The Star Clusters Young & Old Newsletter

edited by Giovanni Carraro, Martin Netopil, and Ernst Paunzen
http://www.univie.ac.at/scyon/
email: scyon@univie.ac.at

The official Newsletter of
the IAU Commission H4.

SCYON Issue No. 73 September 15^{th}, 2017

Dear Colleagues,

This issue includes 28 abstracts that cover all main topics of the Newsletter. In particular the research field of globular clusters is strongly represented, ranging from investigations of the mass functions to abundance analyses or kinematic properties. Furthermore, we want to draw your attention to a job announcement by Antonino Milone and some forthcoming conferences.

On the following page you also find an announcement by Richard de Grijs (President of the IAU star cluster Commission H4) concerning IAU membership and a call to submit star cluster related IAU Symposia.

The SCYON editor team fully supports Richard's call to the community to strengthen our research field. Currently, there are almost 200 members in the IAU Commission H4 and already about 600 subscribers of SCYON. The Commission H4 and SCYON can only prosper with your help!

CONTENTS

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

Did you know that the SCYON newsletter is an official communication channel of International Astronomical Union (IAU) Commission H4 (Star Clusters)?

Commission H4 aims at bringing together community members interested in all aspects of star cluster research. While star cluster research is going strong around the world, our efforts can be made more efficient through formal IAU support – and for that to work best, we need your support too!

If you are a member of the IAU, please make sure you apply for Commission H4 membership. Just send an email to the IAU secretariat (iauinfos@iap.fr) and a copy to the Commission's President at grijs@pku.edu.cn

If you are not (yet) an IAU member, please consider whether your host country would allow you to become a member – and then join the Commission following your induction. The IAU only updates its membership at its General Assemblies, and you will need to be recommended for membership by your national IAU representation. IAU membership is free to individuals. In most countries, you will need to apply to your domestic IAU representative agency by the end of 2017 for General Assembly endorsement in 2018.

See for details: https://www.iau.org/administration/membership/individual/qualification/

Commission H4 needs your support in proposing and endorsing IAU Symposia on all aspects of star cluster research. This is particularly urgent at the present time, since no such Symposia were selected by the IAU's Executive for 2018. Given the central role star cluster research plays in many aspects of astrophysics, this is extremely disappointing.

Please consider proposing the organisation of an IAU Symposium for 2019; although Letters of Intent were due by September 15, you can still submit full proposals by 15 December 2017. Please check the rules for IAU Symposium proposals here: https://www.iau.org/science/meetings/rules/. The submission website can be accessed only after you have logged in to your IAU member area; go to https://www.iau.org/science/meetings/proposals/submission/

We hope to welcome many star cluster proposals! And, of course, we look forward to strengthening global star cluster research and support structures.

Clear skies,

Richard de Grijs
(President, Commission H4)

Star Forming Regions

Kinematics of OB-associations in Gaia epoch

A. M Mel'nik and A. K. Dambis
Sternberg Astronomical Institute, Lomonosov Moscow State University, Moscow, Russia

We use stellar proper motions from the TGAS catalog to study the kinematics of OB-associations. The TGAS proper motions of OB-associations generally agree well with the Hipparcos proper motions. The parameters of the Galactic rotation curve obtained with TGAS and Hipparcos proper motions agree within the errors. The average one-dimensional velocity dispersion inside 18 OB-associations with more than 10 TGAS stars is σ_v=3.9 km s^{-1}, which is considerably smaller, by a factor of 0.4, than the velocity dispersions derived from Hipparcos data. The effective contribution from orbital motions of binary OB-stars into the velocity dispersion σ_v inside OB-associations is σ_b=1.2 km s^{-1}. The median virial and stellar masses of OB-associations are equal to 7.1 10^5 and 9.0 10^3 M$_\odot$, respectively. Thus OB-associations must be unbound objects provided they do not include a lot of dense gas. The median star-formation efficiency is ϵ=2.1 percent. Nearly one third of stars of OB-associations must lie outside their tidal radius. We found that the Per OB1 and Car OB1 associations are expanding with the expansion started in a small region of 11–27 pc 7–10 Myr ago. The average expansion velocity is 6.3 km s^{-1}.

Accepted by : Monthly Notices of the Royal Astronomical Society
https://arxiv.org/abs/1708.08337

Galactic Open Clusters

A search for peculiar stars in the open cluster Hogg 16

S. Cariddi [1], N. Azatyan [2], P. Kurfürst [3], and 5 co-authors

([1]) Dipartimento di Fisica e Astronomia Galileo Galilei - Università degli Studi di Padova, Padova, Italy; ([2]) Byurakan Astrophysical observatory, Byurakan, Armenia; ([3]) Department of Theoretical Physics and Astrophysics, Masaryk University, Brno, Czech Republic

The study of chemically peculiar (CP) stars in open clusters provides valuable information about their evolutionary status. Their detection can be performed using the Δa photometric system, which maps a characteristic flux depression at $\lambda \sim 5200$ Å. This paper aims at studying the occurrence of CP stars in the earliest stages of evolution of a stellar population by applying this technique to Hogg 16, a very young Galactic open cluster (∼25 Myr). We identified several peculiar candidates: two B-type stars with a negative Δa index (CD−60 4701, CPD−60 4706) are likely emission-line (Be) stars, even though spectral measurements are necessary for a proper classification of the second one; a third object (CD−60 4703), identified as a Be candidate in literature, appears to be a background B-type supergiant with no significant Δa index, which does not rule out the possibility that it is indeed peculiar as the normality line of Δa for supergiants has not been studied in detail yet. A fourth object (CD−60 4699) appears to be a magnetic CP star of 8 $M_\odot$, but obtained spectral data seem to rule out this hypothesis. Three more magnetic CP star candidates are found in the domain of early F-type stars. One is a probable nonmember and close to the border of significance, but the other two are probably pre-main sequence cluster objects. This is very promising, as it can lead to very strong constraints to the diffusion theory. Finally, we derived the fundamental parameters of Hogg 16 and provide for the first time an estimate of its metal content.

Accepted by : New Astronomy
http://adsabs.harvard.edu/abs/2018NewA...58....1C

. . . . . .

The open cluster King 1 in the second quadrant

R. Carrera [1,2], L. Rodríguez Espinosa [1,2], L. Casamiquela [3], and 4 co-authors

([1]) Instituto de Astrofísica de Canarias, Tenerife, Spain; ([2]) Departamento de Astrofísica, Universidad de La Laguna, Tenerife, Spain; ([3]) Departament de Física Quántica i Astrofísica, Institut Ciéncies Cosmos (ICCUB), Universitat de Barcelona, Barcelona, Spain

We analyse the poorly-studied open cluster King 1 in the second Galactic quadrant. From wide-field photometry we have studied the spatial distribution of this cluster. We determined that the centre of King 1 is located at $\alpha_{(2000)}$=00h22m and $\delta_{(2000)}$=+64°23′. By parameterizing the stellar density with a King profile we have obtained a central density of ρ_0=6.5±0.2 star arcmin^{-2} and a core radius of r_{core}=1′.9±0′.2. By comparing the observed color-magnitude diagram of King 1 with those of similar open clusters and with different sets of isochrones, we have estimated an age of 2.8±0.3 Gyr, a distance modulus of $(m-M)_0$=10.6±0.1 mag, and a reddening of $E(B-V)$=0.80±0.05 mag. To complete our analysis we acquired medium resolution spectra for 189 stars in the area of King 1. From their derived radial velocities we determined an average velocity $<V_r>$=−53.1±3.1 km s^{-1}. From the strength of the infrared Ca II lines in red giants we have determined an average metallicity of <[M/H]>=+0.07±0.08 dex. From spectral synthesis we have also estimated an α-elements abundance of <[α/M]>=−0.10±0.08 dex.

Accepted by : Monthly Notices of the Royal Astronomical Society
http://adsabs.harvard.edu/abs/2017MNRAS.470.4285C

On the assessment of the nature of open star clusters and the determination of their basic parameters with limited data

G. Carraro [1], G. Baume [2], A. F. Seleznev [3], and E. Costa [4]

([1]) Università degli Studi di Padova, Padova, Italy; ([2]) Instituto de Astrofísica de La Plata (CONICET, UNLP), La Plata, Argentina; ([3]) Astronomical Observatory, Ural Federal University, Ekaterinburg, Russia; ([4]) Departamento de Astronomía Universidad de Chile, Santiago, Chile

Our knowledge of stellar evolution and of the structure and chemical evolution of the Galactic disk largely builds on the study of open star clusters. Because of their crucial role in these relevant topics, large homogeneous catalogues of open cluster parameters are highly desirable. Although efforts have been made to develop automatic tools to analyse large numbers of clusters, the results obtained so far vary from study to study, and sometimes are very contradictory when compared to dedicated studies of individual clusters. In this work we highlight the common causes of these discrepancies for some open clusters, and show that at present dedicated studies yield a much better assessment of the nature of star clusters, even in the absence of ideal data-sets. We make use of deep, wide-field, multi-colour photometry to discuss the nature of six strategically selected open star clusters: Trumpler 22, Lynga 6, Hogg 19, Hogg 21, Pismis 10 and Pismis 14. We have precisely derived their basic parameters by means of a combination of star counts and photometric diagrams. Trumpler 22 and Lynga 6 are included in our study because they are widely known, and thus provided a check of our data and methodology. The remaining four clusters are very poorly known, and their available parameters have been obtained using automatic tools only. Our results are in some cases in severe disagreement with those from automatic surveys.

Accepted by : Astrophysics and Space Science
http://adsabs.harvard.edu/abs/2017Ap%26SS.362..128C

.....

Metallicity calibrations for dwarf stars and giants in the Geneva photometric system

M. Netopil

Institut für Astrophysik, Universität Wien, Vienna, Austria

We use the most homogeneous Geneva seven-colour photometric system to derive new metallicity calibrations for early A- to K-type stars that cover both, dwarf stars and giants. The calibrations are based on several spectroscopic data sets that were merged to a common scale, and we applied them to open cluster data to obtain an additional proof of the metallicity scale and accuracy. In total, metallicities of 54 open clusters are presented. The accuracy of the calibrations for single stars is in general below 0.1 dex, but for the open cluster sample with mean values based on several stars we find a much better precision, a scatter as low as about 0.03 dex. Furthermore, we combine the new results with another comprehensive photometric data set to present a catalogue of mean metallicities for more than 3000 F- and G-type dwarf stars with $\sigma \sim 0.06$ dex. The list was extended by more than 1200 hotter stars up to about 8500 K (or spectral type A3) by taking advantage of their almost reddening free characteristic in the new Geneva metallicity calibrations. These two large samples are well suited as primary or secondary calibrators of other data, and we already identified about 20 spectroscopic data sets that show offsets up to about 0.4 dex.

Accepted by : Monthly Notices of the Royal Astronomical Society
http://adsabs.harvard.edu/abs/2017MNRAS.469.3042N

BVI Photometric Study of the Old Open Cluster Ruprecht 6

S. C. Kim [1,2,3], J. Kyeong [1], H. S. Park [1,2,3], and 5 co-authors

([1]) Korea Astronomy and Space Science Institute, Daejeon, Korea; ([2]) Korea University of Science and Technology, Daejeon, Korea; ([3]) Visiting Astronomer, CTIO, National Optical Astronomy Observatory

We present a BVI optical photometric study of the old open cluster Ruprecht 6 using the data obtained with the SMARTS 1.0 m telescope at the CTIO, Chile. Its color-magnitude diagrams show the clear existence of the main-sequence stars, of which turn-off point is located around $V \sim 18.45$ mag and $B-V \sim 0.85$ mag. Three red clump (RC) stars are identified at $V = 16.00$ mag, $I = 14.41$ mag and $B-V = 1.35$ mag. From the mean K_s-band magnitude of RC stars ($K_s = 12.39 \pm 0.21$ mag) in Ruprecht 6 from 2MASS photometry and the known absolute magnitudes of the RC stars ($M_{K_s} = -1.595 \pm 0.025$ mag), we obtain the distance modulus to Ruprecht 6 $(m-M)_0 = 13.84 \pm 0.21$ mag (d=5.86 $\pm$ 0.60 kpc). From the $(J-K_s)$ and $(B-V)$ colors of the RC stars, comparison of the $(B-V)$ and $(V-I)$ colors of the bright stars in Ruprecht 6 with those of the intrinsic colors of dwarf and giant stars, and the PARSEC isochrone fittings, we derive the reddening values of $E(B-V) = 0.42$ mag and $E(V-I) = 0.60$ mag. Using the PARSEC isochrone fittings onto the color-magnitude diagrams, we estimate the age and metallicity to be: log(t) = 9.50 $\pm$ 0.10 (t = 3.16 $\pm$ 0.82 Gyr) and [Fe/H] = -0.42 ± 0.04 dex. We present the Galactocentric radial metallicity gradient analysis for old (age > 1 Gyr) open clusters of Dias et al. catalog, which likely follow a single relation of [Fe/H] =$(-0.034 \pm 0.007)R_{GC} + (0.190 \pm 0.080)$ (rms = 0.201) for the whole radial range or dual relation of [Fe/H] =$(-0.077 \pm 0.017)R_{GC} + (0.609 \pm 0.161)$ (rms = 0.152) and constant ([Fe/H] ~ -0.3 dex) value, inside and outside of $R_{GC} \sim 12$ kpc, respectively. The metallicity and Galactocentric radius (13.28 $\pm$ 0.54 kpc) of Ruprecht 6 obtained in this study seem to be consistent with both of the relations.

Accepted by : Journal of the Korean Astronomical Society (JKAS)
http://adsabs.harvard.edu/abs/2017JKAS...50...79K

.....

A Multi-Membership Catalogue for 1876 OCs using UCAC4 data

L. Sampedro [1,2], W. S. Dias [3], E. J. Alfaro [2], H. Monteiro [3], and A. Molino [1,2]

([1]) Instituto de Astronomía, Geofísica e Cincias Atmosféricas, Universidade de São Paulo, Cidade Universitária, São Paulo, Brazil; ([2]) Instituto de Astrofísica de Andalucía, IAA-CSIC, Granada, Spain; ([3]) UNIFEI, Instituto de Física e Química, Universidade Federal de Itajubá, Itajubá, Brazil

The main objective of this work is to determine the cluster members of 1876 open clusters, using positions and proper motions of the astrometric fourth United States Naval Observatory (USNO) CCD Astrograph Catalog (UCAC4). For this purpose we apply three different methods, all based on a Bayesian approach, but with different formulations: a purely parametric method, another completely non-parametric algorithm, and a third, recently developed by Sampedro & Alfaro, using both formulations at different steps of the whole process. The first and second statistical moments of the members' phase-space subspace, obtained after applying the three methods, are compared for every cluster. Although, on average, the three methods yield similar results, there are also specific differences between them, as well as for some particular clusters. The comparison with other published catalogues shows good agreement. We have also estimated for the first time the mean proper motion for a sample of 18 clusters. The results are organized in a single catalogue formed by two main files, one with the most relevant information for each cluster, partially including that in UCAC4, and the other showing the individual membership probabilities for each star in the cluster area. The final catalogue, with an interface design that enables an easy interaction with the user, is available in electronic format at the Stellar Systems Group (SSG-IAA) web site (http://ssg.iaa.es/en/content/sampedro-cluster-catalog).

Accepted by : Monthly Notices of the Royal Astronomical Society
http://adsabs.harvard.edu/abs/2017MNRAS.470.3937S

Galactic Globular Clusters

The Outer Envelopes of Globular Clusters. II. NGC 1851, NGC 5824 and NGC 1261

P. B. Kuzma, G. S. Da Costa, and A. D. Mackey
Research School of Astronomy & Astrophysics, Australian National University, Canberra, Australia

We present a second set of results from a wide-field photometric survey of the environs of Milky Way globular clusters. The clusters studied are NGC 1261, NGC 1851 and NGC 5824: all have data from DECam on the Blanco 4m telescope. NGC 5824 also has data from the Magellan Clay telescope with MegaCam. We confirm the existence of a large diffuse stellar envelope surrounding NGC 1851 of size at least 240 pc in radius. The radial density profile of the envelope follows a power-law decline with index $\gamma = -1.5 \pm 0.2$ and the projected shape is slightly elliptical. For NGC 5824 there is no strong detection of a diffuse stellar envelope, but we find the cluster is remarkably extended and is similar in size (at least 230 pc in radius) to the envelope of NGC 1851. A stellar envelope is also revealed around NGC 1261. However, it is notably smaller in size with radius ∼105 pc. The radial density profile of the envelope is also much steeper with $\gamma = -3.8 \pm 0.2$. We discuss the possible nature of the diffuse stellar envelopes, but are unable to draw definitive conclusions based on the current data. NGC 1851, and potentially NGC 5824, could be stripped dwarf galaxy nuclei, akin to the cases of α Cen, M54 and M2. On the other hand, the different characteristics of the NGC 1261 envelope suggest that it may be the product of dynamical evolution of the cluster.

Accepted by : Monthly Notices of the Royal Astronomical Society
http://arxiv.org/abs/1709.02915 (paper II)
http://adsabs.harvard.edu/abs/2016MNRAS.461.3639K (paper I)

. . . . . .

The global mass functions of 35 Galactic globular clusters: I. Observational data and correlations with cluster parameters

A. Sollima [1] and H. Baumgardt [2]
([1]) INAF Osservatorio Astronomico di Bologna, Bologna, Italy; ([2]) University of Queensland, St. Lucia, Australia

We have derived the global mass functions of a sample of 35 Galactic globular clusters by comparing deep Hubble Space Telescope photometry with suitable multimass dynamical models. For a subset of 29 clusters with available radial velocity information we were also able to determine dynamical parameters, mass-to-light ratios and the mass fraction of dark remnants. The derived global mass functions are well described by single power-laws in the mass range $0.2 < m/\mathrm{M}_\odot < 0.8$ with mass function slopes $\alpha > -1$. Less evolved clusters show deviations from a single-power law, indicating that the original shape of their mass distribution was not a power-law. We find a tight anticorrelation between the present-day mass function slopes and the half-mass relaxation times, which can be understood if clusters started from the same universal IMF and internal dynamical evolution is the main driver in shaping the present-day mass functions. Alternatively, IMF differences correlated with the present-day half-mass relaxation time are needed to explain the observed correlation. The large range of mass function slopes seen for our clusters implies that most globular clusters are dynamically highly evolved, a fact that seems difficult to reconcile with standard estimates for the dynamical evolution of clusters. The mass function slopes also correlate with the dark remnant fractions indicating a preferential retention of massive remnants in clusters subject to high mass-loss rates.

Accepted by : Monthly Notices of the Royal Astronomical Society
http://adsabs.harvard.edu/abs/2017MNRAS.471.3668S

The Global Mass Functions of 35 Galactic globular clusters: II. Clues on the Initial Mass Function and Black Hole Retention Fraction

H. Baumgardt [1] and A. Sollima [2]

([1]) University of Queensland, St. Lucia, Australia; ([2]) INAF Osservatorio Astronomico di Bologna, Bologna, Italy

In this paper we compare the mass function slopes of Galactic globular clusters recently determined by Sollima & Baumgardt (2017) with a set of dedicated N-body simulations of star clusters containing between 65,000 to 200,000 stars. We study clusters starting with a range of initial mass functions (IMFs), black hole retention fractions and orbital parameters in the parent galaxy. We find that the present-day mass functions of globular clusters agree well with those expected for star clusters starting with Kroupa or Chabrier IMFs, and are incompatible with clusters starting with single power-law mass functions for the low-mass stars. The amount of mass segregation seen in the globular clusters studied by Sollima & Baumgardt (2017) can be fully explained by two-body relaxation driven mass segregation from initially unsegregated star clusters. Based on the present-day global mass functions, we expect that a typical globular cluster in our sample has lost about 75% of its mass since formation, while the most evolved clusters have already lost more than 90% of their initial mass and should dissolve within the next 1 to 2 Gyr. Most clusters studied by Sollima & Baumgardt also show a large difference between their central and global MF slopes, implying that the majority of Galactic globular clusters is either near or already past core collapse. The strong mass segregation seen in most clusters also implies that only a small fraction of all black holes formed in globular clusters still reside in them.

Accepted by : Monthly Notices of the Royal Astronomical Society
https://arxiv.org/abs/1708.09530

Tycho-Gaia Astrometric Solution Parallaxes and Proper Motions for Five Galactic Globular Clusters

L. L. Watkins and R. P. van der Marel

Space Telescope Science Institute, Baltimore, USA

We present a pilot study of Galactic globular cluster (GC) proper motion (PM) determinations using Gaia data. We search for GC stars in the Tycho-Gaia Astrometric Solution (TGAS) catalog from Gaia Data Release 1 (DR1), and identify five members of NGC 104 (47 Tucanae), one member of NGC 5272 (M3), five members of NGC 6121 (M4), seven members of NGC 6397, and two members of NGC 6656 (M22). By taking a weighted average of member stars, fully accounting for the correlations between parameters, we estimate the parallax (and, hence, distance) and PM of the GCs. This provides a homogeneous PM study of multiple GCs based on an astrometric catalog with small and well-controlled systematic errors and yields random PM errors similar to existing measurements. Detailed comparison to the available Hubble Space Telescope (HST) measurements generally shows excellent agreement, validating the astrometric quality of both TGAS and HST. By contrast, comparison to ground-based measurements shows that some of those must have systematic errors exceeding the random errors. Our parallax estimates have uncertainties an order of magnitude larger than previous studies, but nevertheless imply distances consistent with previous estimates. By combining our PM measurements with literature positions, distances, and radial velocities, we measure Galactocentric space motions for the clusters and find that these also agree well with previous analyses. Our analysis provides a framework for determining more accurate distances and PMs of Galactic GCs using future Gaia data releases. This will provide crucial constraints on the near end of the cosmic distance ladder and provide accurate GC orbital histories.

Accepted by : Astrophysical Journal
http://adsabs.harvard.edu/abs/2017ApJ...839...89W

NGC 6535: the lowest mass Milky Way globular cluster with a Na-O anti-correlation? Cluster mass and age in the multiple population context.

A. Bragaglia [1], E. Carretta [1], V. D'Orazi [2,3,4], and 4 co-authors

([1]) INAF - Osservatorio Astronomico di Bologna, Bologna, Italy; ([2]) INAF - Osservatorio Astronomico di Padova, Padova, Italy; ([3]) Monash Centre for Astrophysics, School of Physics and Astronomy, Monash University, Melbourne, Australia; ([4]) Department of Physics and Astronomy, Macquarie University, Sydney, Australia

To understand globular clusters (GCs) we need to comprehend how their formation process was able to produce their abundance distribution of light elements. In particular, we seek to figure out which stars imprinted the peculiar chemical signature of GCs. One of the best ways is to study the light-element anti-correlations in a large sample of GCs that are analysed homogeneously. As part of our spectroscopic survey of GCs with FLAMES, we present here the results of our study of about 30 red giant member stars in the low-mass, low-metallicity Milky Way cluster NGC 6535. We measured the metallicity (finding [Fe/H]=−1.95, rms=0.04 dex in our homogeneous scale) and other elements of the cluster and, in particular, we concentrate here on O and Na abundances. These elements define the normal Na-O anti-correlation of classical GCs, making NGC 6535 perhaps the lowest mass cluster with a confirmed presence of multiple populations. We updated the census of Galactic and extragalactic GCs for which a statement on the presence or absence of multiple populations can be made on the basis of high-resolution spectroscopy preferentially, or photometry and low-resolution spectroscopy otherwise; we also discuss the importance of mass and age of the clusters as factors for multiple populations.

Accepted by : Astronomy & Astrophysics
https://arxiv.org/abs/1708.07705

.....

Sodium abundances of AGB and RGB stars in Galactic globular clusters – Analysis and results of NGC 104, NGC 2808, NGC 6121 and NGC 6809

Y. Wang [1,2,3], F. Primas [3], C. Charbonnel [4,5], and 4 co-authors

([1]) Key Laboratory of Optical Astronomy, National Astronomical Observatories, Chinese Academy of Sciences, Beijing, China; ([2]) School of Astronomy and Space Science, University of Chinese Academy of Sciences, Beijing, China; ([3]) European Southern Observatory (ESO), Garching, Germany; ([4]) Department of Astronomy, University of Geneva, Versoix, Switzerland; ([5]) IRAP, UMR 5277 CNRS and Université de Toulouse, Toulouse, France

Galactic globular clusters (GC) are known to have multiple stellar populations and be characterised by similar chemical features, e.g. O-Na anti-correlation. While second-population stars, identified by their Na overabundance, have been found from the main sequence turn-off up to the tip of the red giant branch in various Galactic GCs, asymptotic giant branch (AGB) stars have rarely been targeted. The recent finding that NGC 6752 lacks an Na-rich AGB star has thus triggered new studies on AGB stars in GCs, since this result questions our basic understanding of GC formation and stellar evolution theory. In order to compare the Na abundance distributions of AGB and RGB stars in Galactic GCs and investigate the dependence of AGB Na abundance dispersion on GC parameters, we obtained the high-resolution spectra with the multi-object high-resolution spectrograph FLAMES on ESO/VLT for a sample of AGB and RGB stars in the Galactic GCs of NGC 104, NGC 2808, NGC 6121 and NGC 6809, and determined their Na abundances. This is the first time that the AGB stars in NGC 2808 and NGC 6809 are targeted. We find that NGC 104, NGC 2808 and NGC 6809 have comparable AGB and RGB Na abundance distributions revealed by the K-S test, while NGC 6121 shows a lack of very Na-rich AGB star. Moreover, we also reanalyzed with the same method the data archive for NGC 6752

and collected the literature data for four other GCs, i.e., a total of nine GCs, covering a wide range of GC parameters, were considered in our study. A complex picture of the Na abundances and multiple populations of AGB stars is revealed by the current data. In some GCs, AGB stars have similar Na abundances and/or second-population fractions as their RGB counterparts, while some GCs do not have Na-rich second-population AGB star, and various cases exist between the two extremes. In addition, the fitted relations between fractions of AGB second population and GC global parameters show that AGB second-population fraction slightly anticorrelates with GC central concentration, while no robust dependency can be confirmed with other GC parameters. Current data roughly support the prediction of FRMS scenario. However, considering the weak observational and theoretical trends where scatter and exceptions exist, the fraction of second-population AGB stars can be affected by more than one or two factors, and may even be a result of stochasticity.

Accepted by : Astronomy & Astrophysics
https://arxiv.org/abs/1708.07634 (part II)
http://adsabs.harvard.edu/abs/2016A%26A...592A..66W (part I)

.....

Evolution of long-lived globular cluster stars. IV. Initial helium content and white-dwarf properties

W. Chantereau [1], C. Charbonnel [1,2], and G. Meynet [1]
([1]) Department of Astronomy, University of Geneva, Versoix, Switzerland; ([2]) IRAP, UMR 5277 CNRS and Université de Toulouse, Toulouse, France

Globular clusters host stars with chemical peculiarities. The associated helium enrichment is expected to affect the evolution of stars, in general, and of low-mass stars, and in particular the progenitors of white dwarfs (WDs). We investigate the effects of different initial helium contents on the properties of WDs such as their masses, compositions, and the time since their formation. We used the grid of stellar models that we presented in the first papers of this series, which were computed for low-mass, low-metallicity stars with different helium content at [Fe/H] = −1.75 up to the end of the thermally pulsing asymptotic giant branch (TP-AGB) phase. We determined an initial-to-final mass relation as a function of the initial helium mass fraction, where the final mass is determined at the end of the TP-AGB phase. We couple the results with different possible distributions of the initial helium content for low-mass stars in NGC 6752 to predict the properties of WDs in this cluster. In a globular cluster at a given age, the He enrichment implies lower initial masses for stars at a given phase. Thus it leads to a decrease of the masses of WDs reaching the cooling sequence. In addition the He enrichment increases the total mass and number of WDs and eventually allows the presence of He white dwarf from single progenitors. The low He enrichment determined in most globular clusters with different methods results in negligible effects on the white dwarf properties. However, in the few globular clusters that display a high He enrichment, this may significantly affect the characteristics of the WDs. In NGC 2808 and α Centauri the high He enrichment even leads to the formation of He WDs from single He-rich progenitors. Therefore investigating the white dwarf mass domain in globular clusters with a high He enrichment would provide an additional indirect way to measure and constrain the He enrichment degree.

Accepted by : Astronomy & Astrophysics
http://adsabs.harvard.edu/abs/2017A%26A...602A..13C (paper IV)
http://adsabs.harvard.edu/abs/2016A%26A...592A.111C (paper III)
http://adsabs.harvard.edu/abs/2016A%26A...586A..21C (paper II)
http://adsabs.harvard.edu/abs/2015A%26A...578A.117C (paper I)

The Gaia-ESO Survey. Mg-Al anti-correlation in iDR4 globular clusters

E. Pancino [1], D. Romano [2], B. Tang [3], and 24 co-authors

([1]) INAF - Osservatorio Astrofisico di Arcetri, Firenze, Italy; ([2]) INAF - Osservatorio Astronomico di Bologna, Bologna, Italy; ([3]) Departamento de Astronomía, Universidad de Concepción, Concepción, Chile

We use Gaia-ESO (GES) Survey iDR4 data to explore the Mg-Al anti-correlation in globular clusters that were observed as calibrators, as a demonstration of the quality of Gaia-ESO Survey data and analysis. The results compare well with the available literature, within 0.1 dex or less, after a small (compared to the internal spreads) offset between the UVES and GIRAFFE data of 0.10±0.15 dex was taken into account. In particular, for the first time we present data for NGC 5927, which is one of the most metal-rich globular clusters studied in the literature so far with [Fe/H]=−0.39±0.04 dex; this cluster was included to connect with the open cluster regime in the Gaia-ESO Survey internal calibration. The extent and shape of the Mg-Al anti-correlation provide strong constraints on the multiple population phenomenon in globular clusters. In particular, we studied the dependency of the Mg-Al anti-correlation extension with metallicity, present-day mass, and age of the clusters, using GES data in combination with a large set of homogenized literature measurements.We find a dependency with both metallicity and mass, which is evident when fitting for the two parameters simultaneously, but we do not find significant dependency with age. We confirm that the Mg-Al anti-correlation is not seen in all clusters, but disappears for the less massive or most metal-rich clusters. We also use our data set to see whether a normal anti-correlation would explain the low [Mg/α] observed in some extragalactic globular clusters, but find that none of the clusters in our sample can reproduce it; a more extreme chemical composition, such as that of NGC 2419, would be required. We conclude that GES iDR4 data already meet the requirements set by the main survey goals and can be used to study globular clusters in detail, even if the analysis procedures were not specifically designed for them.

Accepted by : Astronomy & Astrophysics
http://adsabs.harvard.edu/abs/2017A%26A...601A.112P

Clusters in the Magellanic clouds

Young LMC clusters: the role of red supergiants and multiple stellar populations in their integrated light and CMDs

R. S. Asa'd [1], A. Vazdekis [2,3], M. Cerviño [2,3,4], and 3 co-authors

([1]) American University of Sharjah, Physics Department, Sharjah, UAE; ([2]) Instituto de Astrofísica de Canarias (IAC), La Laguna, Tenerife, Spain; ([3]) Departamento de Astrofísica, Universidad de La Laguna, Tenerife, Spain; ([4]) Instituto de Astrofísica de Andalucía (IAA-CSIC), Granada, Spain

The optical integrated spectra of three LMC young stellar clusters (NGC 1984, NGC 1994 and NGC 2011) exhibit concave continua and prominent molecular bands which deviate significantly from the predictions of single stellar population (SSP) models. In order to understand the appearance of these spectra, we create a set of young stellar population (MILES) models, which we make available to the community. We use archival International Ultraviolet Explorer integrated UV spectra to independently constrain the cluster masses and extinction, and rule out strong stochastic effects in the optical spectra. In addition, we also analyze deep colour-magnitude diagrams of the clusters to provide independent age determinations based on isochrone fitting. We explore hypotheses including age-spreads in the clusters, a top-heavy initial mass function, different SSP models and the role of red supergiant stars (RSG). We find that the strong molecular features in the optical spectra can only be reproduced by modeling an increased fraction of about ~ 20 per cent by luminosity of RSG above what is predicted by canonical stellar evolution models. Given the uncertainties in stellar evolution at Myr ages, we cannot presently rule-out the presence of Myr age-spreads in these clusters. Our work combines different wavelengths as well as different approaches (resolved data as well as integrated spectra for the same sample) in order to reveal the complete picture. We show that each approach provides important information but in combination can we better understand the cluster stellar populations.

Accepted by : Monthly Notices of the Royal Astronomical Society
http://adsabs.harvard.edu/abs/2017MNRAS.471.3599A

.....

Structured star formation in the Magellanic inter-Cloud region

A. D. Mackey [1], S. E. Koposov [2,3], G. S. Da Costa [1], and 5 co-authors

([1]) Research School of Astronomy and Astrophysics, Australian National University, Canberra, Australia; ([2]) Institute of Astronomy, University of Cambridge, Cambridge, UK; ([3]) McWilliams Center for Cosmology, Department of Physics, Carnegie Mellon University, Pittsburgh, USA

We use a new contiguous imaging survey conducted using the Dark Energy Camera to investigate the distribution and properties of young stellar populations in the Magellanic inter-Cloud region. These young stars are strongly spatially clustered, forming a narrow chain of low-mass associations that trace the densest HI gas in the Magellanic Bridge and extend, in projection, from the SMC to the outer disk of the LMC. The associations in our survey footprint have ages < 30 Myr, masses in the range $\sim$100-1200 solar masses, and very diffuse structures with half-light radii of up to $\sim$100 pc. The two most populous are strongly elliptical, and aligned to $\sim$10 degrees with the axis joining the centres of the LMC and SMC. These observations strongly suggest that the young inter-Cloud populations formed in situ, likely due to the compression of gas stripped during the most recent close LMC-SMC encounter. The associations lie at distances intermediate between the two Clouds, and we find no evidence for a substantial distance gradient across the imaged area. Finally, we identify a vast shell of young stars surrounding a central association, that is spatially coincident with a low column density

bubble in the HI distribution. The properties of this structure are consistent with a scenario where stellar winds and supernova explosions from massive stars in the central cluster swept up the ambient gas into a shell, triggering a new burst of star formation. This is a prime location for studying stellar feedback in a relatively isolated environment.

Accepted by : Monthly Notices of the Royal Astronomical Society
https://arxiv.org/abs/1708.04363

The most distant clusters

The difference in metallicity distribution functions of halo stars and globular clusters as a function of galaxy type: A tracer of globular cluster formation and evolution

H. Lamers [1], J. M. Diederik Kruijssen [2], Nate Bastian [3], and 3 co-authors
([1]) Astronomical Institute Anton Pannekoek, University of Amsterdam, Amsterdam, The Netherlands; ([2]) Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Heidelberg, Germany, Germany; ([3]) Astrophysics Research Institute, Liverpool John Moores University, Liverpool, UK

Observations of globular clusters (GCs) and field stars in the halos of the giant elliptical galaxy Cen A and the spiral galaxy M31 show a large range of cluster-to-star number ratios (or 'specific frequencies'). The cluster-to-star ratio decreases with increasing metallicity by over a factor of 100-1000, at all galactocentric radii and with a slope that does not seem to depend on radius. In dwarf galaxies, the GCs are also more metal-poor than the field stars on average. These observations indicate a strong dependence of either the cluster formation efficiency and/or the cluster destruction rate on metallicity and environment. We aim to explain the observed trends by considering the various effects that influence the cluster-to-star ratio as a function of metallicity, environment and cosmological history. We discuss the following effects that may influence the observed cluster-to-star ratio: (a) the formation efficiency of GCs; (b) the destruction of embedded GCs by gas expulsion; (c) the maximum masses of GCs; (d) the destruction of GCs by tidal stripping, dynamical friction, and tidal shocks as a function of environment; (e) the hierarchical assembly of GC systems during galaxy formation and the dependence on metallicity. We show that both the cluster formation efficiency and the maximum cluster mass increase with metallicity, so they cannot explain the observed trend. Destruction of GCs by tidal stripping and dynamical friction destroy clusters mostly within the inner few kpc, whereas the cluster-to-star ratio trend is observed over a much larger range of galactocentric radii. We show that cluster destruction by tidal shocks from giant molecular clouds in the high-density formation environments of GCs becomes increasingly efficient towards high galaxy masses and, hence, towards high metallicities. The predicted cluster-to-star ratio decreases by a factor 100-1000 towards high metallicities and should only weakly depend on galactocentric radius due to orbital mixing during hierarchical galaxy merging, consistent with the observations. The observed, strong dependence of the cluster-to-star ratio on metallicity and the independence of its slope on galactocentric radius can be explained by cluster destruction and hierarchical galaxy growth. During galaxy assembly, GC metallicities remain a good tracer of the host galaxy masses in which the GCs formed and experienced most of their destruction. As a result, we find that the metallicity-dependence of the cluster-to-star ratio does not reflect a GC formation efficiency, but a survival fraction.

Accepted by : Astronomy & Astrophysics
https://arxiv.org/abs/1706.00939

Nuclei of dwarf spheroidal galaxies KKs3 and ESO269-66 and their counterparts in our Galaxy

M. E. Sharina [1], V. V. Shimansky [2], and A. Y. Kniazev [3,4,5,1]

([1]) Special Astrophysical Observatory, Russian Academy of Sciences, N. Arkhyz, Russia; ([2]) Kazan Federal University, Kazan, Russia; ([3]) South African Astronomical Observatory, Cape Town, South Africa; ([4]) Southern African Large Telescope Foundation, Cape Town, South Africa; ([5]) Sternberg Astronomical Institute, Lomonosov Moscow State University, Moscow, Russia

We present the analysis of medium-resolution spectra obtained at the Southern African Large Telescope (SALT) for nuclear globular clusters (GCs) in two dwarf spheroidal galaxies (dSphs). The galaxies have similar star formation histories, but they are situated in completely different environments. ESO269-66 is a close neighbour of the giant S0 NGC5128. KKs3 is one of the few truly isolated dSphs within 10 Mpc. We estimate the helium abundance Y=0.3, age=12.6±1 Gyr, [Fe/H]=−1.5,−1.55±0.2 dex, and abundances of C, N, Mg, Ca, Ti, and Cr for the nuclei of ESO269-66 and KKs3. Our surface photometry results using HST images yield the half-light radius of the cluster in KKs3, r_h=4.8±0.2 pc. We demonstrate the similarities of medium-resolution spectra, ages, chemical compositions, and structure for GCs in ESO269-66 and KKs3 and for several massive Galactic GCs with [Fe/H] ~ -1.6 dex. All Galactic GCs posses Extended Blue Horizontal Branches and multiple stellar populations. Five of the selected Galactic objects are iron-complex GCs. Our results indicate that the sample GCs observed now in different environments had similar conditions of their formation ∼1 Gyr after the Big Bang.

Accepted by : Monthly Notices of the Royal Astronomical Society
http://adsabs.harvard.edu/abs/2017MNRAS.471.1955S

Dynamical evolution - Simulations

Stellar-mass black holes in young massive and open stellar clusters and their role in gravitational-wave generation II

S. Banerjee
AIfA/HISKP, University of Bonn, Bonn, Germany

The study of stellar-remnant black holes (BH) in dense stellar clusters is now in the spotlight, especially due to their intrinsic ability to form binary black holes (BBH) through dynamical encounters, that potentially coalesce via gravitational-wave (GW) radiation. In this work, which is a continuation of a recent study (Paper I), additional models of compact stellar clusters with initial masses $\leq 10^5$ $M_\odot$, and also those with small fractions of primordial binaries ($\leq$10%) are evolved for long term, applying the direct N-body approach, assuming state-of-the-art stellar-wind and remnant-formation prescriptions. That way, a substantially broader range of computed models than that in Paper I is achieved. As in Paper I, the general-relativistic BBH mergers continue to be mostly mediated by triples that are bound to the clusters rather than happen among the ejected BBHs. In fact, the number of such in situ BBH mergers, per cluster, tend to increase significantly with the introduction of a small population of primordial binaries. Despite the presence of massive primordial binaries, the merging BBHs, especially the in situ ones, are found to be exclusively dynamically assembled and hence would be spin-orbit misaligned. The BBHs typically traverse through both the LISA's and the LIGO's detection bands, being audible to both instruments. The "dynamical heating" of the BHs keeps the Electron-Capture-Supernova (ECS) neutron stars (NS) from effectively mass segregating and participating in exchange interactions; the dynamically-active BHs would also exchange into any NS binary within <1 Gyr. Such young massive and open clusters have the potential to contribute to the dynamical BBH merger detection rate to a similar extent as their more massive globular-cluster counterparts.

Accepted by : Monthly Notices of the Royal Astronomical Society
https://arxiv.org/abs/1707.00922 (paper II)
http://adsabs.harvard.edu/abs/2017MNRAS.467..524B (paper I)

On the initial binary population for star cluster simulations

D. Belloni [1,2], A. Askar [1], M. Giersz [1], P. Kroupa [3,4], and H. J. Rocha-Pinto [5]
([1]) Nicolaus Copernicus Astronomical Centre, Polish Academy of Sciences, Warsaw, Poland; ([2]) CAPES Foundation, Ministry of Education of Brazil, Brasilia, Brazil; ([3]) Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany; ([4]) Charles University in Prague, Faculty of Mathematics and Physics, Astronomical Institute, Praha, Czech Republic; ([5]) Universidade Federal do Rio de Janeiro, Observatório do Valongo, Rio de Janeiro, Brazil

Colour-magnitude diagrams (CMDs) are powerful tools that might be used to infer stellar properties in globular clusters (GCs), for example, the binary fraction and their mass ratio (q) distribution. In the past few years, observations have revealed that q distributions of GC main-sequence (MS) binaries are generally flat, and a distribution characterized by a strong increase towards q $\approx$ 1 is not typical in GCs. In numerical simulations of GC evolution with the initial binary population (IBP) described by Kroupa, synthetic CMD colour distributions exhibit a peak associated with binaries that have q $\approx$ 1. While the Kroupa IBP reproduces binary properties in star-forming regions, clusters and the Galactic field, the peak in the q distribution towards q $\approx$ 1 observed for GC simulations is not consistent with distributions derived from observations. The objective of this paper is to refine and further improve

the physical formulation of pre-main-sequence eigenevolution proposed by Kroupa in order to achieve CMD colour distributions of simulated GC models similar to those observed in real GCs, and to get a similarly good agreement with binary properties for late-type binaries in the Galactic field. We present in this paper a modified Kroupa IBP, in which early-type stars follow observational distributions, and late-type stars are generated according to slightly modified pre-main-sequence eigenevolution prescriptions. Our modifications not only lead to a qualitatively good agreement with respect to long-term observations of late-type binaries in the Galactic field, but also resolve the above-mentioned problem related to binary distributions in GC models.

Accepted by : Monthly Notices of the Royal Astronomical Society
http://adsabs.harvard.edu/abs/2017MNRAS.471.2812B

The Kinematic Richness of Star Clusters I. Isolated Spherical Models with Primordial Anisotropy

P. G. Breen [1], A. L. Varri [2], and D. C. Heggie [1]
([1]) School of Mathematics and Maxwell Institute for Mathematical Sciences, University of Edinburgh, Edinburgh, UK; ([2]) Institute for Astronomy, University of Edinburgh, Royal Observatory, Edinburgh, UK

We investigate the dynamical evolution of isolated equal-mass star cluster models by means of direct N-body simulations, primarily focusing on the effects of the presence of primordial anisotropy in the velocity space. We found evidence of the existence of a monotonic relationship between the moment of core collapse and the amount and flavour of anisotropy in the stellar system. Specifically, equilibria characterised by the same initial structural properties (Plummer density profile) and with different degrees of tangentially-biased (radially-biased) anisotropy, reach core collapse earlier (later) than isotropic models. We interpret this result in light of an accelerated (delayed) phase of the early evolution of collisional stellar systems ("anisotropic-response"), which we have characterised both in terms of the evolution of the velocity moments and of a fluid model of two-body relaxation. For the case of the most tangentially anisotropic model the initial phase of evolution involves a catastrophic collapse of the inner part of the system which continues until an isotropic velocity distribution is reached. This study represents a first step towards a comprehensive investigation of the role played by kinematic richness in the long-term dynamical evolution of collisional systems.

Accepted by : Monthly Notices of the Royal Astronomical Society
http://adsabs.harvard.edu/abs/2017MNRAS.471.2778B

Stability of Multiplanetary Systems in Star Clusters

M. X. Cai [1,3,4], M. B. N. Kouwenhoven [2,4], S. F. Portegies Zwart [1], and R. Spurzem [3,4,5]
([1]) Leiden Observatory, Leiden University, Leiden, The Netherlands; ([2]) Department of Mathematical Sciences, Xi'an Jiaotong-Liverpool University, Suzhou, China; ([3]) National Astronomical Observatories and Key Laboratory of Computational Astrophysics, Chinese Academy of Sciences, Beijing, China; ([4]) Kavli Institute for Astronomy and Astrophysics, Peking University, Beijing, China; ([5]) Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Heidelberg, Germany

Most stars form in star clusters and stellar associated. To understand the roles of star cluster environments in shaping the dynamical evolution of planetary systems, we carry out direct N-body simulations of four planetary systems models in three different star cluster environments with respectively N=2k, 8k and 32k stars. In each cluster, an ensemble of initially identical planetary systems are assigned to solar-type stars with $\sim 1 M_{\odot}$ and evolved for 50 Myr. We found that following the depletion of protoplanetary disks, external perturbations and planet-planet interactions are two driving

mechanisms responsible for the destabilization of planetary systems. The planet survival rate varies from ∼95% in the N=2k cluster to ∼60% in the N=32k cluster, which suggests that most planetary systems can indeed survive in low-mass clusters, except in the central regions. We also find that planet ejections through stellar encounters are cumulative processes, as only ∼3% of encounters are strong enough to excite the eccentricity by $\Delta e \geq 0.5$. Short-period planets can be perturbed through orbit crossings with long-period planets. When taking into account planet-planet interactions, the planet ejection rate nearly doubles, and therefore multiplicity contributes to the vulnerability of planetary systems. In each ensemble, ∼0.2% of planetary orbits become retrograde due to random directions of stellar encounters. Our results predict that young low-mass star clusters are promising sites for next-generation planet surveys, yet low planet detection rates are expected in dense globular clusters such as 47 Tuc. Nevertheless, planets in denser stellar environments are likely to have shorter orbital periods, which enhances their detectability.

Accepted by : Monthly Notices of the Royal Astronomical Society
http://adsabs.harvard.edu/abs/2017MNRAS.470.4337C

The impact of a star-formation efficiency profile on the evolution of open clusters

B. Shukirgaliyev [1,2], G. Parmentier [1], P. Berczik [3,4,5], and A. Just [1]

([1]) Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Heidelberg, Germany; ([2]) Fesenkov Astrophysical Institute, Almaty, Kazakhstan; ([3]) The International Center of Future Science of the Jilin University, Changchun City, China; ([4]) National Astronomical Observatories of China and Key Laboratory for Computational Astrophysics, Chinese Academy of Sciences, Beijing, China; ([5]) Main Astronomical Observatory, National Academy of Sciences of Ukraine, Kyiv, Ukraine

We study the effect of the instantaneous expulsion of the residual star-forming gas on star clusters wherein the residual gas has a density profile shallower than that of the embedded cluster. This configuration is expected if star formation proceeds with a given star-formation efficiency per free-fall time in a centrally-concentrated molecular gas clump. Methods. We perform direct N-body simulations whose initial conditions are generated by the program "mkhalo" from the package "falcON" (McMillan & Dehnen (2007)) adapted for our models. Our model clusters initially have a Plummer profile and are in virial equilibrium with the gravitational potential of the cluster-forming clump. The residual gas contribution is computed based on the model of Parmentier & Pfalzner (2013). Our simulations include mass loss by stellar evolution and the tidal field of a host galaxy. We find that a star cluster with a minimum global SFE of 15 percent is able to survive instantaneous gas expulsion and to produce a bound cluster. Its violent relaxation lasts no longer than 20 Myr, independently of its global SFE and initial stellar mass. At the end of violent relaxation the bound fractions of surviving clusters with the same global SFEs are similar regardless of their initial stellar mass. Their subsequent lifetime in the gravitational field of the Galaxy depends on their bound stellar masses. We therefore conclude that the critical SFE needed to produce a bound cluster is 15 percent, which is roughly twice smaller than earlier estimates of 33 percent. Thus we have improved the survival likelihood of young clusters after instantaneous gas expulsion. Those can now survive instantaneous gas expulsion with global SFEs as low as those observed for embedded clusters of Solar Neighbourhood (15-30 percent). This is the consequence of the star cluster having a density profile steeper than that of the residual gas. However, in terms of the effective SFE, measured by the virial ratio of the cluster at gas expulsion, our results are in agreement with previous studies.

Accepted by : Astronomy & Astrophysics
https://arxiv.org/abs/1706.03228

Miscellaneous

The formation of UCDs and massive GCs: Quasar-like objects for testing for a variable stellar initial mass function (IMF)

T. Jerabkova [1,2], P. Kroupa [2,1], J. Dabringhausen [1], M. Hilker [3], and K. Bekki ([4])

([1]) Astronomical Institute, Charles University in Prague, Praha, Czech Republic; ([2]) Helmholtz Institut für Strahlen und Kernphysik, Universität Bonn, Bonn, Germany; ([3]) European Southern Observatory, Garching, Germany ([4]) ICRAR, The University of Western Australia, Crawley, Australia

The stellar initial mas function (IMF) has been described as being invariant, bottom heavy or top-heavy in extremely dense star burst conditions. To provide usable observable diagnostic we calculate redshift dependent spectral energy distributions of stellar populations in extreme star burst clusters which are likely to have been the precursors of present day massive globular clusters (GCs) and of ultra compact dwarf galaxies (UCDs). The retention fraction of stellar remnants is taken into account to asses the mass to light ratios of the ageing star-burst. Their redshift dependent photometric properties are calculated as predictions for James Webb Space Telescope (JWST) observations. While the present day GCs and UCDs are largely degenerate concerning bottom-heavy or top-heavy IMFs, a metallicity- and density-dependent top-heavy IMF implies the most massive UCDs, at ages <100 Myr, to appear as objects with quasar-like luminosities with a 0.1-10% variability on a monthly time scale due to core collapse supernovae.

Accepted by : Astronomy & Astrophysics
https://arxiv.org/abs/1708.07127

.....

The dense-gas mass versus star formation rate relation: a misleading linearity?

G. Parmentier

Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Heidelberg, Germany

We model the star formation relation of molecular clumps in dependence of their dense-gas mass when their volume density profile is that of an isothermal sphere, i.e. $\rho_{clump}(r) \propto r^{-2}$. Dense gas is defined as gas whose volume density is higher than a threshold $\rho_{th} = 700\,M_{\odot}.pc^{-3}$, i.e. HCN(1-0)-mapped gas. We divide the clump into two regions: a dense inner region (where $\rho_{clump}(r) \geq \rho_{th}$), and low-density outskirts (where $\rho_{clump}(r) < \rho_{th}$). We find that the total star formation rate of clumps scales linearly with the mass of their dense inner region, even when more than half of the clump star formation activity takes place in the low-density outskirts. We therefore emphasize that a linear star formation relation does not necessarily imply that star formation takes place exclusively in the gas whose mass is given by the star formation relation. The linearity of the star formation relation is strengthened when we account for the mass of dense fragments (e.g. cores, fibers) seeding star formation in the low-density outskirts, and which our adopted clump density profile $\rho_{clump}(r)$ does not resolve. We also find that the star formation relation is significantly tighter when considering the dense gas than when considering all the clump gas, as observed for molecular clouds of the Galactic plane. When the clumps have no low-density outskirts (i.e. they consist of dense gas only), the star formation relation becomes superlinear and progressively wider.

Accepted by : Astrophysical Journal
http://adsabs.harvard.edu/abs/2017ApJ...843....7P

Gaia Data Release 1: The archive visualisation service

A. Moitinho [1], A. Krone-Martins [1], H. Savietto [2], and 31 co-authors
([1]) CENTRA, Universidade de Lisboa, FCUL, Lisboa, Portugal; ([2]) Fork Research, Lisboa, Portugal

The first Gaia data release (DR1) delivered a catalogue of astrometry and photometry for over a billion astronomical sources. Within the panoplyof methods used for data exploration, visualisation is often the starting point and even the guiding reference for scientific thought. However, this is a volume of data that cannot be efficiently explored using traditional tools, techniques, and habits. We aim to provide a global visual exploration service for the Gaia archive, something that is not possible out of the box for most people. The service has two main goals. The first is to provide a software platform for interactive visual exploration of the archive contents, using common personal computers and mobile devices available to most users. The second aim is to produce intelligible and appealing visual representations of the enormous information content of the archive. The interactive exploration service follows a client-server design. The server runs close to the data, at the archive, and is responsible for hiding as far as possible the complexity and volume of the Gaia data from the client. This is achieved by serving visual detail on demand. Levels of detail are pre-computed using data aggregation and subsampling techniques. For DR1, the client is a web application that provides an interactive multi-panel visualisation workspace as well as a graphical user interface. The Gaia archive Visualisation Service offers a web-based multi-panel interactive visualisation desktop in a browser tab. It currently provides highly configurable 1D histograms and 2D scatter plots of Gaia DR1 and the Tycho-Gaia Astrometric Solution (TGAS) with linked views. An innovative feature is the creation of ADQL queries from visually defined regions in plots. These visual queries are ready for use in the Gaia Archive Search/data retrieval service. In addition, regions around user-selected objects can be further examined with automatically generated SIMBAD searches. Integration of the Aladin Lite and JS9 applications add support to the visualisation of HiPS and FITS maps. The production of the all-sky source density map that became the iconic image of Gaia DR1 is described in detail. On the day of DR1, over seven thousand users accessed the Gaia Archive visualisation portal. The system, running on a single machine, proved robust and did not fail while enabling thousands of users to visualise and explore the over one billion sources in DR1. There are still several limitations, most noticeably that users may only choose from a list of pre-computed visualisations. Thus, other visualisation applications that can complement the archive service are examined. Finally, development plans for Data Release 2 are presented.

Accepted by : Astronomy & Astrophysics
http://adsabs.harvard.edu/abs/2017A%26A...605A..52M

Proceedings abstracts

Insights on the properties of the Orion spiral arm. NGC 2302: first result

E. Costa [1], G. Carraro [2], A. Moitinho [3], M. Radiszc [4], and R. Méndez [1]

([1]) Departamento de Astronomía, Universidad de Chile, Santiago, Chile; ([2]) Università degli Studi di Padova, Padova, Italy; ([3]) SIM/CENTRA, Faculdade de Ciencias de Universidade de Lisboa, Lisboa, Portugal; ([4]) Joint ALMA Observatory, Santiago, Chile

The nature of the Local (Orion) arm - LOA is poorly known. We summarize the first results from a program to determine its properties, based on a large and homogeneous set of kinematic and photometric data. We present a study of the LOA cluster NGC 2302 (Costa et al. 2015, A&A, 580, A4) which includes a photometric analysis and determination of its kinematic properties and orbital parameters. A density analysis revealed a round concentration of stars within a radius of $2\farcm5$, centered at α_{2000}=$102\fdg965916$, δ_{2000}=$-7\fdg086300$. Making a geometric registration of our first and second epoch frames (12-year timebase), we determined the systemic PM of NGC 2302 relative to the local field, and, through a comparison with UCAC4, we transformed this PM into absolute. We obtained: $\mu_\alpha \cos\delta$, μ_δ=(−2.09,−2.11) mas yr^{-1}, with a standard error of 0.40 mas yr^{-1}, per coordinate. Using medium-resolution spectroscopy of 76 stars in the field, we derived its systemic RV, which resulted to be 31.2 km s^{-1}, with a standard error of 0.7 km s^{-1}. With photometric diagrams we identified the stellar populations in the field. More than one exists, each affected by a different reddening, with the cluster sequence at $E(B-V) = 0.23$. Isochrone fits, displaced for this reddening and for a distance modulus of $(m-M)_0 = 10.69$ ($d = 1.40$ kpc), indicate a cluster age of log(t)=7.90–8.00. With the kinematics and distance we determined the space motion of NGC 2302, by adopting a gravitational potential for the MW. The shape of the orbit and the resulting orbital parameters, indicate that it is a typical PopI object.

To appear in : Revista Mexicana de Astronomía y Astrofísica (Serie de Conferencias) Vol. 49, pp. 169-169 (2017), XV Latin American Regional IAU Meeting Cartagena 2016
http://adsabs.harvard.edu/abs/2017RMxAC..49R.169C

Conferences

Scientific Exploitation of the Gaia Data (5^{th} International Young Astronomers School)

26 February – 2 March, 2018
Paris, France
https://gaiaschool.wixsite.com/gaia-school2018

registration deadline: 30 November, 2017

EPoS 2018 - The Early Phase of Star Formation

13–18 May, 2018
Ringberg Castle, Kreuth, Germany
http://www.mpia.de/homes/stein/EPoS/2018/2018.php

registration opens in November 2017

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

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

Jobs

Post-doctoral position
at the Department of Physics and Astronomy "G. Galileo"
University of Padova, Padova, Italy

The formation of the Galaxy: constraints from globular clusters

For half a century, globular clusters (GCs) have been considered as prototype of simple stellar populations and their color-magnitude diagrams (CMDs) were believed to be the proxy of an isochrone. My research activity has resulted in one of the most exciting and unexpected developments in stellar-population studies in recent years: the discovery that the CMDs of many GCs are made of two or more intertwined sequences that can be followed continuously from the hydrogen-burning limit to the last stages of the stellar evolution. These findings, together with the discovery that multiple sequences correspond to distinct stellar populations with different helium abundance, have dramatically changed the traditional picture of these seemingly simple stellar systems. Among the open issues are the still-eluding second-parameter problem of the horizontal-branch morphology and the formation mechanisms that build the Galactic halo. Multiple populations may correspond to different generations of stars and prove that GCs, similarly to dwarf galaxies, have experienced a very complex star-formation history. As an alternative, they can be the product of exotic phenomena that have taken place in the proto-GC environment only. The Hubble-Space-Telescope archive is a golden mine to extend these innovative studies that we have introduced on a few objects to a large sample of hundreds clusters. The proposed research is based on this huge dataset, together with the data that Hubble is in process of collecting as part of our surveys of GCs. We will use the last-generation image analysis and spectroscopic techniques to derive the first atlas of multiple populations in the Milky Way and in Magellanic Cloud clusters, derive their helium abundance, investigate their chemical composition, spatial distribution and internal dynamics. In summary, we will trace the series of events that led from massive clouds in the early Universe to the GCs we see today, with their multiple populations.

Duration: 1 year
Application deadline: October 3, 2017

Contact: Dr. Antonino Milone, `antonino.milone@anu.edu.au`

Details are provided at:
`http://www.dfa.unipd.it/index.php?id=973`
Official announcement document (English version starts at page 11)