Asociación Argentina de Astronomía
BAAA, Vol. 48, 2005
E.M. Arnal, A. Brunini, J.J. Clariá Olmedo, J.C. Forte, D.O. Gómez, D. García Lambas, Z. López García, S. M. Malaroda, & G.E. Romero, eds.

COMUNICACIÓN DE TRABAJO – CONTRIBUTED PAPER

NGC 6318: a young, highly reddened open cluster in the Galactic center direction

Andrés E. Piatti

IAFE, Buenos Aires, Argentina, andres@iafe.uba.ar

Juan J. Clariá and Andrea V. Ahumada

Observatorio Astronómico de Córdoba, claria, andrea@oac.uncor.edu

Abstract. We present CCD BVI photometry for the open cluster NGC 6318. Star counts carried out in the cluster field yield an angular radius of $\sim$ 8.0' for NGC 6318. The comparison of the cluster CMDs with isochrones of the Geneva group yields E(B-V) = 1.20 $\pm$ 0.05, E(V-I) = 1.55 $\pm$ 0.10 and V-M_V = 15.45 $\pm$ 0.35 (d = 2.1 $\pm$ 0.5 kpc) for log t = 8.20 (t = 160 Myr) and Z = 0.020. Among the known clusters in the line-of-sight of NGC 6318, Havlen-Moffat 1 and BH 222 are the farthest ones, while those located between 1 and 2 kpc from the Sun appear to be more absorbed than those expected to follow a quasi-linear extinction law.

Resumen. Presentamos fotometría CCD BVI del cúmulo abierto NGC 6318. Recuentos estelares efectuados en la región del cúmulo permiten estimar el radio angular de NGC 6318 en $\sim$ 8'. La comparación de los diagramas CM con isócronas teóricas del grupo de Ginebra implica: E(B-V) = 1.20 $\pm$ 0.05, E(V-I) = 1.55 $\pm$ 0.10 y V-M_V = 15.45 $\pm$ 0.35 (d = 2.1 $\pm$ 0.5 kpc) para log t = 8.20 (t = 1.6x10^8 años) y Z = 0.020. Entre los cúmulos conocidos en la dirección de NGC 6318, Havlen-Moffat 1 y BH 222 son los más distantes, en tanto que aquéllos ubicados entre 1 y 2 kpc del Sol están más absorbidos que lo que deberíamos esperar si los mismos respetaran una ley de extinción cuasi-lineal.

1. Observations

In a preliminary study, Piatti et al. (2000, hereafter PBC) obtained CCD BVI images in a 4'x4' field centred on NGC 6318. Using the 0.6 m telescope of Las Campanas Observatory, they measured 244 stars reaching down to V $\sim$ 19 mag. In addition, from a flux-calibrated integrated spectrum of NGC 6318, they derived E(B-V) = 1.20 and a cluster age between 3 and 30 Myr. The latter values, however, should be treated with caution due to the relatively low S/N ratio of the integrated spectrum. Here we obtained CCD data in a field three times larger than that of the PBC, using a telescope 50% larger. Hence, the number of stars observed is $\sim$ 40 times greater and the quality of the obtained

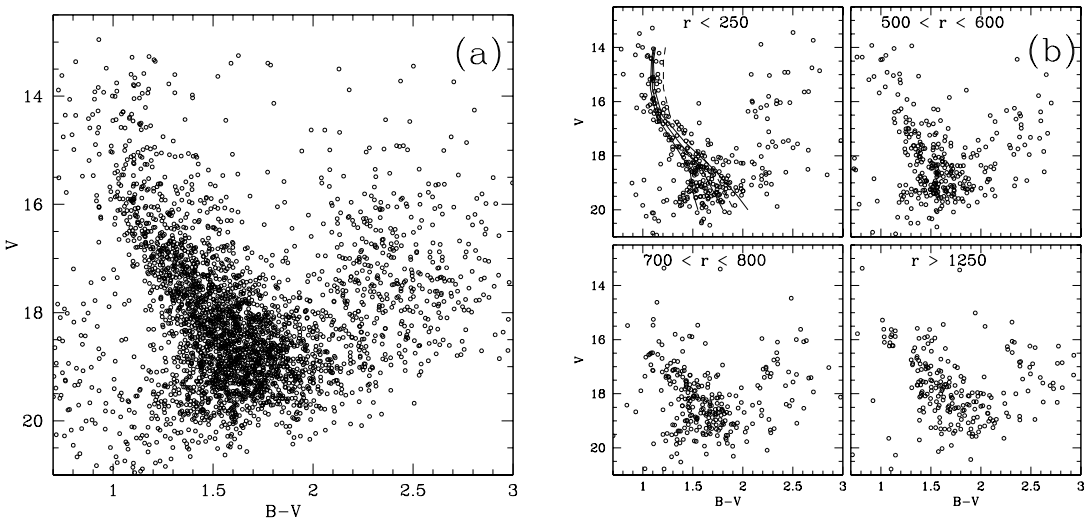

Figure 1. (a): (V,B-V) CMD for stars observed in the field of NGC 6318. (b): (V,B-V) CMDs for stars observed in extracted circular regions.

colour-magnitude diagrams (CMDs) is higher. The images were obtained with the 0.9 m telescope at the CTIO. The detector used has a pixel size of 24 μm, producing a scale on the chip of 0.4 "/pixel.

2. Colour-magnitude diagrams and cluster radius

Fig. 1(a) shows the resulting (V,B-V) CMD. It reveals a crowded broad sequence of stars which traces the cluster main sequence (MS). The central cluster position was determined statistically using stellar density profiles projected onto the X and Y directions. These profiles were fitted using the NGAUSSFIT routine of the STSDS IRAF package. We then built the cluster radial profile from which we estimated the cluster radius as $\sim$ 8'.

Fig. 1(b) shows four CMDs extracted from three circular regions and from the surrounding field (r $>$ 1250 pixels). The upper left-hand panel shows the cluster fiducial MS, whereas in the lower right-hand panel the cluster features are practically absent. In the upper right-hand panel some trails of cluster MS stars still appear, while the lower left-hand panel is dominated by field stars. The field MS of the lower right-hand panel is placed to the right of the cluster MS (r $>$ 250 pixels), which means that although NGC 6318 appears to be highly reddened, the observed field stars would be located even farther behind the cluster. Thin solid lines in the upper left-hand panel represent the lower and upper limits of the defined MS width. We shifted the fiducial cluster MS redwards until we reached the lower limit estimated by Burki (1975) for clusters with differential reddening, Δ(B-V) = 0.11, which corresponds to Δ(V-I) = 0.15, if a value of

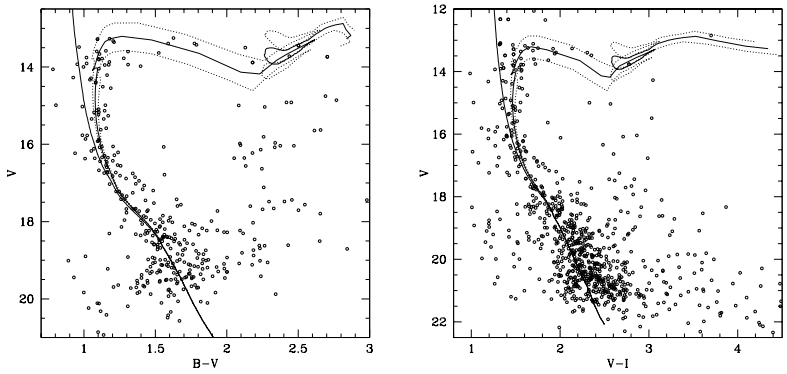

Figure 2. (V,B-V) and (V,V-I) CMDs of NGC 6318. The ZAMS and the Geneva isochrones for log t = 8.10, 8.20 and 8.30 (Z = 0.020) are overplotted.

1.33 for the E(V-I)/E(B-V) ratio is adopted. Neither photometric errors nor differential reddening seem to be the responsible for the broadness of the cluster MS. We used the innermost extracted CMD as representative of the cluster CMD. Similar (V,V-I) CMDs with stars within the same regions were also built.

3. Fundamental cluster parameters

Firstly, we independently fitted the ZAMS to the (V,B-V) and (V,V-I) CMDs for each selected metallicity and derived the cluster colour excesses and apparent distance modulus, namely E(B-V) = 1.20, E(V-I) = 1.55 and V-M_V = 15.45. Secondly, we selected isochrones of ages of some hundred million years and used the derived pairs of (V-M_V,E(B-V)) and (V-M_V, E(V-I)) values to estimate the cluster age. Finally, we compared the best fits obtained from two different metallicities and chose the one that best resembles the cluster MS, particularly the upper MS region. The isochrone of log t = 8.20 (t = 160 Myr) and Z = 0.020 turned out to be the one which most accurately reproduces the cluster features in both CMDs. To match this isochrone, we used the previously derived reddening and distance modulus. In Fig. 2 we overlapped the ZAMS and the isochrone of log t = 8.20 for Z = 0.020 to the cluster CMDs, and two additional isochrones of log t = 8.10 and 8.30 for comparison purposes. When comparing our value of E(V-I)/E(B-V) = 1.29 with that coming from the interstellar extinction law (= 1.33, Cousins 1978), we found an excellent agreement. Using A_V/E(B-V) = 3.2 (Cousins 1978) we then derived V_o-M_V = 11.6 ± 0.5, which implies a distance from the Sun of 2.1 ± 0.5 kpc.

4. Open clusters in the Galactic center direction

We searched on the Webda database for open clusters with well-determined reddenings and distances from the Sun. We required for a cluster to be included

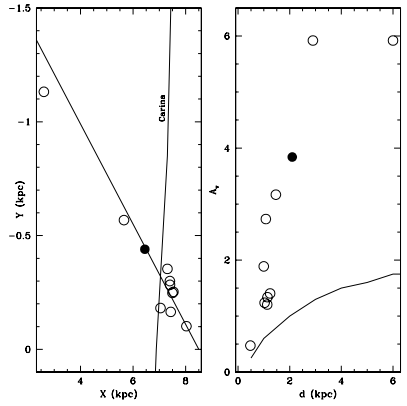

Figure 3. Galactic plane with the (X,Y) positions of the selected clusters. The line-of-sight as seen from the Sun to NGC 6318 and the Carina spiral arm are shown (left panel). The visual interstellar absorption A_v versus the cluster distance (d) from the Sun and the relation for the Baade's window superimposed (right panel). NGC 6318 is drawn with a filled circle.

in the output list that (l, b)$_{cluster}$ = (l, b)$_{NGC\,6318}$ ± 5°, in order to examine the properties of the clusters aligned along the line-of-sight of NGC 6318. We found 10 clusters fulfilling the required conditions. In the left panel of Fig. 3 we see that the distance between the outermost and the innermost clusters is more than 5 kpc and that NGC 6318 is located behind the Carina spiral feature. The right panel shows the relationship between the visual interstellar absorption and the distance from the Sun. For the sake of comparison, we also included the relationship for the Baade's window (solid line) obtained by Ng et al. (1996). A close inspection of this figure allowed us to note the following features: (i) Havlen-Moffat 1 and BH 222 are the farthest open clusters of the sample: they are placed at 2.9 and 6.0 kpc from the Sun, respectively. However, in spite of being separated by more than 3 kpc, they surprisingly are affected by the same visual absorption. On the other hand, note that at the BH 222 distance, the visual absorption towards the Baade's window - not too far from the direction towards NGC 6318 - is ∼ 4 mags smaller. (ii) Open clusters located between ∼ 1 and 2 kpc from the Sun exhibit slightly higher visual absorption than those expected for a quasi-linear extinction law. It would be interesting to investigate if this effect can be attributed to the presence of the Carina spiral feature.

References

Burki G. 1975, A&A, 43, 37

Cousins A.W.J. 1978, Mon. Notes Soc. Southern Africa, 37, 62

Lejeune T. & Schaerer D. 2001, A&A, 366, 538

Ng Y.K., Bertelli G., Chiosi C. & Bressan A. 1996, A&A, 310, 771

Piatti A.E., Bica E. & Clariá J.J. 2000, A&A, 362, 959 (PBC)