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Lyngå 11: an unstudied open cluster in the inner Galactic disk

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Abstract. The field of the open cluster Lyngå 11 is investigated by means of CCD BVI$_{KC}$ photometry. This previously unstudied object appears to be rich, highly absorbed, moderately young and probably of solar metallicity. An angular radius of 4.5'± 0.5' is estimated from star counts in the cluster field. Adopting the theoretical metal content Z = 0.02, which provides the best global fit, we derive an age of 630 ± 70 Myr. Simultaneously, colour excesses E(B-V) = 0.70 and E(V-I) = 0.85 and an apparent distance modulus V-M$_V$ = 14.0 are obtained. These results place Lyngå 11 at a distance of 2.3 ± 0.5 kpc from the Sun and ∼ 6.5 kpc from the Galactic centre. The properties of a sample of clusters aligned along the line-of-sight of Lyngå 11 are examined as well.

Resumen. Usando fotometría CCD BVI$_{KC}$ se investiga la región del cúmulo abierto Lyngå 11. Este objeto previamente no estudiado resulta ser un cúmulo rico, altamente absorbido, moderadamente joven y probablemente de metalicidad solar. A partir de recuentos estelares en la región del cúmulo se estima un radio angular de 4.5' ± 0.5'. El mejor ajuste global de isócronas teóricas obtenido con Z = 0.02 implica una edad de (630 ± 70)x10^6 años. Simultáneamente, resultan los siguientes valores: E(B-V) = 0.70, E(V-I) = 0.85 y V-M$_V$ = 14.0. Estos resultados ubican a Lyngå 11 a una distancia de 2.3 ± 0.5 kpc del Sol y ∼ 6.5 kpc del centro Galáctico. Se examinan además las propiedades de una muestra de cúmulos ubicados en la misma dirección que Lyngå 11.

1. CCD observations

The present work is part of an ongoing project of observation of some unstudied or poorly studied open clusters, located in different regions of the Milky Way. Lyngå 11 is a small-sized object located near the Galactic centre direction at l = 338°, b = +0.43°. CCD images were obtained with the Johnson B and V and Kron-Cousins I filters using the 0.9 m telescope at CTIO (Chile). The telescope was equipped with the 2048 x 2048 pixel Tektronix 2K No. 3 CCD. The detector used has a pixel size of 24 μm, producing a scale on the chip of 0.4 "/pixel.

2. Cluster extent and extracted CM diagrams

The cluster main sequence appears as a broad sequence of stars among crowded field features in the (V,B-V) diagram (Fig. 1, left panel). By using the NGAUSSFIT routine available within the IRAS/STSDAS package, projected stellar density profiles were fitted and the cluster central coordinates were obtained. Then we applied a method described by Piatti et al. (2004) to estimate the cluster radius. An angular radius of 4.5' $\pm$ 0.5', equivalent to 3.0 $\pm$ 0.3 pc was obtained. We then built (V,V-B) CMDs with stars located within circular regions of 300 and 700 pixels in radius, as well as with stars spread out of a radius of 900 pixels from the cluster centre (Fig. 1, right panel). The bottom left-hand panel of this figure corresponds to the result of a statistical field star contamination subtraction performed on the r $<$ 700 pixels CMD. We will use the latter CMD to estimate the cluster fundamental parameters. Similar (V,V-I) CMDs with stars within the same circular regions were also built.

3. Reddening, distance and age

We estimated the E(B-V) and E(V-I) colour excesses, the V-M_V apparent distance modulus, the age and the metallicity of Lyngå 11 by fitting theoretical isochrones of Lejeune & Schaerer (2001) to the observed cluster CMDs. We selected subsets of isochrones including overshooting effects for solar (Z = 0.02) and subsolar (Z = 0.008) chemical compositions. For each selected metallicity, we first fitted the ZAMS to the (V,B-V) and (V,V-I) CMDs and derived distance modulus and colour excesses. Second, we selected isochrones 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. The isochrone of log t = 8.80 (t = 630 Myr) and Z = 0.020 turned out to be the one that most accurately reproduces the cluster features in both CMDs. Such a fit is obtained by using E(B-V) = 0.70, E(V-I) = 0.85 and V-M_V = 14.00, which come from the fitting of the ZAMS. Fig. 2 shows the ZAMS and the Geneva isochrone of log t = 8.80 for Z = 0.020 overlapping the two cluster CMDs, as well as two additional isochrones of log t = 8.75 and 8.85 for comparison purposes. We calculated the true distance modulus using the derived reddening and apparent distance modulus and the most frequently used value for the A_V/E(B-V) ratio (Straizys 1992). We thus obtained V_0-M_V = 11.80 $\pm$ 0.40, which implies a distance from the Sun of 2.3 $\pm$ 0.5 kpc.

4. Open clusters along the line-of-sight of Lyngå 11

With the aim of examining the properties of a sample of open clusters located nearly in the same direction of Lyngå 11, we used the WEBDA database for searching open clusters with well determined E(B-V) values and distances. We restricted the search to clusters located at $(l, b)_{cluster} = (l, b)_{Lyngå\,11} \pm 5^\circ$ and found 17 objects. A view of the clusters projected onto the Galactic plane is illustrated in the left panel of Fig. 3, wherein the Carina spiral arm and the line-of-sight from the Sun to Lyngå 11 are indicated. Note that the distance between the outermost and innermost clusters in the considered direction is more than

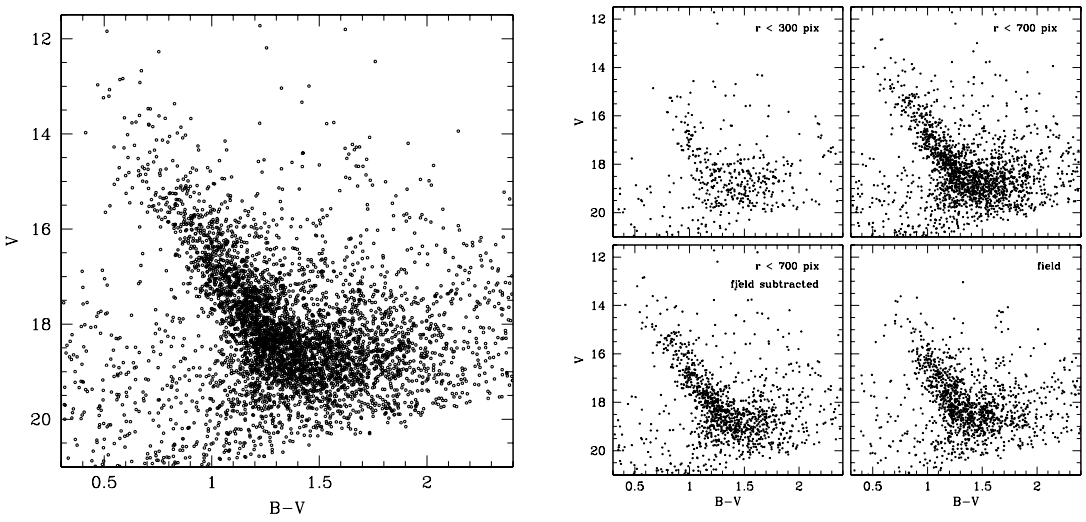

Figure 1. *Left:* (V,B-V) CMD for stars observed in the field of Lyngå 11. *Right:* (V,B-V) CMDs for stars observed in different extracted circular regions.

4 kpc and that Lyngå 11 is located behind the Carina spiral arm as seen from the Sun. The right panel of Fig. 3 shows the relationship between the visual absorption A_V and the distance d from the Sun. For comparison purposes, we included with a solid line the relationship for the Baade's window (l, b) = (1°, -3.9°) obtained by Ng et al. (1996). This figure reveals that most of the clusters located around 1 kpc from the Sun are not severely reddened, while only one cluster (Westerlund 1) is absorbed by nearly 14 mags. Notice that such high absorption is reduced in front of the Carina arm, probably caused by a lone small dark cloud. On the other hand, although clusters are in general slightly more reddened than the absorption resulting from the Baade's window law, they are not far apart much either.

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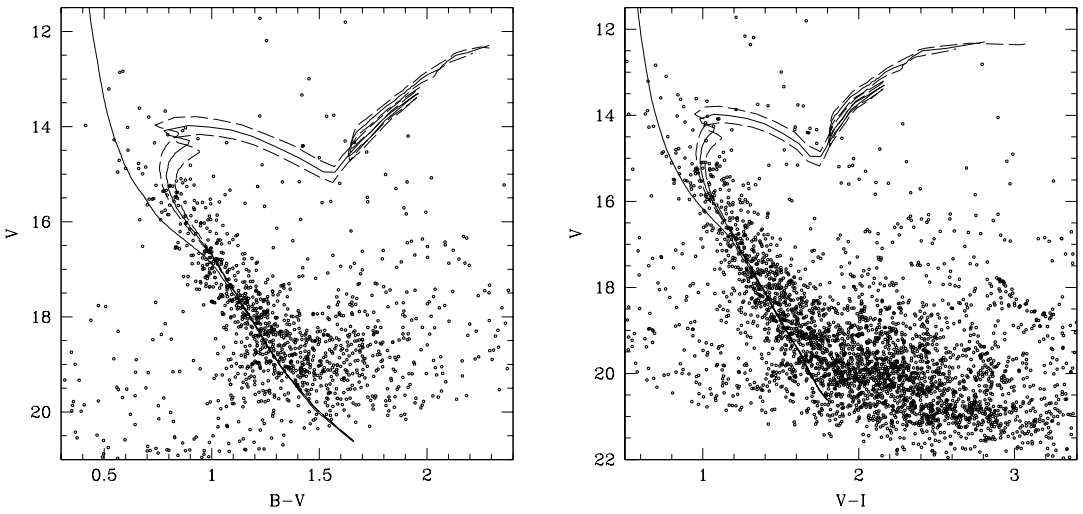

Figure 2. Extracted (V,B-V) and (V,V-I) CMDs (r < 700 pix) of Lyngå 11. The ZAMS and the Geneva isochrones for log t = 8.75, 8.80 and 8.85 (Z = 0.020) are overplotted.

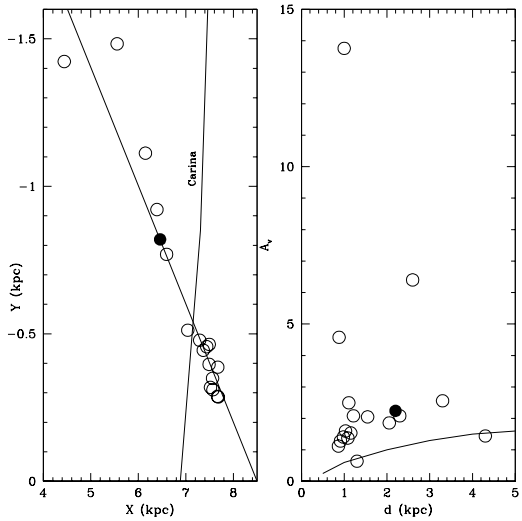

Figure 3. Galactic plane with the (X,Y) positions of the selected clusters and the line-of-sight as seen from the Sun to Lyngå 11 and the Carina spiral arm superimposed (left panel). The visual interstellar absorption A_V versus the cluster distance (d) from the Sun and the relation for the Baade's window superimposed (right panel). Lyngå 11 is drawn with a filled circle in both panels