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DCld 273.3+02.5 dark cloud distance estimation

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Abstract. This study is part of a larger investigation aimed at mapping the local interstellar medium. In this work we seek to estimate the distance to the dark cloud DCld 273.3+02.5 by using $E(b-y)$ Color Excess vs. Diagrams, as well as maps of the spatial distribution of the reddening. An abrupt transition band in the absorption towards the stars in the line of sight of the dark cloud are looked for. A sample of stars from the StarHorse2 catalog has been taken in a 30 arcmin radius. It has been observed that there is a transition located in a diffuse area in the vicinity of the cloud, where occurs a jump in $E(b-y)$ from 0.1 to 0.2 magnitude, at a distance of $(550 \pm 50)pc$. In addition, there is a second transition in $E(b-y)$ from 0.3 to 0.5 magnitude, at a distance of $(850 \pm 50)pc$. It is suggested that the first transition is related to the Vela Shell, since the Local Bubble would not extend so far in this direction, according to recent results by Pelgrims et al.(2020). The second transition, concentrated in the line of sight to the dark cloud, suggests that the distance to DCld 273.3+02.5 is $(850 \pm 50)pc$. In the near future, polarimetric data collected at OPD/LNA will be used to refine the results.

Resumo. Este estudo faz parte de uma investigação mais ampla que visa mapear o meio interestelar local. Neste trabalho buscamos estimar a distância até a nuvem escura DCld 273.3+02.5. Por meio de Diagramas de Excesso de Cor $E(b-y)$ por Distância, bem como mapas da distribuição espacial do avermelhamento, busca-se por uma faixa de transição abrupta na absorção das estrelas que estão na linha de visada da nuvem escura. Para essa análise foi utilizada uma amostra de estrelas do catálogo StarHorse2, cobrindo um raio de 30 minutos de arco centrado na nuvem. Uma transição foi localizada numa área difusa na vizinhança da nuvem, na qual há um salto em $E(b-y)$ de 0,1 para 0,2 magnitude, à uma distância de $(550 \pm 50)pc$. Além disso, há uma segunda transição em $E(b-y)$ de 0,3 para 0,5 magnitude, à uma distância de $(850 \pm 50)pc$. Sugere-se que a primeira transição esteja relacionada com a Vela Shell, uma vez que a Bolha Local não se estenderia tão longe nessa direção de acordo com resultados recentes de Pelgrims et al.(2020). A segunda transição, concentrada na linha de visada da nuvem escura, sugere que a distância até a DCld 273.3+02.5 é $(850 \pm 50)pc$. Num futuro próximo, dados de polarimetria, coletados no OPD/LNA, serão usados para refinar os resultados.

Keywords. ISM: dark clouds– distance – dust

1. Introduction

The interstellar medium (ISM) is composed mainly of gas and dust, distributed in vast molecular clouds as well as high-energetic particles such as the cosmic rays. Studying the ISM is crucial to understanding the dynamics and evolution of the Galaxy. This study is part of a larger project that seeks to understand the origin and to map the distribution of the ISM up to 2 kpc from the Sun. The mapping of the ISM has revealed that we are immersed in the Local Bubble (LB), a low-density, irregularly shaped region that surrounds the Sun (e.g. Reis & Corradi (2008), Santos et al. (2011)). This bubble is surrounded by other interstellar structures, sometimes related to intense star formation (Corradi et al. 1997).

In this work we specifically aim to estimate the distance to the dark cloud DCld 273.3+02.5. This dark cloud is located at the coordinates RA= 09h 34m 55s and DEC= -48° 38' 4", corresponding to Galactic coordinates $(l, b) = 279.9, +02.44)$. It has been first catalogued by Hartley, M. et al. (1986), a unified catalogue containing 525 high-latitude clouds and dealing mainly with optical dark nebulae. Determining the exact distances of the dark clouds and understanding their distribution in the ISM are fundamental aspects that can provide important constraints to the star formation theories.

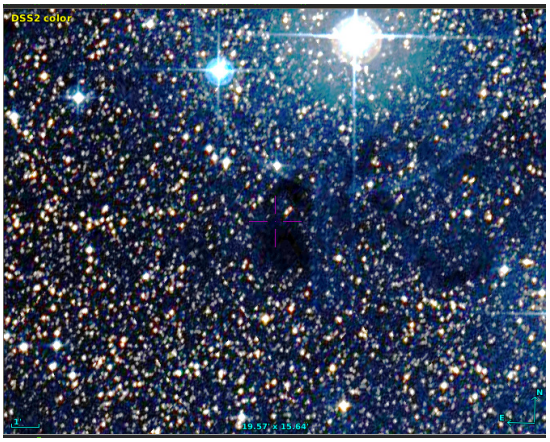

Figure 1. Image of the dark cloud DCld 273.3+02.5 obtained from Aladin DSS2. Changes have been made to the contrast of the figure for better visualization.

2. Methodology

We have made use of Maps of the Spatial Distribution of Reddening and Color Excess *vs* Distance Diagrams to estimate the distance to the dark cloud, aiming to determine the components of the ISM along the line of sight to the DCld 273.3+02.5. According to Corradi et al. (1997) and Reis & Corradi (2008)

abrupt changes in the absorption of light from the stars indicate a transition in the color excess that can represent the distance to the dark cloud. In this work it has been used data from the Starhorse2 catalog Anders F. et al. (2022), which uses data from Gaia EDR3. To convert the visible absorption (AV) into the Strömgren color excess $E(b-y)$, the expression $E(b-y) = Av/4.3$ has been used Strömgren (1966).

A general region of 30 arcmin has been analyzed. To improve the analysis, we have divided the data in some regions within the line of sight to the cloud and outside it, to compare the results. The following confidence intervals and exclusion criteria were used to clear the sample: distance up to 2kpc, the flags fidelity > 0.5 and FlagOut < 1. The the initial sample, without applying the exclusion filters, had 17286 stars, and after the filtering the sample has been reduced to 3241 stars. The result can be seen in Figure 2.

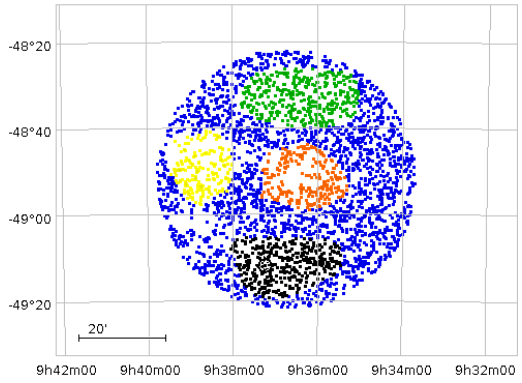

Figure 2. Sample after applying the exclusion criteria in blue, in orange the region of the cloud's line of sight and in black, green and yellow regions outside the cloud's line of sight for comparison.

3. Results

After analyzing the diagrams, as shown in Figure 3, there are two significant jumps in $E(b-y)$, one at (550±50)pc and the other at (850±50)pc. The first component at 550pc, the color excess jumps from 0.1 to approximately 0.2 mag. It is suggested that it is related to the Vela Shell, since the Local Bubble would not extend that far in this direction, according to Pelgrims V. et al. (2020). The second component at 850 pc, which is directly in the cloud's line of sight, has a more significant jump in color excess from 0.3 to approximately 0.5. So, we estimate that the distance to the dark cloud is (850 ±50)pc.

Figure 4 shows the Colour Excess vs. Distance Diagrams of regions outside of the cloud's line of sight. Regions in black, green and yellow of figure 2, respectively, for comparison. It can be seen that there are no clear jump in the absorption, reinforcing our conclusion about the cloud's distance.

4. Conclusion

In this study we have determined the distance to the dark cloud DCld 273.3+02.5 as (850±50)pc. In addition, we have noticed a component at (550±50)pc that is assumed to be related to the Vela Shell, since the Local Bubble does not extend so far in this direction. In the near future, we will refine these results, by using polarimetric data collected at the OPD/LNA..

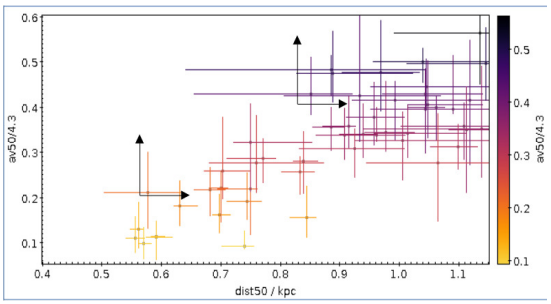

Figure 3. Color Excess vs Distance Diagram. With a color scheme coded based on $E(b-y)$. It is possible to notice two significant jumps in absorption, represented in the image by the black arrows for better visualization.

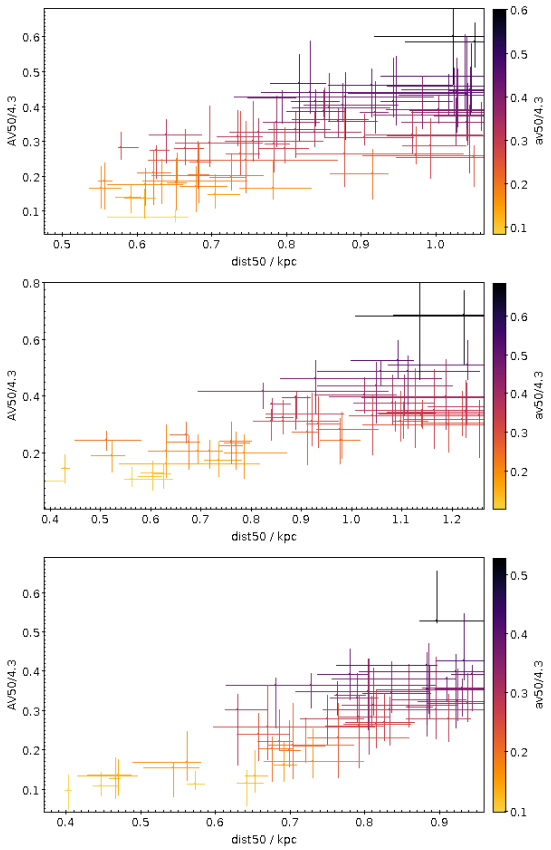

Figure 4. Color Excess vs Distance Diagram. Outside the cloud's line of sight. From top to bottom the regions in green, black and yellow in figure 2.

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