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Determination of the distance to the dark cloud DC299.5+05.9

D. Saraiva[1], Corradi, W. J. B.[2], W. Reis[3], D. A. Brissi[4] & N. Sasaki[5]

[1] Universidade Federal de Minas Gerais (UFMG) e-mail: dvotoni1@ufmg.br
[2] Laboratório Nacional de Astrofísica (LNA) e-mail: wbcorradi@lna.br
[3] Faculdade IBMEC e-mail: wilson@física.ufmg.br
[4] Instituto Federal de São Paulo - Campus Birigui (IFSP) e-mail: deidimar@ifsp.edu.br
[5] Universidade Estadual do Amazonas (UEA) e-mail: nsasaki@uea.edu.br

Abstract. This research aims at the determination of the distance to the dark cloud [DB2002b] G299.48+5.89. The method consists of using the Color Excess $E(b-y)$ vs. Distance Diagram and reddening spatial maps, based on Starhorse 2 data to look for a sudden increase in the reddening at a certain distance, taken as the cloud location. In the surveyed area, it has been identified four transitions on the color excess $E(b-y)$, at the distances of (300 ± 25) pc, (750± 25) pc, (950 ± 25) pc and (1100±50)pc. In the transition at (300 ± 25) pc,in the color excess goes to 0,15 mag, compatible with absorption caused by the Loop I Bubble, suggesting that we may have crossed its back. The second and third components have $E(b-y)$ going from (0,15 to 0,3) and (0,2 to 0,4) mag, respectively. Compared to regions outside the dark cloud's area, only the second component can be noticed. Together with the exhibited higher reddening values, we can conclude that the distance to [DB2002b] G299.48+5.89 is (950 ± 25) pc. The transition at (1100±50)pc seems, probably, the Galaxy's arm. In the near future, polarimetric data collected at OPD/LNA will be used to investigate the magnetic field hoping to disentagled the origin of these interstellar components.

Resumo. Esta pesquisa tem como objetivo a determinação da distância da nuvem escura [DB2002b] G299.48+5.89. O método consiste em utilizar Diagramas de Excesso de Cor $E(b-y)$ por distância e mapas de distribuição espacial do avermelhamento, baseado em dados do Starhorse2 para buscar por variações abruptas no avermelhamento em um dada distância, o que indica a localização da nuvem. Na área estudada foram identificadas quatro transições no excesso de cor $E(b-y)$, nas distâncias de (300 ± 25) pc, (750 ± 25) pc, (950 ± 25) pc e em (1100 ± 50). Na transição em (300 ± 25) pc o excesso de cor vai a 0,15 mag, compatível com a absorção causada pela Bolha Loop I, sugerindo que a sua parte de trás possa ter sido atravessada. A segunda e terceira componentes possuem $E(b-y)$ indo de (0,15 a 0,3) e (0,2 a 0,4) mag, respectivamente. Comparado com as regiões fora da linha de visada da nuvem, apenas a segunda componente pode ser notada. Analisado junto com os valores mais altos de excesso de cor, pode-se concluir que a distância da nuvem escura [DB2002b] G299.48+5.89 é (950 ± 25) pc. A transição em (1100±50)pc parecer ser o braço espiral. No futuro próximo, dados polarimétricos coletados no OPD/LNA serão utilizados para estudar o campo magnético, na expectativa de entender a origem dessas componentes interestelares.

Keywords. Interstellar Clouds – Distances – ISM

1. Introduction

Dark Clouds are regions in the interstellar space with higher density, from 10 to 1000 particles/cm^3, cold, with temperature from 10K to 100K (Hartley et al. 1986). The dark cloud DC299.5+05.9 has been chosen for this study because it is well detached from the background. It is also known as [DB2002b] 299.48+5.89 or simply G299.48+5.89 (Dutra & Bica 2002). The cloud coordinates are $(RA, DEC) = (12h23m35s; -56^o31'8")$ with a diameter of 3 arcmin in the sky, as can be seen in Figure 1.

2. Methodology

The methodology employed in this research has made use of reddening spatial distribution maps and Color Excess $E(b-y)$ vs. Distance d(pc) Diagrams. The investigation of interstellar medium components along the line of sight to [DB2002b] 299.5+05.9 and the other surrounding clouds have been carried out following the methodology described in Corradi et al. (1997) and Reis & Corradi (2008).

As indicated in Reis et al. (2011); Reis & Corradi (2008) we look for abrupt changes in the absorption of the starlight at a certain distance, indicated by a transition in the color excess, that would represent the distance to the interstellar component. The

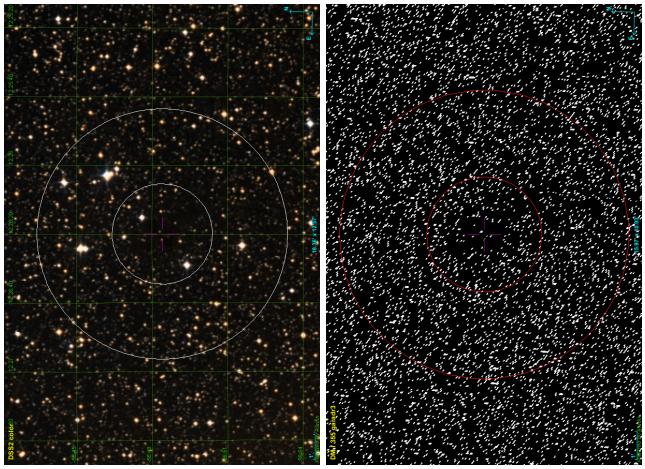

Figure 1. Dark Cloud [DB2002b] 299.48+5.89 in the DSS2 on the left and Gaia EDR3 on the right

distance and absorption in the visible A_V were obtained from the StarHORSE2 Catalog (Anders et al. 2022).

To obtain the $E(b-y)$ Color Excess, the relation of Crawford & Mandewewala (1976) $E(b-y) = \frac{A_V}{4.3}$ has been used. The data, centered in the equatorial coordinates $(RA, DEC) = (12h, 26m, 19s; -56^o, 48', 24")$, covered a radius of 30 arcmin.

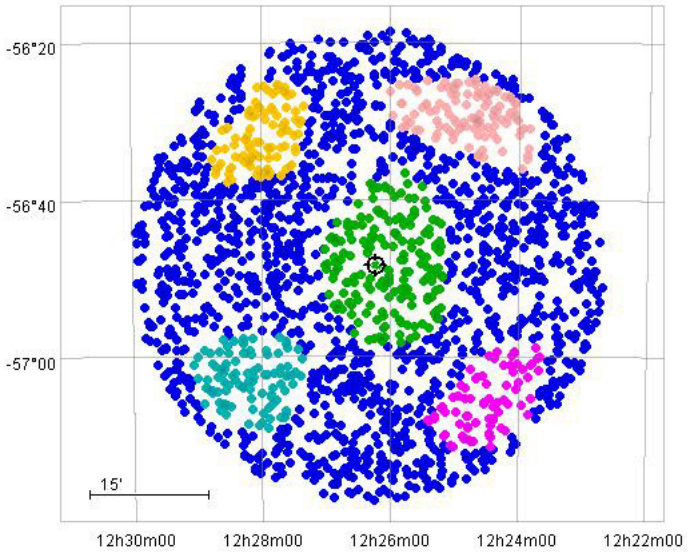

Figure 2. In blue is the area of 30arcmin; in green the dark cloud's line of sight; in pink, light pink, cyan, and yellow areas outside the line of sight to compare.

The following confidence intervals and exclusion criteria have been applied to the data: Distance ≤ 2 kpc, the flags Fidelity > 0.5 and FlagOut < 1. The final sample has 3184 stars.

3. Discussion

The Color Excess $E(b-y)$ vs. Distance Diagram towards the [DB2002b] 299.48+5.89 direction are shown in Fig. 3. A color scheme based on the E(b-y) has been used.

It is noticeable that there are no data before (250±25)pc. However, according to Reis & Corradi (2008),Reis et al. (2011),Santos et al. (2011) and Egger R.J. et al. (1995), the Local and Loop I Bubbles interface is located about 100pc and has $E(b-y) = 0.050$ to 0.100 mag. Although our data do not allow to confirm it, according to Pelgrims V. et al. (2020) the backside of the Loop I Bubble might have been crossed, since the star around 300pc has $E(b-y) = 0.15$ mag.

After that, only three significant changes in absorption occur, one at (750±25)pc, other at (950±25)pc and the last one at (1100±50) pc. The first transition can be seen in the lower and upper regions shown in Fig. 3, but not the (950±25) pc one, which is only detected in the region towards the cloud. Therefore, the distance to DC299.5+05.9 is (950±25) pc. The transition at (1100±50) pc seems, probably, related to the Galaxy's arm.

4. Conclusion

- There are no data before (250±25 pc) preventing us to access the Local Bubble impact;
- A transition at (300±25 pc with $E(b-y) = 0.15$ mag could be the backside of the Loop I Bubble;
- The distance to DC299.5+05.9 is (950±25) pc;
- The transition at (1100±50) pc seems related to the Galaxy's arm.
- Polarimetric data collected at OPD/LNA will be used to investigate the magnetic field in the near future.

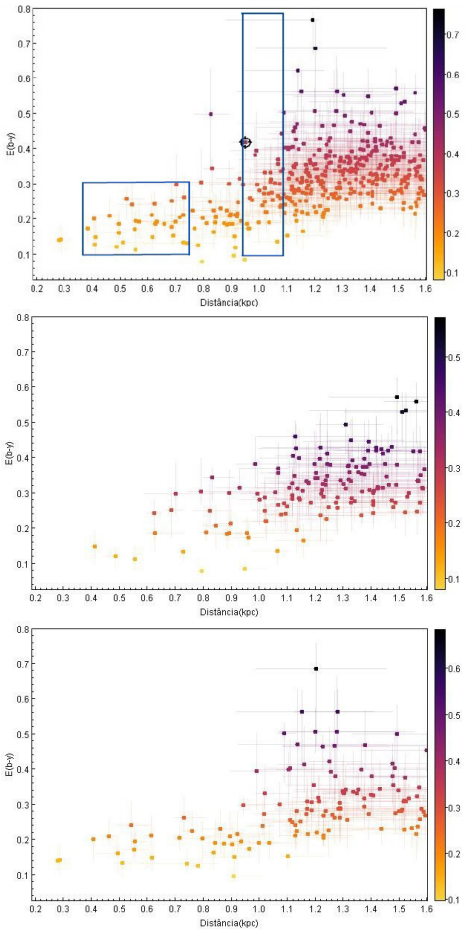

Figure 3. (top) This diagram shows the complete area of 30 arcmin, the two boxes indicate significant transitions in 400 pc and 950 pc. (middle) The diagram shows the lower region in the 30 arcmin area to compare with the line of sight of cloud. (bottom) This shows the upper region of this 30 arcmin area

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