

Determination of the distance to the Bok globule CB218

R. Almeida¹, W. J. B. Corradi², W. Reis³, & N. Sasaki⁴

¹ Universidade Federal de Minas Gerais (UFMG) e-mail: rafaelarsa@ufmg.br

² Laboratório Nacional de Astrofísica (LNA) e-mail: wbcorradi@lna.br

³ Faculdade IBMEC e-mail: wilson@fisica.ufmg.br

⁴ Universidade do Estado do Amazonas (UEA) e-mail: nsasaki@uea.edu.br

Abstract. In this work we seek to determine the distance and the number of components of the interstellar medium in the direction to the Bok Globule CB 218 (also known as LBN 041.37-18.83). A sample of 2,294 stars have been selected from the Starhorse Catalog within a radius of 16 arcmin. Absorption in the visible A_V has been used to derive the Strömgen $E(b - y)$ Colour Excess. The confidence interval for the data is 0 to 2% for the distance and 0.009 mag for the reddening. Colour Excess vs. Distance Diagrams and Spatial Reddening Distribution Maps have been constructed, in which an abrupt variation in reddening at certain distance indicates the presence of a component of the interstellar medium. One can notice that at (162 ± 20) pc the interface of the Local and Loop I Bubbles, with $E(b - y) = 0.067$ mag seems to be crossed. At (250 ± 30) pc, a diffuse cloud is detected, that according to the spatial diagram is located in a peripheric area. At (380 ± 30) pc, another significant jump in $E(b - y)$ can be detected, from 0.15 mag to 0.29 mag revealing that a denser region has been crossed. This region maybe the back of the Loop I Bubble. Further on, around (770 ± 40) pc, a minimum value $E(b - y) = 0.32$ mag clearly reveals the presence of CB218.

Resumo. Neste trabalho buscamos determinar a distância e o número de componentes do meio interestelar na direção da nuvem escura CB 218 (LBN 041.37-18.83). Para tanto foi selecionada, em um raio de 16 arcmin, uma amostra de 2.294 estrelas no Catálogo Starhorse de Anders et al. (2022). Deste, usamos a absorção visual A_V para obter o excesso de cor no sistema de Strömgen $E(b - y)$. O intervalo de confiança dos dados é de 0 a 2% na distância e 0.009 mag no avermelhamento. Foram construídos diagramas de excesso de cor $E(b - y)$ por distância e mapas da distribuição espacial do avermelhamento, nos quais, as variações abruptas no avermelhamento indicam a presença de componentes do meio interestelar. Notamos que em (162 ± 20) pc manifesta-se a interface da Bolha Local com a Loop I em $E(b - y) = 0.067$ mag. Em (250 ± 30) pc, temos uma nuvem difusa que no diagrama espacial encontra-se em uma área periférica. Já em (380 ± 30) pc, temos um salto significativo com absorção mais evidente, passando por uma região mais densa, de 0,15 mag para 0,29 mag. Essa região, talvez seja a parte de trás de Loop I, e mais adiante, em torno de (770 ± 40) pc, verificamos a nuvem com valor mínimo $E(b - y) = 0,32$ mag que revela claramente a presença de CB218.

Keywords. interstellar medium – distance – dark cloud CB218

1. Introduction

In this work, an investigation of the physical properties of the interstellar medium towards the Bok Globule CB 218 (Clemens & Barvainis 1988) is reported. Following Reis et al. (2011) and Santos et al. (2011), the idea has been to investigate the origin and distribution of the dark clouds up to 2 kpc from the Sun. These clouds have temperatures between 10 K and 10²K and densities from 10⁴ to 10⁶ particles per cm³.

Furthermore, the Bok CB 218 globule, also called LBN 111 or LBN 041.37-18.83, is located in the constellation of the Eagle. Its coordinates are RA = (20h 13m 17.0s) and DEC = -01h 20m 54s.

2. Methodology

Colour Excess $E(b - y)$ vs. Distance $D(pc)$ Diagrams and Reddening Spatial Distribution Maps have been used to identify the components of the interstellar medium along the line of sight, following the method described in Corradi et al. (1997, 2004). In order to identify where the cloud is located in the diagram, we look for transitions in the color excess. Where a jump between the stars towards the cloud and outside the cloud occurs indicates the distance to the cloud (e.g. Reis and Corradi 2008). The distance and visual absorption A_V (used to derive the colour excess $E(b - y) = A_V/4.3$) have been taken from the Starhorse catalog (Anders et al. (2022)). In the radius of 16 arcmin a sample of 2,294 stars were selected. The confidence interval is 0 – 2%

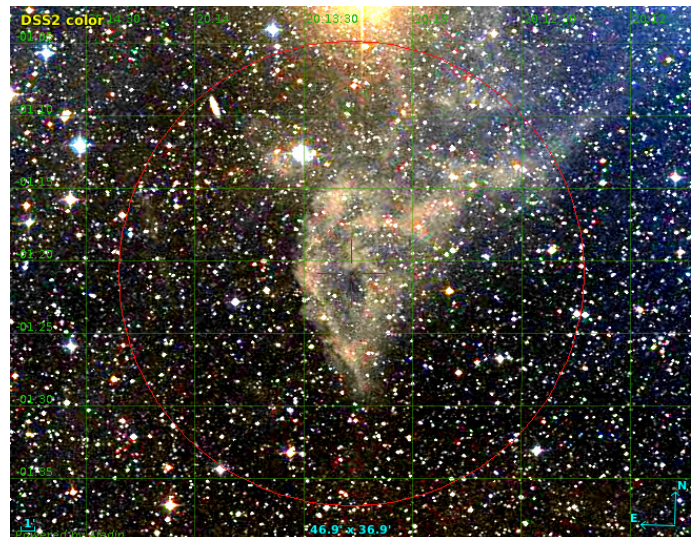


FIGURE 1. Image of the CB218 globule extracted from DSS2. Radius of the red circle is 16 arc minutes. The contrast has been adjusted to improve the visualization of the globule region.

(distance) and 0.009 mag ($E(b-y)$). Some of the evolved stars or those that have peculiarities in the spectrum are not useful for the study of interstellar reddening and compromise the reliability of the results. The exclusion criterion with relative error <

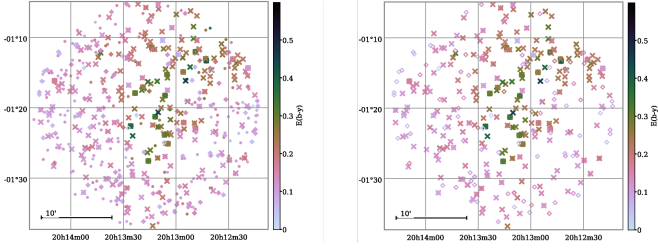


FIGURE 2. Sky Map. Total sample with 2294 stars (on the left) and after exclusion criteria with 554 objects (on the right).

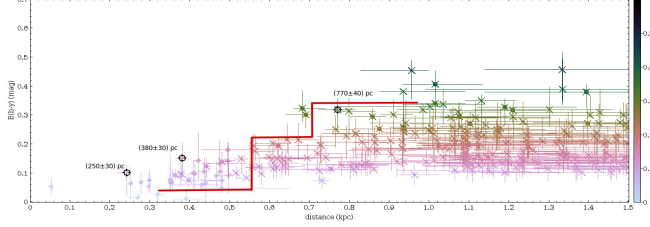


FIGURE 3. $E(b-y)$ vs. Distance Diagram. Note the steps (in red) indicating the distance of the components. CB 218 (darker green dots).

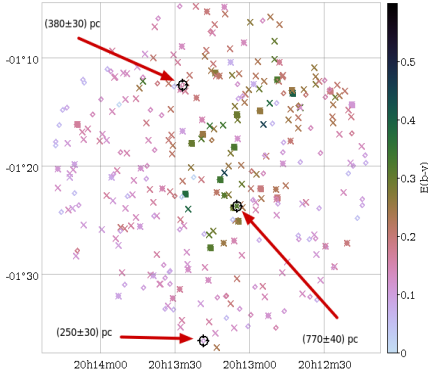


FIGURE 4. Stars in regions of higher density, at a distance of (770 ± 40) pc, are in the line of sight of Globule CB 218. Indication that the remarked stars are located in a peripheric area.

20% (distance) and error less than 0.015 mag (colour excess) as well as the percentile P05 and P95 have been used. From this, we obtained a final sample of 554 stars, 19 of which being the more reliable data.

3. Discussion

From the analysis, one can notice that a minimum value of $E(b-y) = 0.050$ mag goes up to 300 pc, suggesting that the interface of the Local Bubble with Loop I (e.g. Reis et al. 2011), has been crossed. After (320 ± 30) pc a new in step in the reddening appears. The $E(b-y)_{min} = 0.080$ mag and $E(b-y)_{max} = 0.150$ mag, suggests that the back of Loop I Bubble may have been crossed.

From (550 ± 40) pc we have a significant jump with more evident absorption, passing through a denser region, from 0.10 mag to 0.29 mag. At (770 ± 40) pc, in the direction of CB 218 there is a step in the reddening from $E(b-y)_{min} = 0.20$ mag to $E(b-y)_{max} = 0.32$ mag indicating the distance of a much denser cloud, compatible with the CB 218 globule. This is in agreement with the reddening spatial distribution map in Figure 4.

4. Conclusions

- We detected signals from the Local Bubble and Loop I interface up to about 300 pc;
- The possible backside of Bubble Loop I may be located at (320 ± 30) pc;
- A dense component seems to cover almost the entire region at (550 ± 40) pc;
- The CB 218 Globule is located at (770 ± 40) pc from the Sun, with colour excess as high as $E(b-y) = 0.32$ mag, equivalent to $A_v > 1$ mag.

In the near future, we intend to refine these results by using polarimetric data collected with the *PE1.60m* and *BC60cm* Telescopes, equipped with the IAGPOL polarimeter, located at the Observatório Pico dos Dias (OPD - LNA).

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