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Analysis of the color excess towards the open star cluster UFMG 11

D. A. Pereira[1] & W. J. B. Corradi[2], M. S. Angelo[3], W. Reis[4], N. M. S. A. Sasaki[5], F. A. Ferreira[1], J. F. C. S. Junior[1], F. F. S. Maia[6], D. A. Brissi[7]

[1] UFMG e-mail: andrewss.daisy@gmail.com, filipeandradeferreira@hotmail.com, jsantos@fisica.ufmg.br
[2] LNA e-mail: wbcorradi@lna.br
[3] CEFET-MG e-mail: mateusangelo@cefetmg.br
[4] IBMEC e-mail: wilsonreisj@hotmail.com
[5] UEA e-mail: nsasaki@lna.br
[6] UFRJ e-mail: ffsmaia@if.ufrj.br
[7] IFSP e-mail: deidimar@ifsp.edu.br

Abstract. In this work we have studied a recently identified open cluster known as UFMG 11, located at the Galactic coordinates (330.69°, -1.37°). Using distance and absorption data obtained from the Starhorse2 catalog, we have conducted an analysis employing Color Excess $E(b-y)$ vs. Distance Diagrams and reddening maps. Our analysis revealed four distinct components in color excess: (a) at (110±50) pc, with $E(b-y)$ ranging from 0.03 to 0.10 mag, that seems the interface region between the Local and the Loop I Bubbles; (b) at (350±50) pc, with $E(b-y)$ ranging from 0.13 to 0.23 mag, plausibly related to the background of the Loop I Bubble; (c) at (800±50) pc, with $E(b-y)$ ranging from 0.25 to 0.45 mag, where there is a component that occupies the entire area before the cloud; (d) at (1220±60) pc, with $E(b-y)$ ranging from 0.5 to 1.4 mag, that has been identified as the dense cloud obstructing the view towards UFMG 11. Our forthcoming endeavors involve further analysis of this open cluster using our color magnitude diagram decontamination method with Gaia DR3 data, as well as polarimetric data collected at the Pico dos Dias Observatory - OPD/LNA.

Resumo. Neste trabalho investigamos um aglomerado aberto recentemente identificado, conhecido como UFMG 11, localizado nas coordenadas Galácticas (330.69°, -1.37°). Utilizando dados de distância e absorção obtidos do catálogo Starhorse2, foram construidos Diagramas de Excesso de Cor $E(b-y)$ vs. Distância e mapas de avermelhamento. A análise indica a presença de quatro componentes distintas em excesso de cor: (a) em (110±50) pc, com valores de $E(b-y)$ variando de 0.03 a 0.10 mag, o que parece ser a região de interface entre as Bolhas Local e Loop I; (b) em (350±50) pc, com valores de $E(b-y)$ variando de 0.13 a 0.23 mag, possivelmente relacionada ao fundo da Bolha Loop I; (c) em (800±50) pc, com valores de $E(b-y)$ variando de 0.25 a 0.45 mag, onde há uma componente que ocupa toda a área antes da nuvem; (d) em (1220±60) pc, com valores de $E(b-y)$ variando de 0.5 a 1.4 mag, identificada como a nuvem densa que obstrui a visão em direção ao UFMG 11. Nossos próximos esforços envolvem uma análise mais aprofundada deste aglomerado aberto usando o nosso método de descontaminação do diagrama cor-magnitude com dados do Gaia DR3, bem como dados polarimétricos obtidos no Observatório do Pico dos Dias - OPD/LNA.

Keywords. ISM: clouds – open clusters and associations: individual: UFMG 11 – dust, extinction

1. Introduction

Open star clusters are crucial for understanding the history and structural composition of the Galactic Disk. This study focuses on the recently identified open cluster UFMG 11, located at the Galactic coordinates (330.69°, -1.37°) in the constellation Norma, at approximately (2455 ± 340) pc (see Figure 1). Towards the cluster there is a dark cloud obstructing its view. The goal of this study is to determine the interstellar components in the direction of UFMG 11, by using color excess vs. distance diagrams, as well as to determine the distance to the cloud. An analysis of the structural astrophysical parameters of the UFMG 11 cluster, conducted using data from Gaia DR3, can be observed in Figure 2.

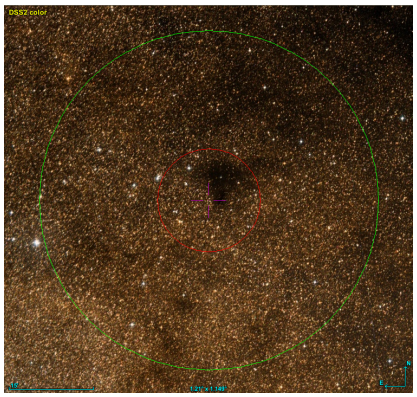

FIGURE 1: Concentric area of 30 arcminutes (green) and 546 arcseconds (red) centered on UFMG 11 in DSS2. The first indicates the analyzed region and the second indicates the cluster's region.

2. Methodology

To determine the distance to cloud, we have built Color Excess $E(b-y)$ *vs.* Distance Diagrams and developed Spatial Distribution Maps to analyze the reddening of stars along the line of sight to the cloud. A sudden increase in the color excess at a certain distance indicates that an overdensity region (interstellar component) has been crossed (Reis & Corradi 2008; Corradi *et al.* 1997, 2004). The data we used included Distance and Absorption in the visible (Av) are from the Starhorse2 catalog. To convert to $E(b-y)$ color excess we have used (Crawford & Mandwewala 1976).

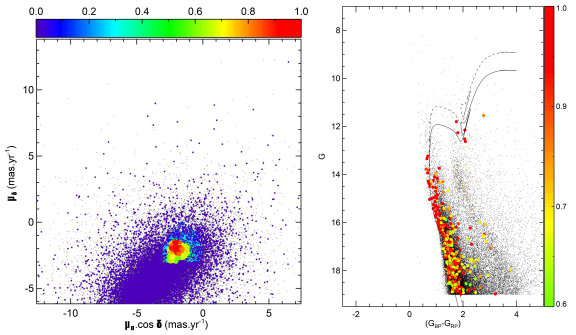

FIGURE 2: (left) The vector point diagram (VPD). (right) The color-magnitude diagram (CMD), where the colors represent the membership likelihood. The continuous lines are isochrones fitted to the data of the cluster.

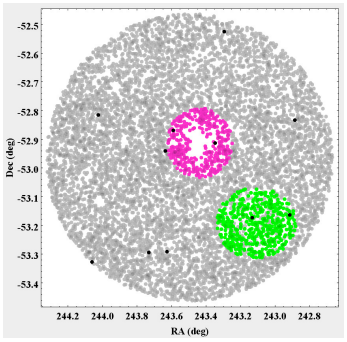

FIGURE 3: Reddening Spatial Distribution Map of the region centred on UFMG 11 within a 30arcmin radius. The pink area denotes the cloud region, while the green area represents a region outside the cloud. In black, the stars within 200 pc. All stars have a 50% restriction on distance error and no restrictions regarding color excess error.

3. Results

To identify the interstellar component it has been done a map of the color excess distribution (Figure 3). In Figure 4 we have Color Excess $E(b-y)$ *vs.* Distance Diagrams for both regions. In the cloud region, at (800±50) pc, $E(b-y)$ seems to go from 0.25 and 0.45 mag and at (1220±60) pc, $E(b-y)$ seems to go from 0.5 to 1.4 mag, characterizing a very high density region, which has been recognized as the dense cloud blocking the line of sight to UFMG 11. Making a comparison with the region outside the cloud, we can see that the color excess values in the region outside the cloud are lower than those in the cloud region.

In Figure 5, one can observe a comparison between the color excess of stars located within 800 pc and beyond 800 pc. Since $E(b-y)$ on the right is much higher than on the left, the cloud has to located beyond 800 pc.

4. Conclusion

The analysis revealed four interstellar components. The first one at (110±50) pc, exhibiting $E(b-y)$ values ranging from 0.03 to 0.10 mag. This component seems to be the interface between the Local and the Loop I Bubbles (Reis *et al.* 2011; Santos *et al.* 2011). The second one at (350±50) pc, with $E(b-y)$ ranging from 0.13 to 0.23 mag, is plausibly related to the background of the Loop I Bubble. The third one at (800±50) pc, with $E(b-y)$ ranging from 0.25 to 0.45 mag, where there is a component that occupies the entire area before the cloud. The last one at

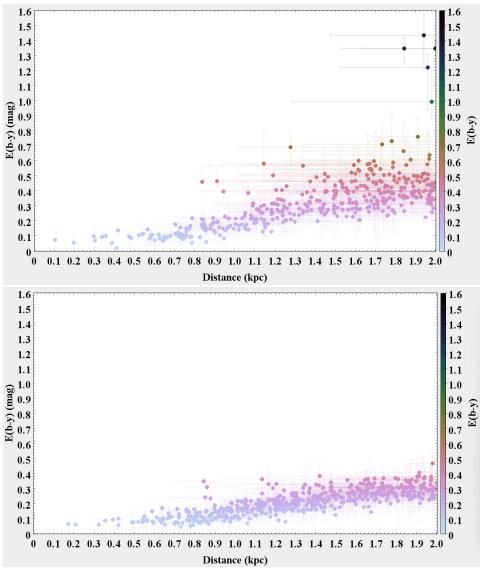

FIGURE 4: Color Excess Diagram $E(b-y)$ *vs.* Distance. (top) Region encompassing the cloud. (bottom) Region beyond the cloud.

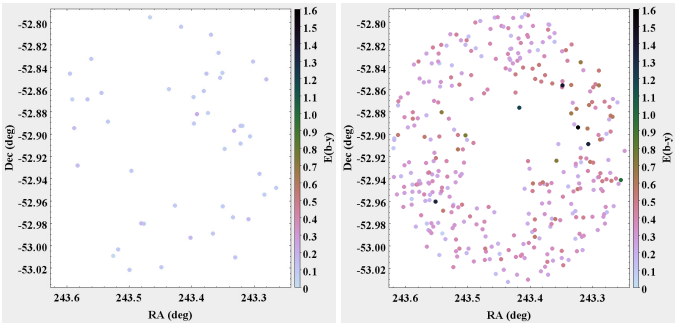

FIGURE 5: Reddening Spatial Distribution Maps of the cloud region. (left) Stars located before 800 pc. (right) Stars located beyond 800 pc.

(1220±60) pc, with $E(b-y)$ ranging from 0.5 to 1.4 mag, that has been identified as the dense cloud obstructing the view towards UFMG 11. Further analysis will involve our CMD decontamination method using Gaia DR3 data and polarimetric data from OPD/LNA.

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