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Investigation of the interstellar medium in the direction of the Bok Globule CB 176

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Abstract. In this work we have analysed the components of the interstellar medium in the direction of the Bok globule [CB88] 176. We have made use of the visual absorption and distance obtained from StarHORSE catalog, from which the Strömgren $E(b-y$ colour excess has been calculated. The distance of three objects - [CB88] 176, Dobashi 1277 and Dobashi 1303 have been obtained from colour excess vs. distance diagrams and reddening spatial distribution maps. At (480 ± 30) pc the backside of Loop I seems to be crossed, whereas at (800 ± 40) pc one can find the [CB88] 176 globule and the Dobashi 1303 dark cloud. Finally, Dobashi 1277 is located at (850 ± 40) pc. These data lead us to suggest that [CB88] 176, Dobashi 1277 and Dobashi 1303 may be part of the same structure.

Resumo. Neste trabalho foram analisadas as componentes do meio interestelar na direção do glóbulo de Bok [CB88] 176. Dados de absorção no visível e distância foram extraidos do catálogo StarHORSE, a partir dos quais o excesso de cor $E(b-y)$ no sistema de Strömgren foi determinado. A distância de três objetos [CB88] 176, Dobashi 1277 e Dobashi 1303 foram obtidos através da análise de diagramas de excesso de cor versus distância e de mapas de distribuição espacial do avermelhamento. Em (480 ± 30) pc temos Back of Loop I, em (800 ± 40) pc encontramos o glóbulo [CB88] 176 e Dobashi 1303 e, por fim, Dobahi 1277 está localizado em (850 ± 40) pc. Estes dados nos levam a sugerir que [CB88] 176, Dobashi 1277 e Dobashi 1303 podem ser parte da mesma estrutura.

Keywords. ISM – clouds – bubbles.

1. Introduction

Bok globules are high-density structures - 10^4 and 10^6 particles/cm^3, low temperatures (10 K to 20 K), small and dark, with a diameter ranging from a few tenths to a few tens of light-years (Bok 1947; Dame 1987). In this work, an area of r = 30 arcmin centred on the Bok globule CB176, that encompass Dobashi 1277 and Dobashi 1303 objects will be studied.

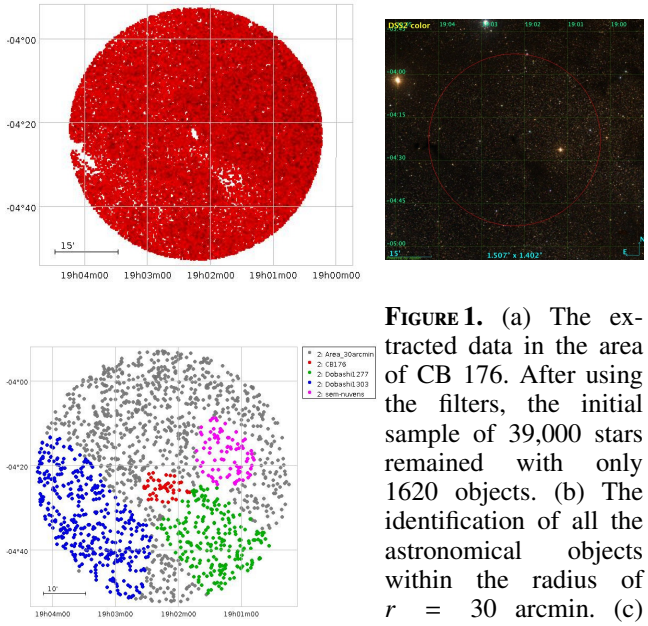

Figure 1. (a) The extracted data in the area of CB 176. After using the filters, the initial sample of 39,000 stars remained with only 1620 objects. (b) The identification of all the astronomical objects within the radius of r = 30 arcmin. (c) Division of the sub-areas.

2. Methodology

It has been adapted the method reported by Reis *et al.* (2011) as follows:

1. Colour Excess $E(b-y)$ versus Distance Diagrams and Maps of the spatial distribution of the interstellar reddening to infer the cloud's distance.
2. After crossing the cloud $E(b-y)$ jumps to higher values.
3. Data: distance and visual absorption A_v, Colour excess $E(b-y) = A_v/4.3$.
4. Catalog: StarHorse catalog (Anders 2022).
5. The confidence interval is 0−0.2% for the distance and 0.009 mag for $E(b-y)$.
6. Centred in (RA, DEC) with (hh:mm:ss, dd:mm:ss) - (19:02:13.77, −04:22:46.8).
7. Exclusion: relative error < 30% (distance) and lower than 0.020 mag $E(b-y)$.
8. Final sample: 1620 stars.

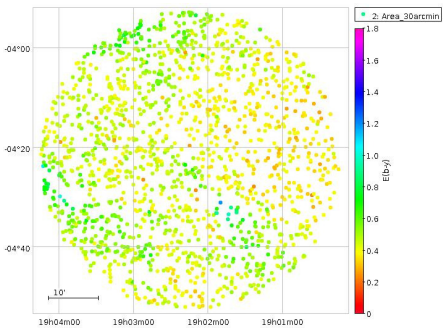

Figure 2. Reddening Spatial Distribution Map of the surveyed area

3. Results

In the Figure 3, at (550 ± 20) pc, $E(b-y)$ seems to go from 0.3 to 0.5 mag (arrow 1). At (800 ± 40) pc (arrow 2), $E(b-y)$ = 0.4 mag jumps to 0.7 mag, characterizing a very high density region believed to be [CB88] 176.

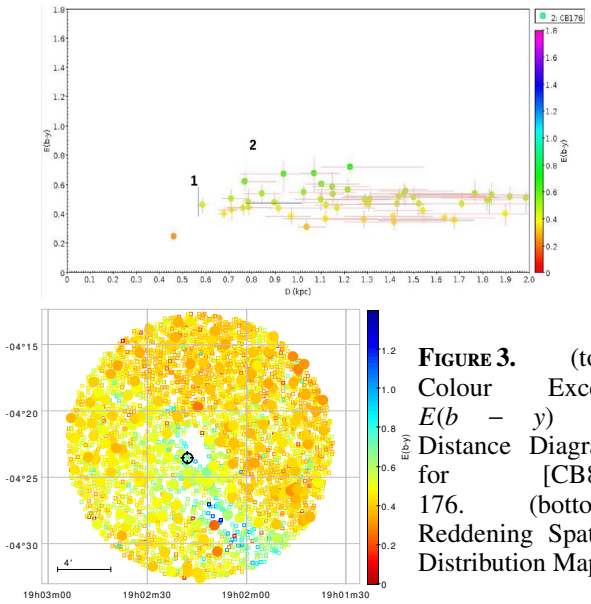

Figure 3. (top) Colour Excess $E(b-y)$ vs. Distance Diagram for [CB88] 176. (bottom) Reddening Spatial Distribution Map

In the Figure 4, at (480 ± 30)pc (arrow 3), the value of $E(b-y)$ jumps from 0.35 mag to 0.7 mag, possibly the backside of the Loop I Bubble. At (800 ± 40) pc (arrow 4), the value of $E(b-y)$ jumps from 0.35 mag to 0.7 mag, corresponding to Dobashi 1303.

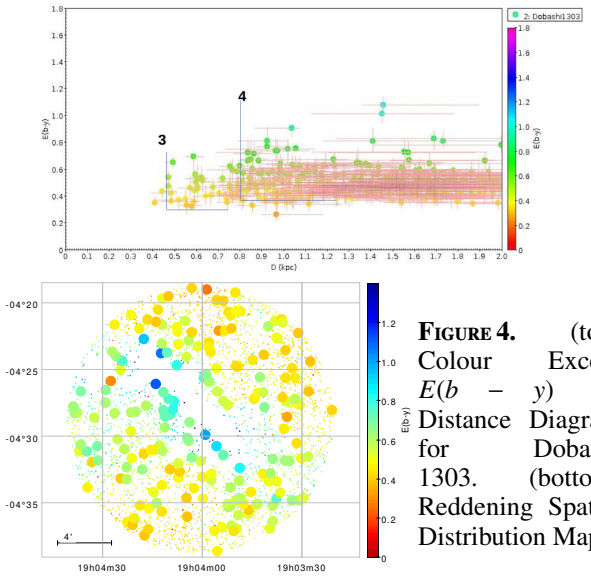

Figure 4. (top) Colour Excess $E(b-y)$ vs. Distance Diagram for Dobashi 1303. (bottom) Reddening Spatial Distribution Map

In the Figure 5, at (480 ± 30)pc (arrow 5), the value of $E(b-y)$ jumps from 0.35 mag to 0.7 mag, possibly the backside of the Loop I Bubble. At (850 ± 40)pc (arrow 6), the range of $E(b-y)$ increases up to 1.0 mag, suggesting that Dobashi 1277 has been crossed.

In the Figure 6 the value of $E(b-y)$ jumps from 0.35 mag to 0.7 mag, possibly the backside of the Loop I Bubble. However, at such distance the range of $E(b-y)$ does not increase up to

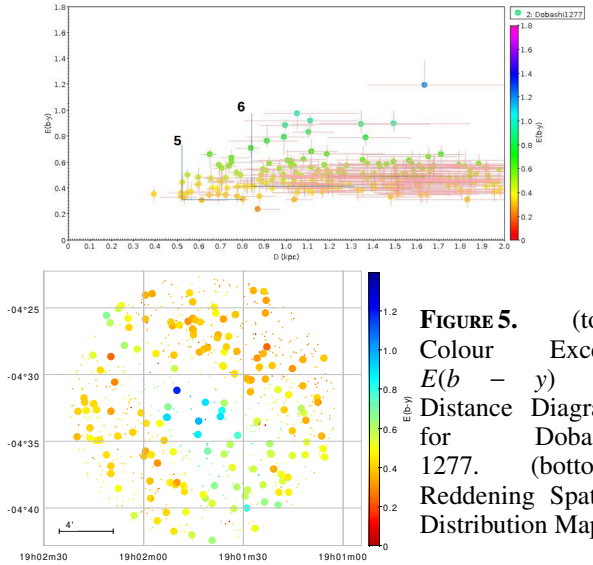

Figure 5. (top) Colour Excess $E(b-y)$ vs. Distance Diagram for Dobashi 1277. (bottom) Reddening Spatial Distribution Map

distances greather than 1.5kpc. This corroborates the fact any other denser structure, like the studied dark clouds are present in the line of sight (Corradi et al. 1997, 2004; Santos et al. 2011, Reis & Corradi 2008).

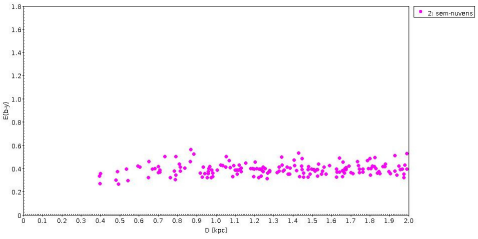

Figure 6. Colour Excess $E(b-y)$ vs. Distance Diagram for the region without cloud.

4. Conclusions

The distances determined to the clouds (vide Table 1) suggest that CB 176, Dobashi 1277 and Dobashi 1303 may be parts of the same structure. Out of the dark clouds no other similar denser structure seems to be present up to 1.5kpc.

Table 1. Estimated distances for [CB88] 176, Dobashi 1277, Dobashi 1303 and Loop I Bubble backside.

ID	d(pc)	ID	d(pc)
[CB88] 176	(800 ± 40)	Dobashi 1303	(800 ± 40)
Dobashi 1277	(850 ± 40)	Loop I backside	(480 ± 30)

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