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Letter to the Editor

KMHK 1762: Another star cluster in the Large Magellanic Cloud age gap

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ABSTRACT

Context. The star cluster (SC) age distribution of the Large Magellanic Cloud (LMC) exhibits a gap from ~4 to 10 Gyr ago, with an almost total absence of SCs. Within this age gap, only two confirmed SCs have been identified hitherto. Nonetheless, the star field counterpart does not show the same characteristics, making the LMC a peculiar galaxy where the star formation history and cluster formation history appear to differ significantly.

Aims. We re-analysed the colour-magnitude diagram (CMD) of the KMHK 1762 SC by using the deep optical photometry provided by the 'Yes, Magellanic Clouds Again' survey, so as to robustly assess its age.

Methods. First, we partially removed foreground and/or field stars by means of parallaxes and proper motions obtained from the *Gaia* Early Data Release 3. Then, we applied the Automated Stellar Cluster Analysis package to the cleaned photometric catalogue to identify the isochrone that best matches the CMD of KMHK 1762.

Results. The estimated age of KMHK 1762 is $\log(t) = 9.74 \pm 0.15$ dex (~5.5 Gyr), which is more than 2 Gyr older than the previous estimation which was obtained with shallower photometry. This value makes KMHK 1762 the third confirmed age-gap SC of the LMC.

Conclusions. The physical existence of a quiescent period of the LMC SC formation is questioned. We suggest it can be the result of an observational bias, originating from the combination of shallow photometry and limited investigation of the LMC periphery.

Key words. Magellanic Clouds – galaxies: star clusters: general – galaxies: star clusters: individual: KMHK 1762 – Hertzsprung-Russell and C-M diagrams – stars: kinematics and dynamics

1. Introduction

The Large Magellanic Cloud (LMC) is the most massive satellite of the Milky Way (MW) and because of its proximity (i.e. 50 kpc, de Grijs et al. 2014), it is possible to obtain colour-magnitude diagrams (CMDs) deeper than the main-sequence turn-off (MSTO) of the oldest stellar population present in the galaxy. The LMC is therefore one of the few galaxies where it is feasible to carry out a detailed analysis of its star cluster (SC) system (e.g., Pietrzyński & Udalski 2000; Glatt et al. 2010; Piatti et al. 2014; Pieres et al. 2016; Nayak et al. 2016) or to derive its star formation history (SFH) in great detail by studying its resolved stellar population (e.g., Harris & Zaritsky 2004, 2009; Cignoni et al. 2013; Weisz et al. 2013; Rubele et al. 2012; Mazzi et al. 2021; Piatti & Geisler 2013). Investigating if the SFHs of the SCs and field population agree with each other would have important consequences for our understanding of galaxy formation and evolution. For example, in galaxies well beyond the Local Group, where it is impossible to resolve field stars individually, their SC system might be adopted as a proxy to study the galaxy's SFH.

The LMC presents a well-known 'age gap' in the SC age distribution in the range from about 4 to 10 Gyr (Jensen et al. 1988; Da Costa 1991) for which, until a few years ago, only one member was known, namely the SC ESO121-03 with an estimated age of 9.0 ± 0.8 Gyr (Mackey et al. 2006, but see also Mateo et al. 1986). On the other hand, several works from different authors have provided evidence that the stellar field counterpart shows a significant population that formed in that age range (e.g., Tosi 2004; Piatti & Geisler 2013; Mazzi et al. 2021), making the LMC a peculiar galaxy where the SF activity of SCs and the field are different during the age gap period, whereas they are strongly similar outside of this interval (see also Maschberger & Kroupa 2011). As it is thought that most stars of a galaxy form in SCs. (Lada & Lada 2003), if the age-gap is a real feature of the LMC, we should disclose what happened to all SCs that formed the observed field stars in the LMC during the age-gap.

In recent years, and particularly during the last decade, the number of projects surveying different regions of the LMC to search for new SCs has increased remarkably, leading to the discovery of hundreds of new SCs in the MCs (Sitek et al. 2016;

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Piatti et al. 2015, 2018; Piatti 2021a). Most of these works targeted only the central regions of the LMC, where confusion due to crowding makes it extremely difficult to obtain deep and accurate photometry, which is needed to unambiguously detect old SCs, thus bringing modest advances in the comprehension of the age gap feature. One of the few exceptions was the extensive research carried out by Pieres et al. (2016), which probed the outer northern side of the LMC through the public Dark Energy Survey (DES, Dark Energy Survey Collaboration 2016) data, up to distances of 10 kpc from the LMC centre, which increased the number of known SCs in those observed fields by more than 40%. They also provided an estimate of their main parameters, that is the age, metallicity, distance modulus, and reddening for a sub-sample of 117 SCs, by adopting a maximum-likelihood approach to estimate the relevant SC parameters. Besides the confirmation of ESO121-03 as a genuine member of the age gap, Pieres et al. (2016) also revisited the age of NGC 1997 to be ~4.5 ± 0.1 Gyr, which is about 2 Gyr older than previous evaluations (Piatti et al. 2009; Palma et al. 2016), potentially making it a further age gap member since the youngest gap edge is not well defined.

Recently, Gatto et al. (2020, G20 hereafter) presented the discovery of 78 new candidate SCs in the outskirts of the LMC, 16 of which have estimated ages falling within the gap. These SCs were detected thanks to two VST surveys: 'SMC in Time: Evolution of a Prototype interacting late-type dwarf galaxy' (STEP, Ripepi et al. 2014) and the first 21 sq. deg analysed of the 'Yes, Magellanic Clouds Again' (YMCA – Gatto et al., in prep.) survey. Piatti (2021b) re-analysed a sub-sample of age-gap SC candidates reported in G20, using data from the SMASH survey (Nidever et al. 2017). They conclude that some of the candidate SCs may not be real physical systems, but rather field star density fluctuations. A definitive assertion as to the real nature of those SC candidates can be obtained only with deeper photometric observations. Very recently, Piatti (2022) re-estimated the age of the LMC SC KMHK 1592 to be 8.0 ± 0.5 Gyr through deep photometric observations carried out with GEMINI South. This is the second LMC-genuine SC well within the age gap. Because of the presence of only two confirmed members within the age gap[1], Piatti (2022) favoured the scenario of a capture from an external galaxy, such as the SMC for example. As Piatti (2022) suggest that if other confirmed age-gap SCs were discovered, the in situ origin hypothesis would be re-inforced. It is thus crucial to detect as many age gap members as possible, if they exist.

In this context, we are carrying out a systematic search of unknown SCs and a detailed re-analysis of the already catalogued SCs in the YMCA tiles not investigated in G20. In carrying out this work, we came across the already known SC KMHK 1762 (also referred to as OHSC 37 in the catalogue by Bica et al. 2008), whose CMD attracted our attention, as it showed – at first sight – a potentially older age than what is known from the literature. While the candidate SCs detected in G20 should still be confirmed with deeper photometry, the SC nature of KMHK 1762 is secured by some favourable characteristics: (i) it clearly stands out above the background as it resides in a very low-density environment; (ii) it is relatively populous; and (iii) it has several evolved stars which can be confirmed members of the SC and make it easier to identify the different evolutionary phases. Previous photometric observations of KMHK 1762 were carried out at the Cerro Tololo Inter-American Observatory (CTIO) with the 0.9 m telescope (Geisler et al. 1997). These authors adopted the magnitude difference in the Washington T_1 filter between the red clump (RC) stars and the MSTO (δT_1) to derive the age of KMHK 1762, obtaining $t \sim 2.7$ Gyr. A metal content of [Fe/H] = −0.91, based on the spectroscopic measurements of the CaII triplet for one spectroscopically confirmed member star (Olszewski et al. 1991), placed KMKH 1762 at a fairly lower metallicity level with respect to other SCs with similar ages (Geisler et al. 1997). In this Letter, we report the result of our new study of KMHK 1762 SC, based on the YMCA deep and accurate photometry, complemented with parallaxes and proper motions (PMs) from the *Gaia* Early Data Release 3 (EDR3; Gaia Collaboration 2021a).

2. Observations and data reduction

YMCA is an optical survey carried out with the VLT Survey Telescope (VST, Capaccioli & Schipani 2011) as part of the Guaranteed Time Observations (GTO) assigned by the European Southern Observatory (ESO) to the Istituto Nazionale di Astrofisica (INAF). The VST mounts the OmegaCAM which is a mosaic camera of 32-CCD, $16k \times 16k$ detectors, and has a field of view of 1 deg^2 with a pixel scale of 0.214 arcsec/pixel. KMHK 1762 resides within the YMCA tile 5_38 centred at $(\alpha, \delta) = (07{:}12{:}09.384, -69{:}34{:}30.360)$ J2000 (see G20 for a footprint of the YMCA survey), which was observed in g and i bands, with seeing of 1.46″ and 1.13″, respectively, in February–March 2020. We used the Astro-WISE pipeline (McFarland et al. 2013) to execute the pre-reduction, astrometry, and stacking of the different exposures in order to obtain a single mosaic image for each filter. To obtain point spread function (PSF) photometry and to calibrate the catalogue, we followed the same procedure as in G20 (see their Sect. 2 for full details). In particular, we used DAOPHOT IV/ALLSTAR packages (Stetson 1987, 1992) to carry out the PSF photometry, and we adopted the local standard stars provided by the AAVSO Photometric All-Sky Survey (APASS) to obtain the absolute photometry of the stars in the tile. Finally, to filter out extended or spurious sources, we required that the *SHARPNESS* parameter calculated by the DAOPHOT IV package lies in the range $-1.0 \leq SHARPNESS \leq 0.7$.

We also carried out an analysis of the photometric completeness, in particular within the cluster region, to evaluate the impact of crowding effects and poor seeing on the estimation of SC physical parameters. We performed artificial star tests in both g and i bands to retrieve their photometric completeness, following the same procedure reported in Ripepi et al. (2014). The results show that our photometry in the innermost, crowded SC regions is 80% complete in both bands down to $g \sim 21.5$ mag and 50% complete down to $g \sim 22.5$ mag. In all the other regions, it is obviously much more complete.

3. Analysis

The image of KMHK 1762 is displayed in Fig. 1 (left panel). The cluster is located at about 9.8° towards the east of the LMC, making it one of the farthest SCs in the galaxy. The centre and the radius of the cluster were determined through the technique developed and described in detail in G20 (see Sect. 3.2), obtaining $(\alpha, \delta) \simeq (106.9143°, -69.984°)$ (J2000) and $r \sim 0.5'$. We expect that LMC and MW field stars are located in front or in the back of KMHK 1762, thus to exploit its CMD with isochrone fitting, we need to first apply a cleaning procedure to mitigate the impact of the contaminant stars. This task does not appear to be straightforward in the case of KMKH 1762, as it is placed

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[1] Piatti (2022) do not mention NGC 1997 as an age gap member.

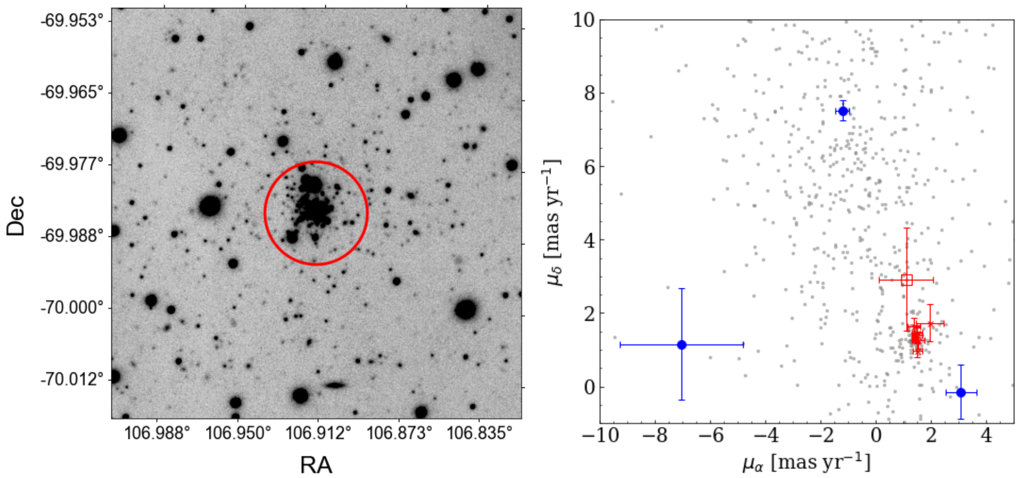

Fig. 1. *Left:* image of about 4′ in diameter in the g band centred on KMHK 1762. The red circle indicates the SC radius of 0.5′. *Right:* PMs of the 12 stars of KMHK 1762 with astrometric data from *Gaia* EDR3. The red crosses are the stars with PMs compatible with the cluster within their uncertainties. The empty red square indicates a star likely with statistically compatible PMs, but with large uncertainties (see text). Blue circles are stars with measured PMs beyond 5σ from the weighted mean SC PM. Grey points represent all stars within 10′ from the cluster centre, without their uncertainties to preserve the readability of the figure.

in a relatively poorly populated region of the LMC and it is thus difficult to apply the usual procedure to remove contaminants by using the CMD of representative fields around the SC (see for example the procedure by Piatti & Bica 2012 already adopted in G20). Therefore, to mitigate the stellar field contamination, we took advantage of the recent *Gaia* EDR3 data, with the purpose of removing likely MW foreground stars based on their parallaxes and PMs. To this aim. we first performed a cross-match of the positions of all YMCA stars within 0.5′ from the KMHK 1762 centre (i.e. the estimated cluster radius) with the *Gaia* EDR3 catalogue by adopting a maximum tolerance of 1″, and we obtained 15 stars in common[2]. Following the criterion described in Gaia Collaboration (2021b), we looked for stars that are not compatible with the LMC distance and excluded them if $\varpi > 5\,\sigma_\varpi$, where ϖ and σ_ϖ are the *Gaia* EDR3 parallaxes and parallax uncertainties. Three stars satisfy the previous condition, thus they are likely Galactic foreground stars. The PMs of the remaining 12 stars that are in common are displayed in the right panel of Fig. 1. We clipped out stars with PMs beyond 5σ from the weighted mean as they likely do not represent actual SC members. The remaining nine stars which, based on their kinematics, might belong to the SC possess a weighted mean PM of $(\mu_\alpha, \mu_\delta) = (1.42 \pm 0.04), (1.31 \pm 0.04)$ mas yr^{-1}. Among them, the star with $(\mu_\alpha, \mu_\delta) = (1.09, 2.92)$ mas yr^{-1} is barely consistent with the clump of objects closely piling up around the average KMHK 1762 PM values, and only by virtue of the large uncertainties of its PMs. We mark it with a different symbol in Fig. 1.

Figure 2 (left panel) shows the CMD of KMHK 1762 where the stars that have parallaxes or PMs incompatible with those of the cluster are highlighted with different symbols. The CMD presents a clump of stars at $g \sim 22.0$ mag which we identify as the SC MSTO, a sub-giant branch (SGB) as well as a few stars in the red giant branch (RGB) and in the RC, which can be identified at $(g - i, g) \simeq (0.8, 19.5)$ mag. In the right panel of the same Figure, we display the CMD of a field used as a comparison by taking all stars within an annulus of inner radius $r_{\rm in} = 1.0'$ (i.e. two times larger than the KMHK 1762 estimated radius) with an area 25 times larger than that of the SC. In normalising the number of field stars to the cluster area, only a few stars within the cluster area are expected to be non-cluster members, preventing any effort to remove contamination from field and foreground stars through the CMD, as discussed above.

The left panel of Fig. 2 shows the CMD of KMHK 1762 superimposed with an isochrone from the PARSEC database (Bressan et al. 2012)[3] with the age and metallicity reported by Geisler et al. (1997), that is $t \simeq 2.7$ Gyr and [Fe/H] = −0.91 dex (in addition they used $E(B - V) = 0.15$ mag and $m - M = 18.49$ mag). The figure clearly shows that the isochrone with the labelled age and metallicity does not match the SC stars on the CMD. In particular, the isochrone's SGB is about one mag brighter than the stars that are piled up at $g \sim 22$ mag and in the colour interval $g - i \simeq [0.2, 1]$, which we assume to be the actual SGB of the SC. Therefore, the proper SC age should be much older than previously estimated.

We thus carried out an objective isochrone matching procedure through the Automated Stellar Cluster Analysis package (`ASteCA`, Perren et al. 2015). `ASteCA` adopts synthetic generated single stellar populations coupled with a genetic algorithm to find the isochrone that best matches the observed CMD. We performed two runs with `ASteCA`, adopting two different choices for the priors. In particular, in *Run 1* we fixed the metallicity to the value [Fe/H] = −0.91 dex estimated through spectroscopic measurements by Olszewski et al. (1991), while in *Run 2* we let it free to vary in the $-3 \leq$ [Fe/H] ≤ 0 dex interval. In both runs, we restricted the distance modulus between 18 and 19 mag, which encompasses the average LMC distance of $m - M = 18.49$ mag (de Grijs et al. 2014). In Table 1 we list the output of `ASteCA` in the two configurations, while the best isochrones from each of the two runs are overlaid with the KMHK 1762 CMD in Fig. 2 (left panel). The isochrone calculated with *Run 1* (i.e. with fixed metallicity) better approximates the bright end of the RGB compared with that from *Run 2*, which shows a more bended RGB at $g \leq 19.5$ mag, as a consequence of the larger estimated metallicity (i.e. [Fe/H] $= -0.65^{+0.27}_{-0.41}$ dex). Even the RC that was identified at $(g - i, g) \simeq (0.8, 19.5)$ is better matched with the *Run 1* set of parameters, whereas the isochrone obtained in *Run 2* provides a

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[2] The small number of matches is due to the shallow limiting magnitude of *Gaia* which is $g \simeq 21$ mag.

[3] We note that these models adopt $Z_\odot = 0.0152$.

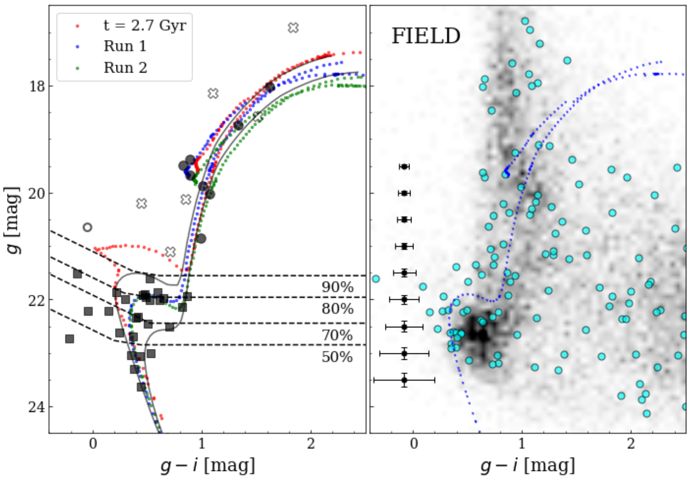

Fig. 2. *Left:* CMD of KMHK 1762. Dots represent stars that remain after *Gaia* parallaxes and PM cuts. We note that the cross-match with the *Gaia* dataset was able to clean the CMD only for stars brighter than $g \sim 21$ mag. Crosses indicate stars that should not be SC members based on their parallaxes and/or PM estimates. The empty circle indicates a star that is likely non-member of the cluster, but with statistically compatible PMs (see text). Squares are stars for which we do not have any membership information. The red, blue, and green dotted lines represent the isochrone of a SSP with parameters adopted from Geisler et al. (1997), and those estimated in this work, *Run 1* and *Run 2*, respectively. Black solid lines are isochrones of 4 Gyr and 10 Gyr, showing the boundaries of the age gap. In the same panel, completeness curves, which were built through artificial star tests in the inner 0.25′ from the cluster centre, are displayed as dashed lines. *Right:* cyan dots are field stars taken at 1′ from the cluster centre and lying in an area 25 times larger to compare the CMD of KMHK1762 with that of a local field. In the background, the Hess diagram of all stars within the YMCA tile 5_38 is displayed. Blue points represent best-fit isochrone from *Run 1*. In the same panel, we show the typical photometric uncertainties.

slightly fainter ($g \sim 20$ mag) RC magnitude with respect to the observed CMD. We therefore judge that the solution provided by *Run 1* is the best one, even if, from the purely statistical point of view, the two runs provide parameters in agreement with each other within the uncertainties. The left panel of Fig. 2 also shows completeness curves in the inner 0.25′ from the cluster centre, which were derived as described in Sect. 2. The putative SGB is entirely at the 80% completeness level, giving us confidence that the actual cluster age is well within the uncertainties provided by `ASteCA`[4], and thus we are confident it is within the age gap, as is also shown by the isochrones of 4 Gyr and 10 Gyr (boundaries of the age gap) in the left panel of Fig. 2.

Our best age estimate is therefore considerably larger compared with the Geisler et al. (1997) estimate. This discrepancy can be due to the different kind of data and analysis between their work and ours. To estimate the age of KMHK 1762, Geisler et al. (1997) did not use the isochrone fitting method (we note that the PARSEC isochrones were not available at that time), but they adopted a calibration of the magnitude difference between the RC and MSTO versus age in the Washington photometric system. In said system, they observed with a shallower faint limit ($T1 \sim 21$–22 mag) and a consequent significant noise at the level of MSTO, which makes it difficult to identify this feature precisely. In the right panel of Fig. 2, we also display the best isochrone retrieved in *Run 1* to show that the majority of the LMC stellar population within the YMCA tile 5_38 is older than KMHK 1762, and therefore the SGB we observe at $g \sim 22$ mag is unlikely a contamination effect by LMC field stars.

Table 1. Properties of KMHK 1762.

Property	*Run 1*	*Run 2*
$\log(t)$	9.74 ± 0.15 dex	9.69 ± 0.14 dex
μ_0	$18.62^{+0.24}_{-0.29}$ mag	$18.68^{+0.19}_{-0.27}$ mag
[Fe/H]	-0.91 dex (fixed)	$-0.65^{+0.27}_{-0.41}$ dex
$E(B-V)$	$0.09^{+0.06}_{-0.05}$ mag	$0.08^{+0.07}_{-0.05}$ mag

Notes. The errors were provided by the `ASteCA` package as 16th and 84th around the median value.

4. Discussion

The age of KMHK 1762, which was estimated as discussed in the previous section, is $t = 5.5^{+2.3}_{-1.6}$ Gyr. This means that it is the third confirmed age-gap SC, in addition to ESO121-03 and KMHK 1592, as mentioned in the introduction. Hereafter we also include NGC 1997 in the discussion since the end of the age gap period is not strongly constrained and this SC may also fall within it. The actual presence of an age gap among the LMC SC system is still an open question, considering that both old and recent studies devoted to the reconstruction of the LMC SFH in the stellar field do not show an absence of star formation in the ~4–10 Gyr interval (see e.g., Tosi 2004; Piatti & Geisler 2013; Rubele et al. 2012; Mazzi et al. 2021, and references therein). More quantitatively, adopting the recent work by Mazzi et al. (2021), we can calculate that the LMC formed at least $0.5 \times 10^9 M_\odot$ in the age gap period (see their Fig. 17). Therefore, the hypothesis of a quiescent period of SC formation in the LMC during the age gap interval contradicts one of the paradigms of star formation, which foresees that a great fraction of stars is formed within SCs (Lada & Lada 2003). Hence, we should conclude that we do not observe SCs in the age gap because they could have been destroyed by the tidal forces of the LMC, but this hypothesis is at odds with the steep increase in the SC age distribution at ~3 Gyr (see e.g., Pieres et al. 2016, G20, and references therein). Even assuming that this sharp increase in SC formation about 3 Gyr ago is due to a close encounter with the SMC, it is however difficult to imagine an ad hoc disruption mechanism which only acts in the age interval 4–10 Gyr and becomes suddenly inefficient at an age of 3 Gyr (Da Costa 2002).

The presence of the age gap also prevents the derivation of the age-metallicity relation (AMR) by means of the LMC SC system, and furthermore a similar gap is also present in the metallicity (Rich et al. 2001). The AMR for a sub-sample of LMC SCs is shown in Fig. 3. In particular, we adopted the samples recently analysed through spectroscopic observations by Song et al. (2021) and Mucciarelli et al. (2021). While the old LMC GCs are on average all metal-poor (the majority have [Fe/H] ≤ -1.3 dex), the younger SCs have on average [Fe/H] $\simeq -0.7$ dex, thus they are separated by a considerable gap in the metal content. In between the two sub-populations, the presence of ESO121-03, KMHK 1592, and now KMHK 1762 stands out, thanks to its newly estimated age. We note the position of NGC 1997 which appears too young for the estimated metallicity, which is however not derived from spectroscopy, but by isochrone fitting to a CMD.

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[4] Beyond 0.25′ from the cluster centre, the corresponding completeness levels are about 0.5–0.75 mag deeper.

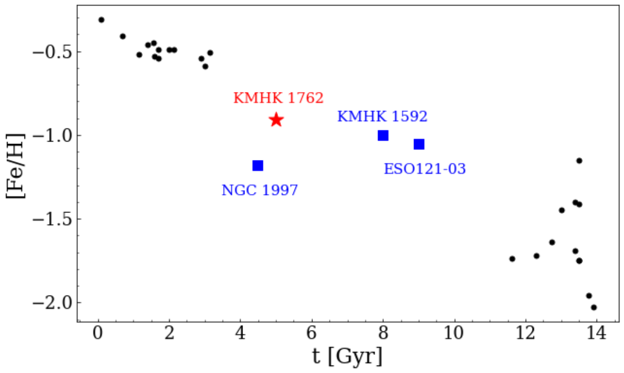

Fig. 3. Metallicity as a function of the age for the LMC analysed by Song et al. (2021) and Mucciarelli et al. (2021) is plotted as black points. The red star marks the position in the plot of KMHK 1762, while blue squares indicate the SC ESO121-03 and KMHK 1592. For KMHK 1762, we adopted the metal content estimated by Olszewski et al. (1991) (i.e. Fe/H = −0.91 dex).

The case of KMHK 1762 appears emblematic: SC ages estimated on the basis of photometry that is too shallow or not correctly de-contaminated CMDs can be significantly younger than their true age value. It is worth noticing that also in the case of NGC 1997, the analysis of deeper data led to an age estimate 2 Gyr older than past investigations, shifting this SC slightly into the age gap (Pieres et al. 2016). These results do not clarify the physical origin of the age gap, supporting instead its explanation as an observational bias. Indeed, G20 show that, while the spatial distribution of young SCs traces the main features of the LMC, such as the central bar or the spiral arms, that traced by SCs older than 1 Gyr is rather clumpy (see their Fig. 18), since they are generally located in the regions explored with modern deep photometric observations. In fact, most of the works devoted to the search of undiscovered SCs focussed in the LMC central regions leaving the outskirts (i.e. $d > 4$ kpc) quite unexplored and were conducted on the basis of photometrically shallow surveys, allowing researchers to detect only SCs younger than ~1–1.5 Gyr (Pietrzyński & Udalski 2000; Glatt et al. 2010; Nayak et al. 2016).

Figure 4 displays the relative positions of all SCs collected in the catalogue by Bica et al. (2008) with respect to the LMC centre. All age-gap SCs discussed in this work reside in the outer regions of the LMC, indicating that we can more easily detect them in the periphery, either because of fainter tidal stresses that let them survive longer (physical effect) or as a consequence of a less crowded environment (observational effect). These arguments suggest that the issue of the SC age gap in the LMC deserves to be revisited (a) after a more complete census of the SC population has been obtained (Gatto et al., in prep.) and (b) with new age estimates based on deep photometry for known (supposedly) intermediate age clusters. Both actions will certainly be possible in the near future once the Rubin-LSST survey is in operation and providing the first results.

5. Summary

In this work we have presented a study of the SC KMHK 1762 based on the deep photometry provided by the YMCA survey which allowed us to construct a CMD in the g and i bands reaching at least 1.5–2 mag below the MSTO, which is significantly deeper than the previous works in the literature. We took advantage of the PMs and parallaxes provided by the *Gaia* EDR3 to mitigate the contamination of the KMHK 1762 CMD due to MW foreground and LMC field stars. The bright limiting magnitude of the *Gaia* mission (i.e. $g \simeq 21$ mag) allowed us to clean the CMD from non-cluster members only in the post-main sequence evolutionary phases, which are, however, crucial to constrain the metal content of the SC based on the inclination of the RGB.

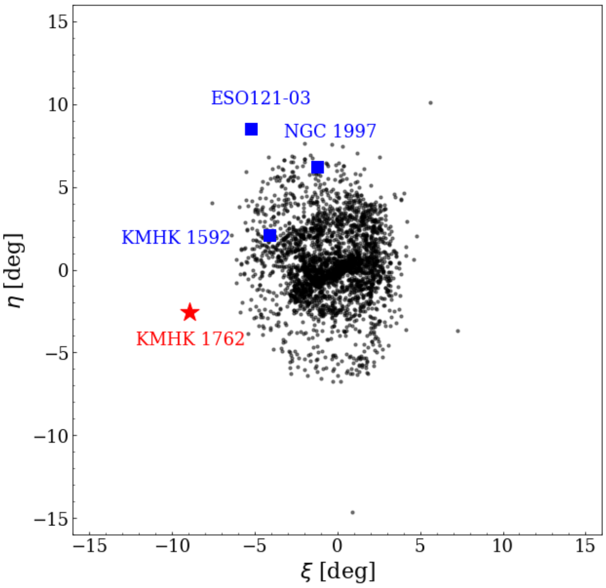

Fig. 4. Relative positions of SCs collected in the catalogue by Bica et al. (2008) with respect to the LMC centre. The red star indicates the position of KMHK 1762, whereas the blue squares mark the position of ESO121-03, KMHK 1592, and NGC 1997, the other age-gap SCs known hitherto.

The SGB clearly visible at $g \sim 22$ mag indicates that KMHK 1762 is older than previously estimated based on shallower photometry. Indeed, the automatic isochrone fitting procedure performed with the `ASteCA` package yielded an age of $t = 5.5^{+2.3}_{-1.6}$ Gyr, and analysis of completeness levels suggest that it is a lower limit for the age, making it the third or the fourth confirmed age-gap SC ever discovered, after ESO121-03 and KMHK 1592, and possibly also NGC 1997. We speculate that other intermediate-age SCs analysed with shallow photometry could actually be older and thus potentially have formed during the age gap period. In addition, as recently shown by G20, several age-gap SCs could be hidden in the outskirts of the LMC, and due to their intrinsic faintness, they can only be revealed on the basis of deep photometry. On these grounds, the increased number of confirmed or suspected SCs that formed in the age gap period suggests that the age gap may be an observational bias, possibly combined with a high destruction rate in the more LMC central regions, rather than a true quiescent period of SC formation in the LMC.

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