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Polarimetric study of the dark cloud DCld 282.7 -02.5

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Abstract. In a previous study in the direction of the dark cloud DCld 282.7-02.5, Almeida et al. (2024) determined the distance and reddening of the cloud using data from the Starhorse2 catalog, by Anders et al. (2022). Excess Color by Distance Diagrams and Spatial Reddening Distribution Maps were used to determine the components of the interstellar medium along the line of sight. For the first time, we infer that at $700 \pm 40\,pc$, there is a significant jump with evident excess color, where the minimum value of E(b-y) rises to $0.5\,mag$ going up to $1.5\,mag$, suggesting a dense region associated with the cloud. This object of study is close to Carina, where other clouds have been observed in the region that may have connections, forming part of a larger structure. Subsequently, polarimetric data collected at the Pico dos Dias Observatory (OPD/LNA) in 2024 were analyzed using the 1.60 m Perkin-Elmer telescope equipped with the IAGPOL polarimetric box, in V and I filters. For this, Polarization and Polarization Angle θ diagrams as a function of distance were constructed. It was possible to identify a step where P increases from 0.5% to 1.0% at a distance between $580 \pm 11\,pc$ and $1650 \pm 95\,pc$, with θ of approximately 119°. Then, there is a second transition with an increase in polarization from 1.7% to 3.7%, starting at a distance of $1780 \pm 134\,pc$, revealing a second structure. Comparing this with the interstellar result, we also framed the distance and polarization within the same region. Therefore, we identified one component that can integrate a broader structure and another that corroborates the result of interstellar extinction.

Resumo. Em um estudo prévio na direção da nuvem escura DCld 282.7-02.5, Almeida et al. (2024), determinaram a distância e o avermelhamento da nuvem, utilizando dados do catálogo Starhorse2, de Anders et al.(2022). Os Diagramas de Excesso de Cor por Distância e Mapas da Distribuição Espacial do Avermelhamento, foram usados para determinar os componentes do meio interestelar ao longo da linha de visada. De forma inédita, inferimos que em $700 \pm 40\,pc$, temos um salto significativo com excesso de cor evidente, onde o valor mínimo de E(b-y) sobe para $0,5\,mag$ indo até $1,5\,mag$, sugerindo uma região densa, associada à nuvem. Esse objeto de estudo, está próximo de Carina, onde foram observadas outras nuvens na região que possam ter conexões, fazendo parte de uma estrutura maior. Em continuidade, foram analisados os dados polarimétricos coletados no Observatório do Pico dos Dias (OPD/LNA) em 2024, utilizando o telescópio Perkin-Elmer de 1,60 m e equipado com a gaveta polarimétrica IAGPOL, nos filtros V e I. Para isso, foram construídos Diagramas da Polarização e do Ângulo de Polarização θ em função da Distância. Foi possível identificar, um degrau em que P sobe de $0,5$% para $1,0$% na distância entre $580 \pm 11\,pc$ até $1650 \pm 95\,pc$, com θ de aproximadamente 119°. Depois, há uma segunda transição com aumento na polarização de $1,7$% para $3,7$%, a partir da distância de $1780 \pm 134\,pc$, revelando uma segunda estrutura. Comparando isso com o resultado interestelar, enquadramos a distância e a polarização também na mesma região. Portanto, identificamos uma componente que pode integrar uma estrutura ampla e uma outra que corrobora com o resultado da extinção interestelar.

Keywords. ISM: clouds – Polarization – Distances

1. Introduction

Dark interstellar clouds represent the primordial environment where gravitational collapse occurs, giving rise to new stars and planetary systems, making them fundamental to understanding the initial processes of star formation. The analysis of physical and structural parameters—such as distance, matter distribution, extinction, polarization, and magnetic field morphology—is crucial for investigating their evolution and the role of the surrounding interstellar medium in their dynamics (Reis & Corradi 2008, Santos et al. 2011).

In this work, we continue the study of the Interstellar Medium in the direction of the dark cloud DCld 282.7 -02.5, which was first cataloged by Hartley et al. (1986) using polarimetric data. Almeida et al. (2024) determined, for the first time, the distance of $700 \pm 40\,pc$ and the reddening of the cloud, using data from the Starhorse2 catalog by Anders et al. (2022). An image of the cloud can be seen in figure 1.

The dark cloud has galactic coordinates (282.69 -02.51) and is located in the constellation Carina and near the Gum Nebula.

Figure 1. Image of the DCld 282.7 -02.5 cloud extracted from DSS2. The yellow box indicates the image region of the observation. The white circle indicates the region of interest.

In this paper, the main objective is to determine its distance, analyze the degree and angle of polarization, as well as its characteristics through polarimetric study.

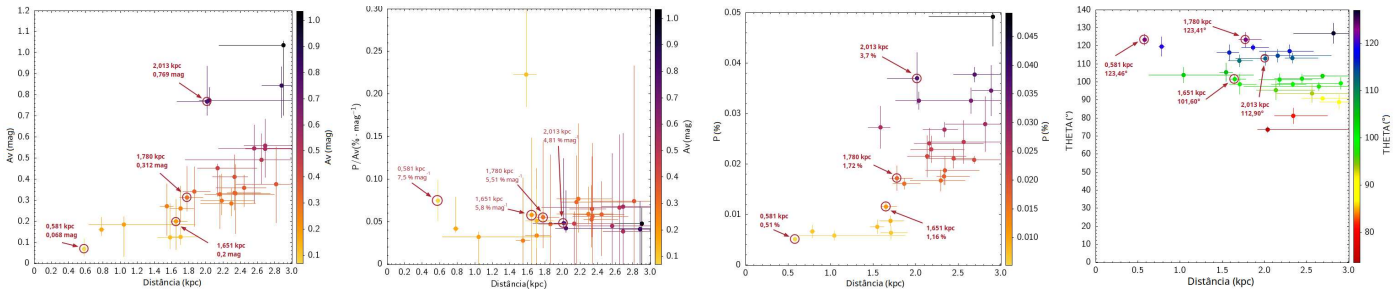

Figure 2. Extinction (Av) vs. Distance and Polarization and Extinction (P/Av) vs. Distance (top panel). Polarization (P) vs. Distance and Polarization Angle (θ) vs. Distance (bottom panel).

2. Methodology

The analysis method involved processing polarimetric data collected at the Pico dos Dias Observatory (OPD/LNA) in 2024 using the Perkin-Elmer telescope, equipped with IAGPOL. The data was reduced according to the Solvepol Pipeline by Ramirez et al. (2017) and combined with the Starhorse2 catalog. Image 3 is a photographic result of this polarimetric reduction, showing the central region (yellow box) in figure 1, and we can see the alignment of the magnetic field. The reduction results allowed for the investigation of interstellar medium properties, based on graphs of Visual Absorption as a function of Distance, Diagrams of Polarization and Polarization Angle as functions of Distance, and the Interstellar Reddening Map following the methods of Corradi et al. (1997), Reis Corradi (2008), and Santos et al. (2011).

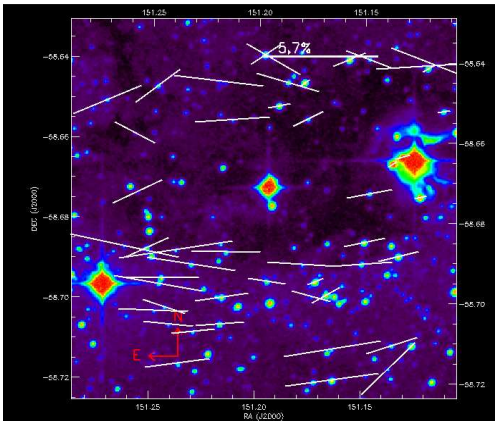

Figure 3. DSS (R-band) graph obtained from images in filter I, reduced with Solvepol.

The polarimetric approach aims to detect abrupt increases in the degree of polarization P(%) as well as in the polarization angle (θ) oriented towards the cloud. Similarly, the photometric approach looks for similar transitions in excess color. The support of spatial reddening maps is used to help identify these transitions and infer the distance from the cloud (Reis et al. 2011).

To quantify the uncertainties, we used the P05 and P95 percentiles of the probability distributions with the central median value P50, provided by StarHorse, for both distance and color excess, considering only stars with accurate results. This process resulted in a final sample of 2,998 stars, with a confidence interval of 0 - 2% for distance and 0.009 *mag* for color excess. In addition to these precision limits, we adopted additional quality criteria provided by the catalog, keeping only sources with fidelity > 0.5 and flagout < 1.

3. Discussion and Results

First, Polarization vs. Distance Diagrams (third graph in Figure 2) were constructed from these data and combined with the Starhorse2 catalog. This allowed us to identify a step where P increases from 0.5% to 1.0% in the distance between $(580 \pm 11)\,pc$ and $(1650 \pm 95)\,pc$. The Polarization Angle vs. Distance diagram (fourth graph in Figure 2), reveals that this step has a θ of approximately 119. Then, there is a second transition with an increase in polarization from 1.7% to 3.7%, starting at a distance of $(1780 \pm 134)\,pc$, revealing a second structure. This progression indicates that different layers of dust along the line of sight contribute to the cloud.

Comparing this with the interstellar result, we frame the distance and polarization within the same region. Therefore, we identified a component that corroborates the distance result extracted from the interstellar extinction. Furthermore, we distinguished a second component that may be part of a broader structure. This object of study is near Carina, where other clouds in the region have been observed that may have connections forming part of a larger structure.

4. Conclusion

The variation of polarimetric and photometric parameters along the distance, provides evidence of the existence of polarizing components of the interstellar medium located approximately at $(580 \pm 20)\,pc$ and $(1650 \pm 95)\,pc$. These results are consistent with the distance of $(700 \pm 40)\,pc$ previously determined by Almeida et al. (2024).

At greater distances, around $(1780 \pm 134)\,pc$, there is also a compromise in the presence of a more extensive or more complex structure. However, this possible additional component will be investigated in future studies.

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References

Anders, F., et al. 2022, A&A, 658, A91
Angarita, Y., et al. 2023, AJ, 166, 34
Bica, C. M. & Dutra, E. 2002, A&A, 383, 631
Clemens, D. P. & Barvainis, R. 1988, ApJS, 68, 257
Corradi, W. J. B., et al. 1997, A&A, 326, 1215
Corradi, W. J. B., et al. 2004, A&A, 347, 4
Hartley, M., et al. 1986, A&AS, 63, 27
Reis, W. & Corradi, W. J. B. 2008, A&A, 486, 471
Reis, W., et al. 2011, ApJ, 734, 8
Santos, F. P., et al. 2011, ApJ, 734, 8