The Star Clusters Young & Old Newsletter

edited by Giovanni Carraro, Martin Netopil, and Ernst Paunzen
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The official Newsletter of
the IAU Commission H4.

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Dear Colleagues,

We want to remind you to the upcoming deadline of the call for nominations and applications for the IAU Commission H4 Organising Committee on March 15. We strongly encourage the community to actively support cluster research also within the IAU! See also the detailed announcement by Richard de Grijs on the next page.

This new SCYON issue includes 26 abstracts, which cover various topics of star cluster research. There are also several upcoming conferences and a Post-doc job announcement by Antonino Milone (deadline: 7^{th} March!). As the newsletter is currently issued on a 3-month basis, we want to remind you to regularly visit our webpage for the newest information!

The SCYON editor team

Giovanni Carraro, Martin Netopil, and Ernst Paunzen

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About the Newsletter

SCYON publishes abstracts from any area in astronomy, which are relevant to research on star clusters. We welcome all kinds of submitted contributions (abstracts of refereed papers or conference proceedings, PhD summaries, and general announcements of e.g. conferences, databases, tools, etc.)

The mission of this newsletter is to help all the researchers in the field with a quick and efficient link to the scientific activity in the field. We encourage everybody to contribute to the new releases! New abstracts can be submitted *at any time* using the **webform** on the SCYON homepage.

http://www.univie.ac.at/scyon

Stand for election to join the Organising Committee of IAU Commission H4!

From February 15 to March 15, the call for nominations and applications will be open for IAU members to stand for election of the Commission H4 Organising Committee (OC) for 2018–2021. The new OC will take over after the IAU General Assembly in August.

The timeline for the Commission elections is as follows:

– *February 15*: Call to Commission Membership for At-Large OC Candidates
– *March 15*: Closure of Candidate Applications for Commission Elections
– *April 1*: Opening of Commission Elections
– *April 20*: End of Commission OC Elections
– *May 1*: Announcement of the Commission Election Results

Commission H4 will be running elections to appoint a new Vice-President (VP) and three new OC members. This is your chance to make an impact in the community!

The new Commission President, our current Vice-President Amanda Karakas (Monash University, Australia), will have a three-year term, while the new Commission VP will have three years as VP ideally followed by three years as Commission President.

We are therefore inviting IAU members to propose themselves as candidates, for one of these positions: Commission H4 VP or Commission at-large OC Member.

Here is the link to the candidate application form for the Commission elections (IAU login first):
https://www.iau.org/submissions/commission_candidacy/

Please contact the relevant Commission President (grijs@astro-expat.info) for advice and instructions if needed, before filling in the form. You must be a member of the group whose OC you wish to join.

We look forward to welcoming your input!

Richard de Grijs
(Commission H4 President, 2015–2018)

Star Forming Regions

Evidence for feedback and stellar-dynamically regulated bursty star cluster formation: the case of the Orion Nebula Cluster

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A scenario for the formation of multiple co-eval populations separated in age by about 1 Myr in very young clusters (VYCs, ages less than 10 Myr) and with masses in the range 600 – 20000 $M_\odot$ is outlined. It rests upon a converging inflow of molecular gas building up a first population of pre-main sequence stars. The associated just-formed O stars ionise the inflow and suppress star formation in the embedded cluster. However, they typically eject each other out of the embedded cluster within 106 yr, that is before the molecular cloud filament can be ionised entirely. The inflow of molecular gas can then resume forming a second population. This sequence of events can be repeated maximally over the life-time of the molecular cloud (about 10 Myr), but is not likely to be possible in VYCs with mass < 300 $M_\odot$, because such populations are not likely to contain an O star. Stellar populations heavier than about 2000 $M_\odot$ are likely to have too many O stars for all of these to eject each other from the embedded cluster before they disperse their natal cloud. VYCs with masses in the range 600 – 2000 $M_\odot$ are likely to have such multi-age populations, while VYCs with masses in the range 2000 – 20000 $M_\odot$ can also be composed solely of co-eval, mono-age populations. More massive VYCs are not likely to host sub-populations with age differences of about 1 Myr. This model is applied to the Orion Nebula Cluster (ONC), in which three well-separated pre-main sequences in the color-magnitude diagram of the cluster have recently been discovered. The mass-inflow history is constrained using this model and the number of OB stars ejected from each population are estimated for verification using Gaia data. As a further consequence of the proposed model, the three runaway O star systems, AE Aur, μ Col and ι Ori, are considered as significant observational evidence for stellar-dynamical ejections of massive stars from the oldest population in the ONC. Evidence for stellar-dynamical ejections of massive stars in the currently forming population is also discussed.

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http://adsabs.harvard.edu/abs/2018arXiv180103095K

Galactic Open Clusters

The lithium-rotation connection in the 125 Myr-old Pleiades cluster

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The evolution of lithium abundance over a star's lifetime is indicative of transport processes operating in the stellar interior. We revisit the relationship between lithium content and rotation rate previously reported for cool dwarfs in the Pleiades cluster. We derive new LiI 670.8 nm equivalent width measurements from high-resolution spectra obtained for low-mass Pleiades members. We combine these new measurements with previously published ones, and use the Kepler/K2 rotational periods recently derived for Pleiades cool dwarfs to investigate the lithium-rotation connection in this 125 Myr-old cluster. The new data confirm the correlation between lithium equivalent width and stellar spin rate for a sample of 51 early K-type members of the cluster, where fast rotating stars are systematically lithium-rich compared to slowly rotating ones. The correlation is valid for all stars over the (J-K_s) color range 0.50-0.70 mag, corresponding to a mass range from about 0.75 to 0.90 $M_\odot$, and may extend down to lower masses. We argue that the dispersion in lithium equivalent widths observed for cool dwarfs in the Pleiades cluster reflects an intrinsic scatter in lithium abundances, and suggest that the physical origin of the lithium dispersion pattern is to be found in the pre-main sequence rotational history of solar-type stars.

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NGC 6705 a young α-enhanced Open Cluster from OCCASO data

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The stellar [α/Fe] abundance is sometimes used as a proxy for stellar age, following standard chemical evolution models for the Galaxy, as seen by different observational results. In this work we show that the Open Cluster NGC6705/M11 has a significant α-enhancement [α/Fe] > 0.1 dex, despite its young age ($\sim$300 Myr), challenging the current paradigm. We use high resolution (R>65,000) high signal-to-noise ($\sim$70) spectra of 8 Red Clump stars, acquired within the OCCASO survey. We determine very accurate chemical abundances of several α elements, using an equivalent width methodology (Si, Ca and Ti), and spectral synthesis fits (Mg and O). We obtain [Si/Fe]=0.13 $\pm$ 0.05, [Mg/Fe]=0.14 $\pm$ 0.07, [O/Fe]=0.17 $\pm$ 0.07, [Ca/Fe]=0.06 $\pm$ 0.05 and [Ti/Fe]=0.03 $\pm$ 0.03. Our results place these cluster within the group of young [α/Fe]-enhanced field stars recently found by several authors in the literature. The ages of our stars have an uncertainty of around 50 Myr, much more precise than for field stars. By integrating the cluster's orbit in several non-axisymmetric Galactic potentials, we establish the M11's most likely birth radius to lie between 6.8-7.5 kpc from the Galactic center, not far from its current position. Conclusions. With the robust Open Cluster age scale, our results prove that a moderate [α/Fe]-enhancement is no guarantee for a star to be old, and that not all α-enhanced stars can be explained with an evolved blue straggler scenario. Based on our orbit calculations, we further argue against a Galactic bar origin of M11.

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http://adsabs.harvard.edu/abs/2017arXiv171011069C

Gaia 1 cannot be a Thick Disk Galactic cluster

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In this note I show how the recently suggested membership of the open cluster Gaia 1 to the Galactic thick disk is based on incorrect assumptions about the structure of the disk itself, and neglect well-known observational evidences on the disk warp and flare.

Accepted by : Research Notes of the American Astronomical Society
http://adsabs.harvard.edu/abs/2018RNAAS...2...12C

Red giants and yellow stragglers in the young open cluster NGC 2447

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In this work we analyzed, using high-resolution spectroscopy, a sample of 12 single and 4 spectroscopic binary stars of the open cluster NGC 2447. For the single stars we obtained atmospheric parameters and chemical abundances of Li, C, N, O, Na, Mg, Al, Ca, Si, Ti, Ni, Cr, Y, Zr, La, Ce, Nd, Eu. Rotational velocities were obtained for all the stars. The abundances of the light elements and Eu and the rotational velocities were derived using spectral synthesis technique. We obtained a mean metallicity of [Fe/H] = -0.17 ± 0.04. We found that the abundances of all elements are similar to field giants and/or giants of open clusters, even for the s-process elements, which are enhanced as in other young open clusters. We show that the spectroscopic binaries NGC 2447-26, 38 and 42 are yellow-straggler stars, of which the primary is a giant star and the secondary a main-sequence A-type star.

Accepted by : Monthly Notices of the Royal Astronomical Society

Three Giants - Members of the Open Cluster M 67

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We determined the atmospheric parameters and chemical composition of the three giants, which are members of the open cluster M 67. The high resolution spectra (R = 60 000) were obtained with the echelle spectrograph NES mounted on the 6-meter telescope of the SAO RAS. Obtained variations in Na and Zr abundances are within the determination errors. The Li abundance suggest a depletion of Li in the course of stellar evolution. For studied giants, the iron abundances derived from the neutral and ionized iron lines have not shown any significant discrepancies. The [Ba/Fe] values are close to the solar ones.

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http://adsabs.harvard.edu/abs/2017OAP....30..108M

New insights into the origin and evolution of the old, metal-rich open cluster NGC 6791

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NGC 6791 is one of the most studied open clusters, it is massive (∼5000 $M_\odot$), located at the solar circle, old (∼8 Gyr) and yet the most metal-rich cluster ([Fe/H] $\simeq$ 0.4) known in the Milky Way. By performing an orbital analysis within a Galactic model including spiral arms and a bar, we found that it is plausible that NGC 6791 formed in the inner thin disc or in the bulge, and later displaced by radial migration to its current orbit. We apply different tools to simulate NGC 6791, including direct N-body summation in time-varying potentials, to test its survivability when going through different Galactic environments. In order to survive the 8Gyr journey moving on a migrating orbit, NGC 6791 must have been more massive, $M_0 \geq 5 \times 10^4$ $M_\odot$, when formed. We find independent confirmation of this initial mass in the stellar mass function, which is observed to be flat; this can only be explained if the average tidal field strength experienced by the cluster is stronger than what it is at its current orbit. Therefore, the birth place and journeys of NGC 6791 are imprinted in its chemical composition, in its mass-loss and in its flat stellar mass function, supporting its origin in the inner thin disc or in the bulge.

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http://adsabs.harvard.edu/abs/2018MNRAS.474...32M

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Globular cluster chemistry in fast rotating dwarf stars belonging to intermediate age open clusters

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The peculiar chemistry observed in the multiple populations of Galactic globular clusters is not generally found in other systems like dwarf galaxies and open clusters, and at the moment no model can fully explain its presence. Exploring the boundaries of the multiple population phenomenon and the variation of its extent in the space of cluster mass, age, metallicity, and compactness has proven to be a fruitful line of investigation. In the framework of a larger project to search for multiple population in open clusters, based on literature and survey data, I found peculiar chemical abundance patterns in a sample of intermediate age open clusters with publicly available data. More specifically, fast rotating dwarf stars ($v \sin i > 50 \mathrm{km\,s^{-1}}$) belonging to four clusters display a bimodality in either [Na/Fe], [O/Fe] or both. Additionally, two clusters show a Na-O anticorrelation in the fast rotating stars and one cluster shows a large [Mg/Fe] variation among the stars with high [Na/Fe], reaching the extreme Mg depletion observed in NGC 2808. Even considering that the sample sizes are small, these patterns call for attention in the light of a possible connection with the multiple population phenomenon of globular clusters. The specific chemistry observed in these fast rotating dwarf stars is thought to be produced by a complex interplay of different diffusion and mixing mechanisms, like rotational mixing and mass loss, in turn influenced by metallicity, binarity, mass, age, variability, and so on. However, with the sample in hand, it was not possible to identify which stellar parameters cause the observed Na and O bimodality and Na-O anticorrelation, suggesting that other stellar properties might be important besides stellar rotation.

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http://adsabs.harvard.edu/abs/2018arXiv180206654P

High-resolution Spectroscopic Observations of Single Red Giants in Three Open Clusters: NGC 2360, NGC 3680, and NGC 5822

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Single stars in open clusters with known distances are important targets in constraining the nucleosynthesis process since their ages and luminosities are also known. In this work, we analyze a sample of 29 single red giants of the open clusters NGC 2360, NGC 3680, and NGC 5822 using high-resolution spectroscopy. We obtained atmospheric parameters, abundances of the elements C, N, O, Na, Mg, Al, Ca, Si, Ti, Ni, Cr, Y, Zr, La, Ce, and Nd, as well as radial and rotational velocities. We employed the local thermodynamic equilibrium atmospheric models of Kurucz and the spectral analysis code MOOG. Rotational velocities and light-element abundances were derived using spectral synthesis. Based on our analysis of the single red giants in these three open clusters, we could compare, for the first time, their abundance pattern with that of the binary stars of the same clusters previously studied. Our results show that the abundances of both single and binary stars of the open clusters NGC 2360, NGC 3680, and NGC 5822 do not have significant differences. For the Single stars in open clusters with known distances are important targets in constraining the nucleosynthesis process since their ages and luminosities are also known. In this work, we analyze a sample of 29 single red giants of the open clusters NGC 2360, NGC 3680, and NGC 5822 using high-resolution spectroscopy. We obtained atmospheric parameters, abundances of the elements C, N, O, Na, Mg, Al, Ca, Si, Ti, Ni, Cr, Y, Zr, La, Ce, and Nd, as well as radial and rotational velocities. We employed the local thermodynamic equilibrium atmospheric models of Kurucz and the spectral analysis code MOOG. Rotational velocities and light-element abundances were derived using spectral synthesis. Based on our analysis of the single red giants in these three open clusters, we could compare, for the first time, their abundance pattern with that of the binary stars of the same clusters previously studied. Our results show that the abundances of both single and binary stars of the open clusters NGC 2360, NGC 3680, and NGC 5822 do not have significant differences. For the elements created by the s-process, we observed that the open clusters NGC 2360, NGC 3680, and NGC 5822 also follow the trend already raised in the literature that young clusters have higher s-process element abundances than older clusters. Finally, we observed that the three clusters of our sample exhibit a trend in the [Y/Mg]-age relation, which may indicate the ability of the [Y/Mg] ratio to be used as a clock for the giants.elements created by the s-process, we observed that the open clusters NGC 2360, NGC 3680, and NGC 5822 also follow the trend already raised in the literature that young clusters have higher s-process element abundances than older clusters. Finally, we observed that the three clusters of our sample exhibit a trend in the [Y/Mg]-age relation, which may indicate the ability of the [Y/Mg] ratio to be used as a clock for the giants.

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The K2 M67 Study: A Curiously Young Star in an Eclipsing Binary in an Old Open Cluster

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We present an analysis of a slightly eccentric ($e = 0.05$), partially eclipsing long-period ($P = 69.73$ d) main sequence binary system (WOCS 12009, Sanders 1247) in the benchmark old open cluster M67. Using Kepler K2 and ground-based photometry along with a large set of new and reanalyzed spectra, we derived highly precise masses (1.111 ± 0.015 and 0.748 ± 0.005 $M_\odot$) and radii ($1.071 \pm 0.008 \pm 0.003$ and $0.713 \pm 0.019 \pm 0.026$ $R_\odot$, with statistical and systematic error estimates) for the stars. The radius of the secondary star is in agreement with theory. The primary, however, is approximately 15% smaller than reasonable isochrones for the cluster predict. Our best explanation is that the primary star was produced from the merger of two stars, as this can also account for the non-detection of photospheric lithium and its higher temperature relative to other cluster main sequence stars at the same V magnitude. To understand the dynamical characteristics (low measured rotational line broadening of the primary star and the low eccentricity of the current binary orbit), we believe that the most probable (but not the only) explanation is the tidal evolution of a close binary within a primordial triple system (possibly after a period of Kozai-Lidov oscillations), leading to merger approximately 1 Gyr ago. This star appears to be a future blue straggler that is being revealed as the cluster ages and the most massive main sequence stars die out.

Accepted by : Astronomical Journal
http://adsabs.harvard.edu/abs/2018arXiv180205854S

Galactic Globular Clusters

Observing multiple populations in globular clusters with the ESO archive: NGC 6388 reloaded

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The metal-rich and old bulge globular cluster (GC) NGC 6388 is one of the most massive Galactic GCs (M $\sim 10^6$ $M_\odot$). However, the spectroscopic properties of its multiple stellar populations rested only on 32 red giants (only seven of which observed with UVES, the remaining with GIRAFFE), given the difficulties in observing a rather distant cluster, heavily contaminated by bulge and disc field stars. We bypassed the problem using the largest telescope facility ever: the European Southern Observatory (ESO) archive. By selecting member stars identified by other programmes, we derive atmospheric parameters and the full set of abundances for 15 species from high resolution UVES spectra of another 17 red giant branch stars in NGC 6388. We confirm that no metallicity dispersion is appreciable in this GC. About 30% of stars show the primordial composition of first generation stars, about 20% present an extremely modified second generation composition, and half of the stars has an intermediate composition. The stars clearly distribute in the Al-O and Na-O planes into three discrete groups. We find substantial hints that more than a single class of polluters is required to reproduce the composition of the intermediate component in NGC 6388. In the heavily polluted component the sum Mg+Al increases as Al increases. The sum Mg+Al+Si is constant, and is the fossil record of hot H-burning at temperatures higher than about 70 MK in the first generation polluters that contributed to form multiple populations in this cluster.

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http://adsabs.harvard.edu/abs/2018arXiv180206787C

Aluminium abundances in five discrete stellar populations of the globular cluster NGC 2808

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We observed a sample of 90 red giant branch (RGB) stars in NGC 2808 using FLAMES/GIRAFFE and the high resolution grating with the set up HR21. These stars have previous accurate atmospheric parameters and abundances of light elements. We derived aluminium abundances for them from the strong doublet Al I 8772-8773 Å as in previous works of our group. In addition, we were able to estimate the relative CN abundances for 89 of the stars from the strength of a large number of CN features. When adding self consistent abundances from previous UVES spectra analysed by our team, we gathered [Al/Fe] ratios for a total of 108 RGB stars in NGC 2808. The full dataset of proton-capture elements is used to explore in details the five spectroscopically detected discrete components in this globular cluster. We found that different classes of polluters are required to reproduce the (anti)-correlations among all proton-capture elements in the populations P2, I1, and I2 with intermediate composition. This is in agreement with the detection of lithium in lower RGB second generation stars, requiring at least two kind of polluters. To have chemically homogeneous populations the best subdivision of our sample is into six components, as derived from statistical cluster analysis. By comparing different diagrams [element/Fe] vs [element/Fe] we show for the first time that a simple dilution model is not able to reproduce all the sub-populations in this cluster. Polluters of different

masses are required. NGC 2808 is confirmed to be a tough challenge to any scenario for globular cluster formation.

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http://adsabs.harvard.edu/abs/2018arXiv180109689C

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LISA sources in Milky-Way globular clusters

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We explore the formation of double-compact-object binaries in Milky Way (MW) globular clusters (GCs) which may be detectable by the Laser Interferometer Space Antenna (LISA). We use a set of 137 fully-evolved GC models that, overall, effectively match the properties of the observed GCs in the MW. We estimate that, in total, the MW GCs contain ~ 40 sources which will be detectable by LISA. These detectable sources contain all combinations of black hole (BH), neutron star (NS), and white dwarf (WD) components. We predict ~ 10 of these sources will be BH-BH binaries. Furthermore, we show that some of these BH-BH binaries can have signal-to-noise ratios large enough to be detectable at the distance of the Andromeda galaxy or even the Virgo cluster.

Submitted to : The Physical Review
http://adsabs.harvard.edu/abs/2018arXiv180205661K

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Low-mass X-ray binaries ejected from globular clusters

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We explore the population of mass-transferring binaries ejected from globular clusters (GCs) with both black hole (BH) and neutron star (NS) accretors. We use a set of 137 fully evolved globular cluster models which span a large range in cluster properties and, overall, match very well the properties of old GCs observed in the Milky Way. We identify all binaries ejected from our set of models that eventually undergo mass-transfer. These binaries are ejected from their host clusters over a wide range of ejection times and include white dwarf, giant, and main sequence donors. We calculate the orbits of these ejected systems in the Galactic potential to determine their present-day positions in the Galaxy and compare to the distribution of observed low-mass X-ray binaries (XRBs) in the Milky Way. We estimate ~ 300 mass-transferring NS binaries and ~ 180 mass-transferring BH binaries may currently be present in the Milky Way that originated from within GCs. Of these, we estimate, based on mass-transfer rates and duty cycles at the present time, at most a few would be observable as BH-XRBs and NS-XRBs at the present day. Based on our results, XRBs that originated from GCs are unlikely to contribute significantly to the total population of low-mass XRBs in the Galactic field.

Submitted to : Astrophysical Journal
http://adsabs.harvard.edu/abs/2018arXiv180204895K

Clusters in the Magellanic clouds

The Magellanic Bridge cluster NGC 796: Deep optical AO imaging reveals the stellar content and initial mass function of a massive open cluster

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NGC 796 is a massive young cluster located 59 kpc from us in the diffuse intergalactic medium of the 1/5-1/10 $Z_\odot$ Magellanic Bridge, allowing to probe variations in star formation and stellar evolution processes as a function of metallicity in a resolved fashion, providing a link between resolved studies of nearby solar-metallicity and unresolved distant metal-poor clusters located in high-redshift galaxies. In this paper, we present adaptive optics griHα imaging of NGC 796 (at 0.5″, which is ∼0.14 pc at the cluster distance) along with optical spectroscopy of two bright members to quantify the cluster properties. Our aim is to explore if star formation and stellar evolution varies as a function of metallicity by comparing the properties of NGC 796 to higher metallicity clusters. We find from isochronal fitting of the cluster main sequence in the colour-magnitude diagram an age of 20^{+12}_{-5} Myr. Based on the cluster luminosity function, we derive a top-heavy stellar initial mass function (IMF) with a slope $\alpha = 1.99\pm0.2$, hinting at an metallicity and/or environmental dependence of the IMF which may lead to a top-heavy IMF in the early Universe. Study of the Hα emission line stars reveals that Classical Be stars constitute a higher fraction of the total B-type stars when compared with similar clusters at greater metallicity, providing some support to the chemically homogeneous theory of stellar evolution. Overall, NGC 796 has a total estimated mass of 990 ± 200 $M_\odot$, and a core radius of 1.4 ± 0.3 pc which classifies it as a massive young open cluster, unique in the diffuse interstellar medium of the Magellanic Bridge

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OGLE Collection of Star Clusters. New Objects in the Magellanic Bridge and the Outskirts of the Small Magellanic Cloud

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The Magellanic System (MS) encompasses the nearest neighbors of the Milky Way, the Large (LMC) and Small (SMC) Magellanic Clouds, and the Magellanic Bridge (MBR). This system contains a diverse sample of star clusters. Their parameters, such as the spatial distribution, chemical composition and age distribution yield important information about the formation scenario of the whole Magellanic System. Using deep photometric maps compiled in the fourth phase of the Optical Gravitational Lensing Experiment (OGLE-IV) we present the most complete catalog of star clusters in the Magellanic System ever constructed from homogeneous, long time-scale photometric data. In this second paper of the series, we show the collection of star clusters found in the area of about 360 square degrees in the MBR and in the outer regions of the SMC. Our sample contains 198 visually identified star cluster candidates, 75 of which were not listed in any of the previously published catalogs. The new discoveries are mainly young small open clusters or clusters similar to associations.

Accepted by : Acta Astronomica
http://adsabs.harvard.edu/abs/2017AcA....67..363S

Stellar variability at the main-sequence turnoff of the intermediate-age LMC cluster NGC 1846

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Intermediate-age star clusters in the LMC present extended main sequence turnoffs (MSTO) that have been attributed to either multiple stellar populations or an effect of stellar rotation. Recently it has been proposed that these extended main sequences can also be produced by ill-characterized stellar variability. Here we present Gemini-S/GMOS time series observations of the intermediate-age cluster NGC 1846. Using differential image analysis, we identified 73 new variable stars, with 55 of those being of the Delta Scuti type, that is, pulsating variables close the MSTO for the cluster age. Considering completeness and background contamination effects we estimate the number of Delta Scuti belonging to the cluster between 40 and 60 members, although this number is based on the detection of a single Delta Scuti within the cluster half-light radius. This amount of variable stars at the MSTO level will not produce significant broadening of the MSTO, albeit higher resolution imaging will be needed to rule out variable stars as a major contributor to the extended MSTO phenomenon. Though modest, this amount of Delta Scuti makes NGC 1846 the star cluster with the highest number of these variables ever discovered. Lastly, our results are a cautionary tale about the adequacy of shallow variability surveys in the LMC (like OGLE) to derive properties of its Delta Scuti population.

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No Evidence of Chemical Abundance Variations in the Intermediate-age Cluster NGC 1783

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We have analyzed multi-passband photometric observations, obtained with the *Hubble Space Telescope*, of the massive (1.8×10^5 $M_\odot$), intermediate-age (1.8 Gyr-old) Large Magellanic Cloud star cluster NGC 1783. The morphology of the cluster's red giant branch does not exhibit a clear broadening beyond its intrinsic width; the observed width is consistent with that owing to photometric uncertainties alone and independent of our photometric selection boundaries applied to obtain our sample of red-giant stars. The color dispersion of the cluster's red-giant stars around the best-fitting ridgeline is 0.062 ± 0.009 mag, which is equivalent to the width of 0.080 ± 0.001 mag derived from artificial simple stellar population tests, that is, tests based on single-age, single-metallicity stellar populations. NGC 1783 is comparably massive as other star clusters that show clear evidence of multiple stellar populations. After incorporating mass-loss recipes from its current age of 1.8 Gyr to an age of 6 Gyr, NGC 1783 is expected to remain as massive as some other clusters that host clear multiple populations at these intermediate ages. If we were to assume that mass is an important driver of multiple population formation, then NGC 1783 should have exhibited clear evidence of chemical abundance variations. However, our results support the absence of any chemical abundance variations in NGC 1783.

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The most distant clusters

The NGC 7742 star cluster luminosity function: A population analysis revisited

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We re-examine the properties of the star cluster population in the circumnuclear starburst ring in the face-on spiral galaxy NGC 7742, whose young cluster mass function has been reported to exhibit significant deviations from the canonical power law. We base our reassessment on the clusters' luminosities (an observational quantity) rather than their masses (a derived quantity), and confirm conclusively that the galaxy's starburst-ring clusters—and particularly the youngest subsample, $\log(t\ \mathrm{yr}^{-1}) \leq 7.2$—show evidence of a turnover in the cluster luminosity function well above the 90% completeness limit adopted to ensure the reliability of our results. This confirmation emphasises the unique conundrum posed by this unusual cluster population.

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Dense CO in Mrk 71-A: Superwind Suppressed in a Young Super Star Cluster

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We report the detection of CO(J = 2-1) coincident with the super star cluster (SSC) Mrk 71-A in the nearby Green Pea analog galaxy, NGC 2366. Our observations with the Northern Extended Millimeter Array reveal a compact, ∼7 pc, molecular cloud whose mass (10^5 $M_\odot$) is similar to that of the SSC, consistent with a high star formation efficiency, on the order of 0.5. There are two spatially distinct components separated by 11 $\mathrm{km\,s^{-1}}$. If expanding, these could be due to momentum-driven stellar wind feedback. Alternatively, we may be seeing remnants of the infalling, colliding clouds responsible for triggering the SSC formation. The kinematics are also consistent with a virialized system. These extreme, high-density, star-forming conditions inhibit energy-driven feedback; the co-spatial existence of a massive, molecular cloud with the SSC supports this scenario, and we quantitatively confirm that any wind-driven feedback in Mrk 71-A is momentum-driven, rather than energy-driven. Since Mrk 71-A is a candidate Lyman continuum emitter, this implies that energy-driven superwinds may not be a necessary condition for the escape of ionizing radiation. In addition, the detection of nebular continuum emission yields an accurate astrometric position for the Mrk 71-A. We also detect four other massive molecular clouds in this giant star-forming complex.

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The Second Nucleus of NGC 7727: Direct Evidence for the Formation and Evolution of an Ultracompact Dwarf Galaxy

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We present new observations of the late-stage merger galaxy NGC 7727, including HST/WFPC2 images and long-slit spectra obtained with the Clay telescope. NGC 7727 is relatively luminous ($M_V = -21.7$) and features two unequal tidal tails, various bluish arcs and star clusters, and two bright nuclei 480 pc apart in projection. These two nuclei have nearly identical redshifts, yet are strikingly different. The primary nucleus, hereafter Nucleus 1, fits smoothly into the central luminosity profile of the galaxy and appears–at various wavelengths–"red and dead." In contrast, Nucleus 2 is very compact, has a tidal radius of 103 pc, and exhibits three signs of recent activity: a post-starburst spectrum, an $[O\ III]_{5007}$ emission line, and a central X-ray point source. Its emission-line ratios place it among Seyfert nuclei. A comparison of Nucleus 2 ($M_V = -15.5$) with ultracompact dwarf galaxies (UCDs) suggests that it may be the best case yet for a massive UCD having formed through tidal stripping of a gas-rich disk galaxy. Evidence for this comes from its extended star-formation history, long blue tidal stream, and elevated dynamical-to-stellar-mass ratio. While the majority of its stars formed $\gtrsim 10$ Gyr ago, about 1/3 by mass formed during starbursts in the past 2 Gyr. Its weak AGN activity is likely driven by a black hole of mass $3 \times 10^6 - 3 \times 10^8$ $M_\odot$. We estimate that the former companion's initial mass was less than half that of then-NGC 7727, implying a minor, but significant, merger. By now this former companion has been largely shredded, leaving behind Nucleus 2 as a freshly minted UCD that probably moves on a highly eccentric orbit.

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Dynamical evolution - Simulations

Post-Newtonian Dynamics in Dense Star Clusters: Highly-Eccentric, Highly-Spinning, and Repeated Binary Black Hole Mergers

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We present models of realistic globular clusters with post-Newtonian dynamics for black holes. By modeling the relativistic accelerations and gravitational-wave emission in isolated binaries and during three- and four-body encounters, we find that nearly half of all binary black hole mergers occur inside the cluster, with about 10% of those mergers entering the LIGO/Virgo band with eccentricities greater than 0.1. In-cluster mergers lead to the birth of a second generation of black holes with larger masses and high spins, which, depending on the black hole natal spins, can sometimes be retained in the cluster and merge again. As a result, globular clusters can produce merging binaries with detectable spins regardless of the birth spins of black holes formed from massive stars. These second-generation black holes would also populate any upper mass gap created by pair-instability supernovae.

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http://adsabs.harvard.edu/abs/2017arXiv171204937R

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The complex kinematics of rotating star clusters in a tidal field

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We broaden the investigation of the dynamical properties of tidally perturbed, rotating star clusters by relaxing the traditional assumptions of coplanarity, alignment, and synchronicity between the internal and orbital angular velocity vector of their initial conditions. We show that the interplay between the internal evolution of these systems and their interaction with the external tidal field naturally leads to the development of a number of evolutionary features in their three-dimensional velocity space, including a precession and nutation of the global rotation axis and a variation of its orientation with the distance from the cluster centre. In some cases, such a radial variation may manifest itself as a counter-rotation of the outermost regions relative to the inner ones. The projected morphology of these systems is characterized by a non-monotonic ellipticity profile and, depending on the initial inclination of the rotation axis, it may also show a twisting of the projected isodensity contours. These results provide guidance in the identification of non-trivial features which may emerge in upcoming investigations of star cluster kinematics and a dynamical framework to understand some of the complexities already hinted by recent observational studies.

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http://adsabs.harvard.edu/abs/2018MNRAS.475L..86T

Miscellaneous

The emergence of the galactic stellar mass function from a non-universal IMF in clusters

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We investigate how a single generation galactic mass function (SGMF) depends on the existence of variations in the initial stellar mass functions (IMF) of stellar clusters. We show that cluster-to-cluster variations of the IMF lead to a multicomponent SGMF where each component in a given mass range can be described by a distinct power-law function. We also show that a dispersion of ≈ 0.3 $M_{\odot}$ in the characteristic mass of the IMF, as observed for young Galactic clusters, leads to a low mass slope of the SGMF that matches the observed Galactic stellar mass function even when the IMFs in the low mass end of individual clusters are much steeper.

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https://arxiv.org/abs/1711.07487v2

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Globular Cluster Formation and Evolution in the Context of Cosmological Galaxy Assembly: Open Questions

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We discuss some of the key open questions regarding the formation and evolution of globular clusters (GCs) during galaxy formation and assembly within a cosmological framework. The current state-of-the-art for both observations and simulations is described, and we briefly mention directions for future research. The oldest GCs have ages ≥ 12.5 Gyr and formed around the time of reionisation. Resolved colour-magnitude diagrams of Milky Way GCs and direct imaging of lensed proto-GCs at $z \sim 6$ with JWST promise further insight. Globular clusters are known to host multiple populations of stars with variations in their chemical abundances. Recently, such multiple populations have been detected in $\sim$2 Gyr old compact, massive star clusters. This suggests a common, single pathway for the formation of GCs at high and low redshift. The shape of the initial mass function for GCs remains unknown, however for massive galaxies a power-law mass function is favoured. Significant progress has been made recently modelling GC formation in the context of galaxy formation, with success in reproducing many of the observed GC-galaxy scaling relations.

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Identifying two groups of massive stars aligned in the l∼38° Galactic direction

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Recent near-infrared data have contributed to unveiling massive and obscured stellar populations in both new and previously known clusters in our Galaxy. These discoveries have lead us to view the Milky Way as an active star-forming machine. We look for young massive cluster candidates as over-densities of OB-type stars. The first search, focused on the Galactic direction l=38°, resulted in the detection of two objects with a remarkable population of OB-type star candidates. With a modified version of the friends-of-friends algorithm AUTOPOP and using 2MASS and UKIDSS-GPS near-infrared (J, H, and K) photometry for one of our cluster candidates (named Masgomas-6) we selected 30 stars for multi-object and long-slit H and K band spectroscopy. With the spectral classification and the near-infrared photometric data, we derive individual distance, extinction, and radial velocity. Of the 30 spectroscopically observed stars, 20 are classified as massive stars, including OB-types (dwarfs, giants and supergiants), two red supergiants, two Wolf-Rayets (WR122-11 and the new WR122-16), and one transitional object (the LBV candidate IRAS 18576+0341). The individual distances and radial velocities do not agree with a single cluster, indicating that we are observing two populations of massive stars in the same line of sight: Masgomas-6a and Masgomas-6b. The first group of massive stars, located at 3.9 kpc, contains both Wolf-Rayets and most of the OB-dwarfs; the second group, located at 9.6 kpc, hosts the LBV candidate and an evolved population of supergiants. We are able to identify massive stars at two Galactic arms, but we cannot clearly identify whether these massive stars form clusters or associations.

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Jobs

Post-doctoral position
at the Department of Physics and Astronomy, Padova University, Padova, Italy

The appointee will work with Antonino Milone and colleagues, as part of an ERC-funded project. She/he will conduct research on stellar populations in Galactic and extragalactic clusters by using data collected with the Hubble Space Telescope and with the major ground-based facilities.

Applicants should have or expect to obtain a PhD in astrophysics or related area and should have a demonstrated aptitude for research and specifically in the areas of stellar populations.

A 2(+1)-year contract will be offered, with the additional 1-year awarded after positive evaluation.

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Details are provided in the following document:
Announcement (see page 10 for the English version)

Duration: 2(+1) years
Application deadline: March 7, 2018
Contact: Prof. Antonino Milone, (antonino.milone@unipd.it)

Conferences

MODEST 18
Dense stellar systems in the era of Gaia, LIGO & LISA

25–29 June, 2018
Santorini, Greece
http://sites.northwestern.edu/modest18ciera/

Abstract submission deadline: April 6, 2018 (talks), May 31, 2018 (posters)

Multiple Populations in Stellar Clusters

9–13 July, 2018
Sexten, Italy
http://www.sexten-cfa.eu/en/conferences/2018/details/104-multiple-populations-in-stellar-clusters.html

The formation of globular clusters at high and low redshift

16–20 July, 2018
Sexten, Italy
http://www.sexten-cfa.eu/en/conferences/2018/details/106-the-formation-of-globular-clusters-at-high-and-low-z.html

Abstract submission deadline: April 15, 2018 (talks), June 15, 2018 (posters)

ESO Workshop "A revolution in stellar physics with Gaia and large surveys"

3–7 September, 2018
Warsaw, Poland
https://indico.camk.edu.pl/event/9/

Registration and abstract submission deadline: April 15, 2018