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Distance estimate to the cloud DC313.3+3.7

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Abstract. The dark cloud DC313.3+3.7 was initially identified in 1986 by Hartley *et al*. and, until the present date, its distance has not been estimated. In this sense, within our research project to investigate the interstellar components up to 2 kpc from the Sun, the distance determination to the cloud is proposed in this work. Visual Absorption and distances from Starhorse Catalog, based on DR3 Gaia data, have been used to determine the Strömgren Colour Excess $E(b-y)$. By analyzing the $E(b-y)$ vs. distance Diagrams the distance to the cloud can be determined where a jump in the Colour Excess occurs, as well as the Maps of the Reddening Spatial Distribution can be used to investigate its boundaries. We have estimated that the cloud is located at a distance of 850 ± 30 pc. Investigating the area of 30 arcmin around DC313.3+3.7, we have noticed that it seems to be connected with the dark clouds DCld313.3+03.06, PGCC G313.32+03.58, and PGCC G313.18+03.51, also located at the same distance. In the near future polarimetric data, collected at OPD/LNA, shall be used to refine theses results.

Resumo. A nuvem escura DC313.3+3.7 foi catalogada inicialmente em 1986 por Hartley *et al*. e, até a presente data, sua distância não foi estimada. Nesse sentido, dentro do nosso projeto de pesquisa para investigar os componentes interestelares até 2 kpc do Sol, uma estimativa da distância até a nuvem é proposta neste trabalho. A absorção visual e as distâncias do Catálogo Starhorse, baseado nos dados do Gaia DR3, foram usadas para determinar o excesso de cor no sistema de Strömgren $E(b-y)$. Ao analisar os diagramas $E(b-y)$ vs. distância, a distância até a nuvem pode ser determinada onde ocorre um salto no Excesso de Cor, bem como os Mapas da Distribuição Espacial do Avermelhamento podem ser usados para investigar os limites da nuvem. Estimamos que a nuvem esteja localizada a uma distância de 850 ± 30 pc. Investigando a área de 30 minutos de arco em torno de DC313.3+3.7, notamos que ela parece estar conectada com as nuvens escuras DCld313.3+03.06, PGCC G313.32+03.58 e PGCC G313.18+03.51, também localizadas na mesma distância. Num futuro próximo os dados polarimétricos, coletadoss no OPD/LNA, serão utilizados para refinar estes resultados.

Keywords. ISM: clouds – dust – extinction – distance

1. Introduction

The dark cloud DC313.3+3.7 (Fig. 1), located in the direction of the Centaurus Constellation (RA = 14h 09m 36.0s and DEC = -57^o 37$^{'}$ 54.0$^{"}$) was first cataloged by Hartley *et al.* (1986) in a selection of larger and less dense objects than those of Lynds (1962) in the southern hemisphere sky. In the unified All Sky catalog it is known as [DB2002b] G313.26+03.66 (Bica & Dutra 2002). Despite of this, many objects in this catalog still lack of distance estimates.

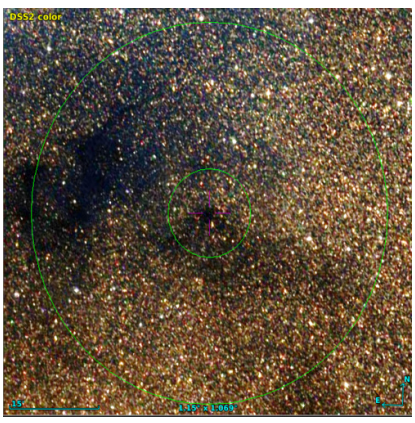

Figure 1. Concentric regions of 7 and 30 arcmin in DC313.3+3.7

The present work is part of a larger project aiming to understand the distribution and origin of interstellar components within 2 kpc of the Sun (Reis *et al*. 2011, Santos *et al*. 2011), and it specifically aims to determine the distance and extinction of the DC313.3+3.7 cloud.

2. Methodology

the analysis of the Colour Excess E(b-y) vs. Distance (pc) Diagrams and the Reddening Spatial Distribution Maps, following the method described by Corradi *et al.* (1997; 2004) for stars along the line of sight of the DC313.3+3.7 cloud reveals that abrupt transitions in reddening indicates the crossing of an overdensity of interstellar material, at the position of the cloud, on the $E(b-y)$ vs. Distance Diagram (e.g. Reis, Corradi, 2008).

Data from the StarHorse2 catalog (Anders *et al.* 2022) has been used, which utilizes Gaia EDR3 data, to obtain distance and to convert the visible absorption (A_V) to the Strömgren Colour Excess $E(b-y)$, from the expression $E(b-y) = Av/4.3$.

Considering that DC313.3+3.7 is visually compact (3x2 arcmin), the analysis has been conducted in a concentric circular regions with an initial radius of 7 arcmin. Subsequently, a 30 arcmin has been used (see Fig. 1), given the observed presence of surrounding dark clouds, suggesting the possibility that these objects might be connected.

To ensure greater reliability in the results, constraints were established based on parameters FlagOut < 1 and fidelity >

0.5 (Anders *et al*. 2022) and on percentiles P95 and P05 for Strömgren Colour Excess $E(b-y)$ and the distances.

In order to standardize and qualitatively optimize the separation of data with different errors, the following division has been made:

1. Best data (filled circles): restricted to errors in distance from 0 to 10% and in reddening from 0 to 20%.
2. Regular data (boxes): restricted to errors in distance from 10% to 20% and in reddening from 20% to 40%.
3. Poorer data (x): errors in distance greater than 20% and in reddening greater than 40%.

3. Results

As can be observed in Fig. 2, it is noticeable that at 150 ± 30 pc, a $E(b-y) = 0.050$ mag becomes the typical value. This value is known to be the reddening caused by the interface between the Local and Loop I bubbles (Reis *et al*. 2011). At 500 ± 40 pc, the Colour Excess may be related to the backside of the Loop I Bubble.

Additionally, it has been observed that there are no stars with $E(b-y) < 0.24$ mag within the visual boundaries of the DC313.3+3.7 cloud for distances lower than 850 ± 30 pc, which is taken as the distance of cloud, as can be seen on the E(b-y) vs. Distance Diagram.

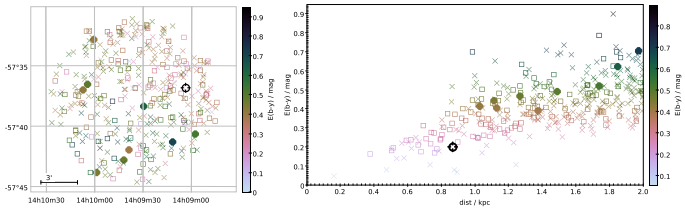

Figure 2. (left) Reddening Spatial Distribution Map and (right) $E(b-y)$ vs. distance Diagrams for the 7 arcmin region.

Observing Figs. 3 and 4, the relationship between the surrounding clouds are evident:

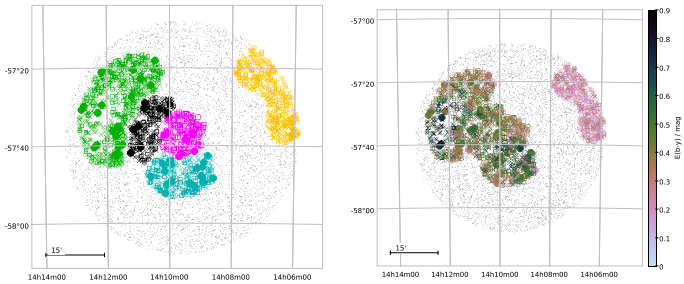

Figure 3. Analysis of the 30 arcmin region centered on DC313.3+3.7. (left) Cutouts in the clouds DCld313.3+03.6 (green), G313.32+03.58 (black), and PGCC G313.18+03.51 (blue), and visually outside the clouds region (yellow). (right) Reddening Spatial Distribution Map for the highlighted regions.

It is noticeable from the analysis that in Figs. 2, 3 and 4 that the minimum values and the dispersion of the $E(b-y)$ at the distance of these nearby clouds are similar and relatively higher than in the regions without the presence of the clouds.

It is also noteworthy that for the distance of 850 pc, all surrounding clouds present the same behaviour in the Colour Excess vs. Distance Diagrams. The clouds DCld313.3+03.6 (green), G313.32+03.58 (black), and PGCC G313.18+03.51 (blue) shown on the $E(b-y)$ vs. distance Diagram (4) present a step in the colour excess at 850 ± 30 pc, just like for the cloud DC313.3+3.7. Considering the best subset of data, it is evident that none of these stars have $E(b-y) < 0.3$ mag.

This is consistent with the Reddening Spatial Distribution maps in the direction to the clouds DC313.3+3.7, DCld313.3+03.6, PGCC G313.32+03.58, and PGCC G313.18+03.51, where one can see that the surrounding regions of the clouds have features very different, when compared to the directions towards the clouds, in this distance of 850 ± 30 pc.

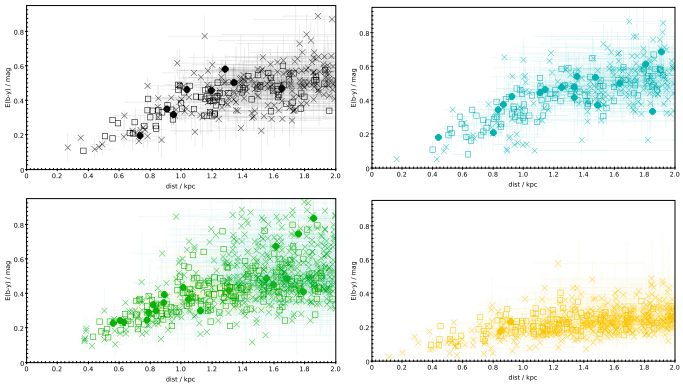

Figure 4. $E(b-y)$ vs. distance Diagram for each highlighted region

4. Conclusions

The distance to the DC313.3+3.7 cloud has been determined as 850 ± 30 pc from the Sun.

The $E(b-y)$ vs. Distance Diagrams, indicates that all clouds surrounding DC313.3+3.7, considering the more restricted dataset, do not show $E(b-y) < 0.3$ mag after the range of 850 ± 30 pc. Thus, it is suggested that the clouds DCld313.3+03.06, PGCC G313.32+03.58, and PGCC G313.18+03.51 may be connected and also located at 800 ± 30 pc.

In the near future, polarimetric data collected in 2023, at the Pico dos Dias Observatory (OPD/LNA), will be used to refine the understanding of the interstellar medium in this particular region.

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