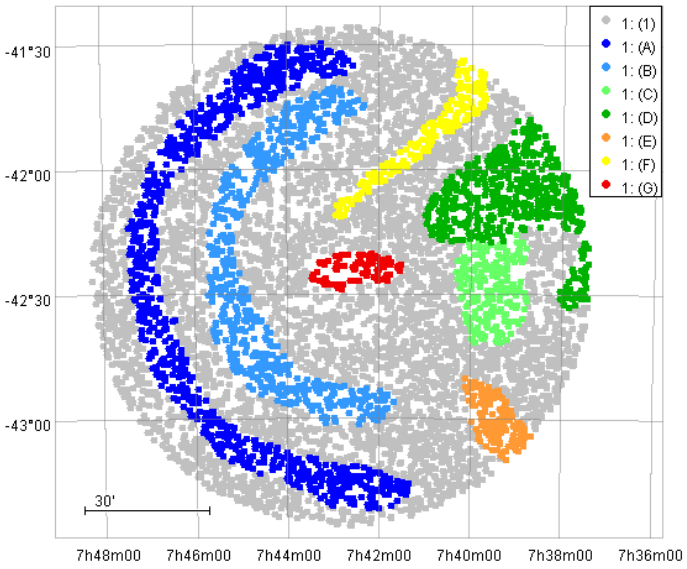
The data used were acquired from the StarHorse2 catalog (Anders et al., 2022), which uses Gaia EDR3 data. To obtain the interstellar reddening we have used the convertion $E(b-y) = A_V/4.3$ stromgren66. A circular area with a radius of 1° (Figure 2a) centered on the cloud's position, (RA, DEC) = (07h42m49.0s, -42d25"48"), has been analyzed. The area has been divided into seven regions, labeled (A) to (G) (Figure 2c), to understand the behavior of the interstellar medium in the cloud's vicinity. Then, in order to have more precise data about the cloud, a circular area with a radius of 5' around the cloud



(a) Spatial Reddening Distribution Map built with the final sample; radius: 1°



(b) Area H; radius: 5'



(c) Division of the final sample into regions: A - G; radius: 1°

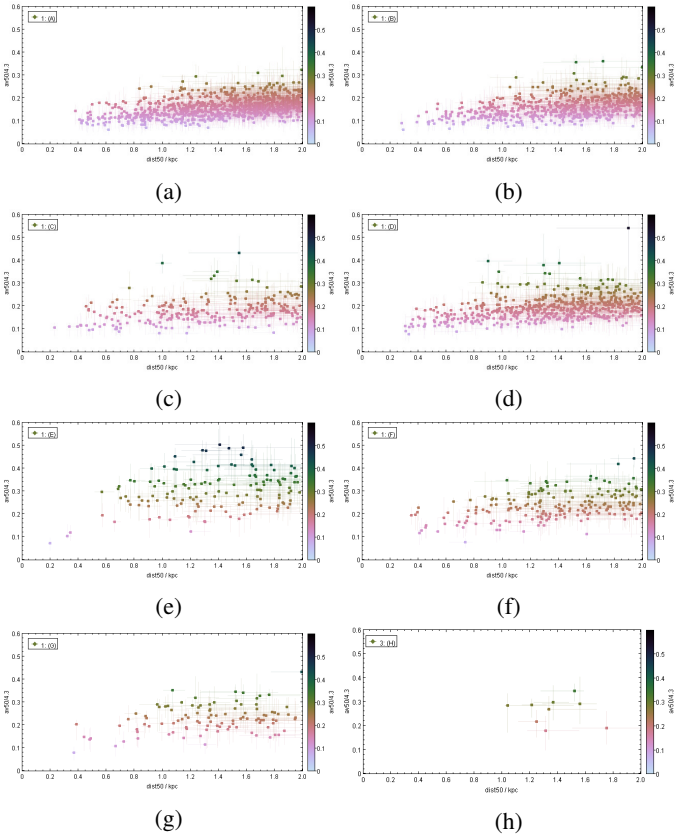
FIGURE 2: StarHorse2 data.

with the nearest stars selected (region H, Figure 2b) has been included in the analysis. For better results, the following confidence intervals and exclusion criteria have been used: distances between 0 and 2 kpc, FlagOut ≤ 1, and Fidelity ≥ 0.5, which resulted in a final sample of 7009 stars.

3. Results

Figure 3 shows the Color Excess $E(b-y)$ vs. Distance (kpc) Diagrams for the regions (A) to (H), identified in Fig. 2b and 2c. The area surrounding the dark cloud is surveyed by region (H). The following transitions have been identified:

- (A): $E(b-y)$ from 0.18 to 0.24 mag at (850 ± 50) pc.
- (B): $E(b-y)$ from 0.09 to 0.14 mag at (425 ± 25) pc and from 0.20 to 0.25 mag at (1000 ± 50) pc.
- (C): $E(b-y)$ from 0.11 to 0.21 mag at (475 ± 25) pc and from 0.24 to 0.38 mag at (1000 ± 50) pc.
- (D): $E(b-y)$ from 0.11 to 0.18 mag at (400 ± 30) pc and from 0.22 to 0.30 mag at (900 ± 50) pc.
- (E): $E(b-y)$ from 0.12 to 0.30 mag at (460 ± 90) pc and from 0.34 to 0.40 mag at (1000 ± 90) pc.
- (F): $E(b-y)$ from 0.28 to 0.34 mag at (1000 ± 20) pc.
- (G): $E(b-y)$ from 0.25 to 0.35 mag at (1000 ± 50) pc.
- (H): $E(b-y)$ from 0.2 to 0.35 mag beyond (1000 ± 50) pc



(a) (b) (c) (d) (e) (f) (g) (h)

FIGURE 3: Color Excess $E(b-y)$ vs. Distance (kpc) Diagrams for regions (A) to (H) identified in Fig 2b and 2c.

4. Conclusions

1. The Gum Nebula (Sahu & Blaauw, 1993) can be identified with the first transition occurring between 400 pc and 450 pc.
2. A second, more diffuse structure, permeating the whole region from 900 pc to 1 kpc.
3. The dark cloud DCld 256.1-09.3 is located at a distance of (1000 ± 50) pc. It is suggested that it may be a condensation in this more diffuse structure.

In the near future, we aim to investigate the possible interaction cloud-shock front with polarimetric data collected with IAGPOL at the Pico dos Dias Observatory (OPD/LNA).

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