Boletim da Sociedade Astronômica Brasileira, **36**, no. 1, 146-147

Determination of the distance of the Bok Globule [CB88] 56

M. G. Leite-Gomes[1], W. J. B. Corradi[2], N. Sasaki[3], W. Reis[4] & D. A. Brissi[5]

[1] Federal University of Rio de Janeiro, Valongo Observatory; e-mail: mgomes@ov.ufrj.br
[2] National Astrophysics Laboratory, Federal University of Minas Gerais; e-mail: wbcorradi@lna.br
[3] Amazonas State University, National Astrophysics Laboratory; e-mail: nsasaki@uea.edu.br
[4] Brazilian Institute of Capital Markets, National Astrophysics Laboratory; e-mail: wilson@fisica.ufmg.br
[5] Federal Institute of Education, Science and Technology, Birigui Campus; e-mail: deidimar@ifsp.edu.br

Abstract. Bok globules are small, isolated and dense dark clouds. The aim of this study is to estimate the distance to the Bok globule [CB88] 56, also known as the molecular cloud [DB2002b] G237.93-6.46. For this purpose, a sample of 17 thousand stars from the StarHorse2 catalog has been selected within a radius of 30 arcminutes. Using $E(b-y)$ Color Excess vs. Distance Diagrams, as well as reddening distribution maps, we have searched for a transition band in the $E(b-y)$ values. The analysis revealed that at a distance of (200±30)pc the interstellar reddening, covering a wider region, is already around $E(b-y) = 0.050$ mag. A second component can be seen at (600±40) pc, with $E(b-y) = 0.05$ to 0.10mag, permeating almost the entire area. The Bok Globule [CB88] 56 is located at a distance of (1050±50)pc, where an abrupt transition in the $E(b-y)$ values occurs, going from 0.1 mag to 0.6 mag. We intend to use polarimetric data collected in 2023 with IAGPOL, installed on the 1.60m telescope at the Pico dos Dias Observatory (OPD/LNA) to determine the polarization and polarization angle in the region, to refine the number of components in this line of sight.

Resumo. Glóbulos de Bok são nuvens interestelares pequenas, isoladas e muito densas. O objetivo deste estudo é estimar a distância do Glóbulo de Bok CB 56, que também é conhecido como a nuvem molecular [DB2002b] G237.93-6.46. Para isso foi selecionado uma amostra de 17 mil estrelas do catálogo StarHorse2 em um raio de 30 arcmin. Por meio de Diagramas de Excesso de Cor E(b−y) por Distância, além de mapas da distribuição espacial do avermelhamento, buscamos uma faixa de transição nos valores de $E(b-y)$. A análise revelou que a uma distância de (200±30)pc o avermelhamento interestelar, cobrindo uma região mais ampla, já está em torno de $E(b-y) = 0.050$ mag. Uma segunda componente pode ser vista em (600±40)pc, com $E(b-y) = 0.05$ até 0.10 mag, permeando quase toda a área. O Glóbulo de Bok [CB88] 56 encontra-se a uma distância de (1050±50) pc, onde ocorre uma transição abrupta nos valores de $E(b-y)$, indo de 0.1 mag para 0.6 mag. Pretendemos utilizar dados polarimétricos coletados em 2023 com o IAGPOL, instalado no telescópio de 1.60m do Observatório do Pico dos Dias (OPD/LNA) para determinar a polarização e o ângulo de polarização na região, para refinar o número de componentes na linha de visada.

Keywords. Clouds – Dust – Magnetic fields.

1. Introduction

Bok globules are the smallest and simplest molecular clouds (Yun & Clemens , 1992). They are small, isolated dark clouds (Roychowdhury et al. , 2024) of gas and dust, cold ($T \sim 10$ K), small (~ 0.1 pc) and with dense cores ($n \sim 10^4$ cm^{-3}) (Yun & Clemens , 1992). These molecular clouds have approximately 1–10 $M_\odot$ and play a crucial role in the formation of low-mass stars (Roychowdhury et al. , 2024).

The Bok globule [CB88] 56 (Fig. 1) has been cataloged by Clemens & Barvainis (1988) and is also known as the molecular cloud [DB2002b] G237.93-6.46, located in the Canis Major constellation. It has equatorial coordinates are (RA, DEC) = (237.9; -06.45) (Barman & Das , 2024). It is a compact and irregularly shaped cloud, with dimensions of 4.5' (major axis) and 2.2' (minor axis) (Dutra & Bica , 2002). Its major axis contains a position angle of 170° (Jorquera & Bertrang , 2018) with respect to the Galactic plane.

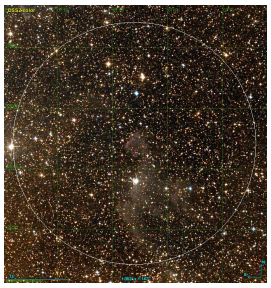

Figure 1. Region in Canis Major with the Bok globule [CB88]56 in visible light (DSS2-color). Source: Aladin Sky Atlas.

[CB88] 56 is a type of cloud, according to Barman & Das (2024), that shows less dynamic activity and turbulence, thus the alignment of polarization vectors with the local magnetic field is expected. Therefore, the magnetic field of [CB88] 56 is practically aligned with the Galactic magnetic field (Chakraborty et al. , 2014), with its average polarization values of 1.08% and a position angle for field stars of 150.94º (Barman & Das , 2024).

Although Jorquera & Bertrang (2018) reported that the distance of [CB88] 56 has not been determined, they stated that the optical polarization signal of the globule is stronger than the interstellar polarization within 200 pc. Therefore, CB 56 should be located at a distance of 200 pc. The objective of this study is to refine the distance determination of the Bok globule [CB88] 56.

2. Methodology

The data were extracted from the StarHorse2 (Anders F. et al., 2022), with a radius of 30 arcmin centered on the equatorial coordinates (RA, DEC) = (07h14m36s, -25º08'54"). The applied exclusion criteria are distance < 2 kpc, Fidelity > 0.5, FlagOut < 1, relative error in distance < 10%, and mean extinction error < 10%, the final sample was 3.447 stars.

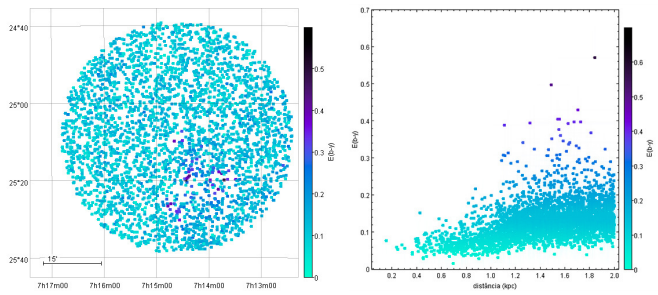

Figure 2. (Left) Spatial Reddening Map (color scheme based on Color Excess $E(b-y)$). (Right) Diagram of $E(b-y)$ by D*(pc)* for [CB88] 56.

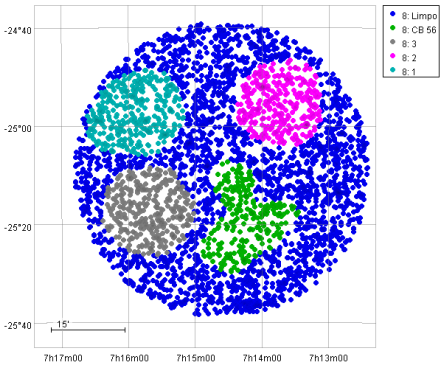

Figure 3. Spatial reddening map with cutouts in [CB88] 56 area.

Through Color Excess $E(b-y)$ vs. Distance Diagrams, in addition to spatial reddening maps, following the method of (Corradi et al., 1997; Reis & Corradi, 2008), a transition range in the values of $E(b-y)$ has been sought. As can be seen in Fig. 2, and after making cuts in different regions in Fig 3.

3. Results

The analysis revealed that at a distance of (200±30) pc, the interstellar reddening covering a broader region is around $E(b-y)$ = 0.050 mag. A second component can be seen at (600±40) pc, with $E(b-y)$ ranging from 0.05 to 0.10 mag, permeating almost the entire area too. The Bok globule [CB88] 56 is located at a distance of (1050±50) pc (Fig. 4), where an abrupt transition occurs in the $E(b-y)$ values, rising from 0.1 mag to 0.6 mag.

4. Conclusion

The Bok Globule [CB88] 56 is located at (1050±50) pc from the Sun, where $E(b-y)$ values rises from 0.1 mag to 0.6 mag. We intend to use polarimetric data collected in 2023 with IAGPOL, at OPD/LNA, to determine the polarization and polarization angle in the region, in refine these findings.

Acknowledgements. The authors thank the support from UFRJ-OV, UFMG, LNA, IBMEC, IFSP - Birigui and UEA. This work used data from the Gaia mission (ESA) and made use of the Aladin Sky Atlas (CDS, France) and TOPCAT (Taylor M. B. 2005 ADASS XIV, 347, 29). W. Corradi acknowledges the support from CNPq - BRICS 440142/2022-9, FAPEMIG APQ 02493-22 and FNDCT/FINEP/REF 0180/22. M. G. Leite-Gomes was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code Nº 88887.000418/2024-00.

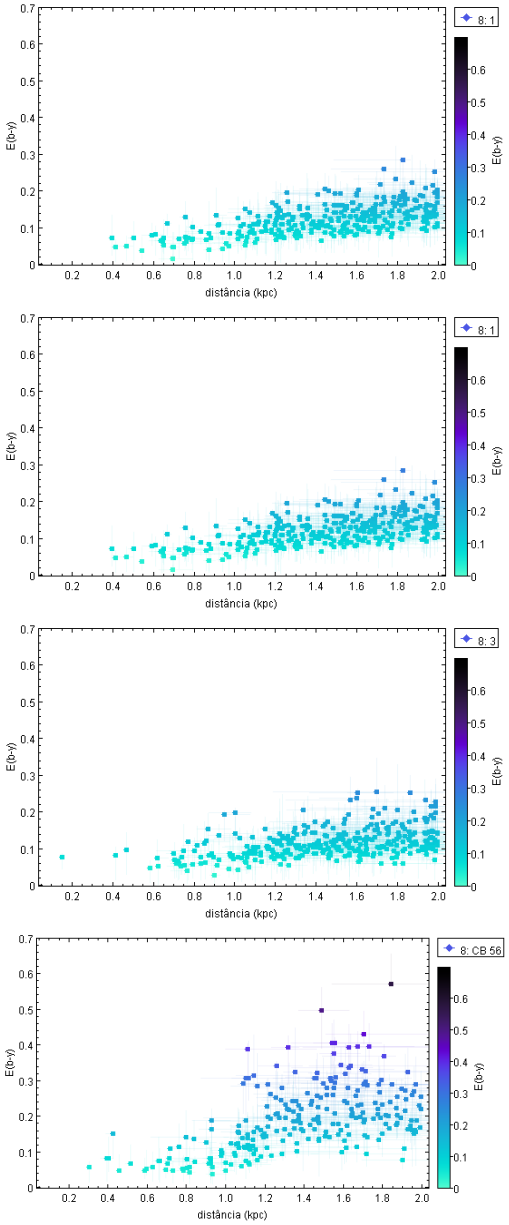

Figure 4. (From top to bottom) Region 1 – Extinction region in the upper left corner. Region 2 – Possible lower extinction above the globule. Region 3 – Extinction on the left side of the globule. CB 56 Region – Central region of the globule.

References

Anders F. et al., 2022, A&A, 658, A91
Barman, B., Das, H.S. 2024, MNRAS, 529, 1715
Corradi, W. J. B. et al., 1997, A&A, 326, 1215
Corradi, W. J. B. et al. 2004, A&A, 347, 4
Chakraborty, A. et al. 2014, MNRAS, 442, 479
Clemens, D. P.; Barvainis, R. 1988, ApJ, 68, 257
Dutra C., Bica E. 2002, A&A, 383, 631
Jorquera, S., & Bertrang, G. H. M. 2018, A&A, 618, A163
Reis, W., Corradi W. J. B. 2008, A&A, 486, 471
Roychowdhury et al. 2024, https://arxiv.org/abs/2412.00201
Yun, J. L., & Clemens, D. P. 1992, ApJ, 385, L21