The Star Clusters Young & Old Newsletter

edited by Angela Adamo, Martin Netopil, and Ernst Paunzen
https://www.univie.ac.at/scyon/
email: scyon@univie.ac.at

The official Newsletter of the IAU Commission H4.

SCYON Issue No. 84 February 1st, 2022

Dear Colleagues,

We hope that this new SCYON issue finds you well! With this issue, Angela Adamo from the Stockholm University and Oskar Klein Centre in Sweden is introduced as new editor (see some words by her below). The new issue includes 39 abstracts in total, a job opportunity, and some conference announcements. We hope that these will be finally carried out in a regular way and do not need to be postponed again or require a switch to a virtual get-together. We thank all conference organizers for their efforts! To finally reflect developments in star cluster research, we introduce new headings. We hope that these are more appropriate to cover the already very broad field of star cluster research.

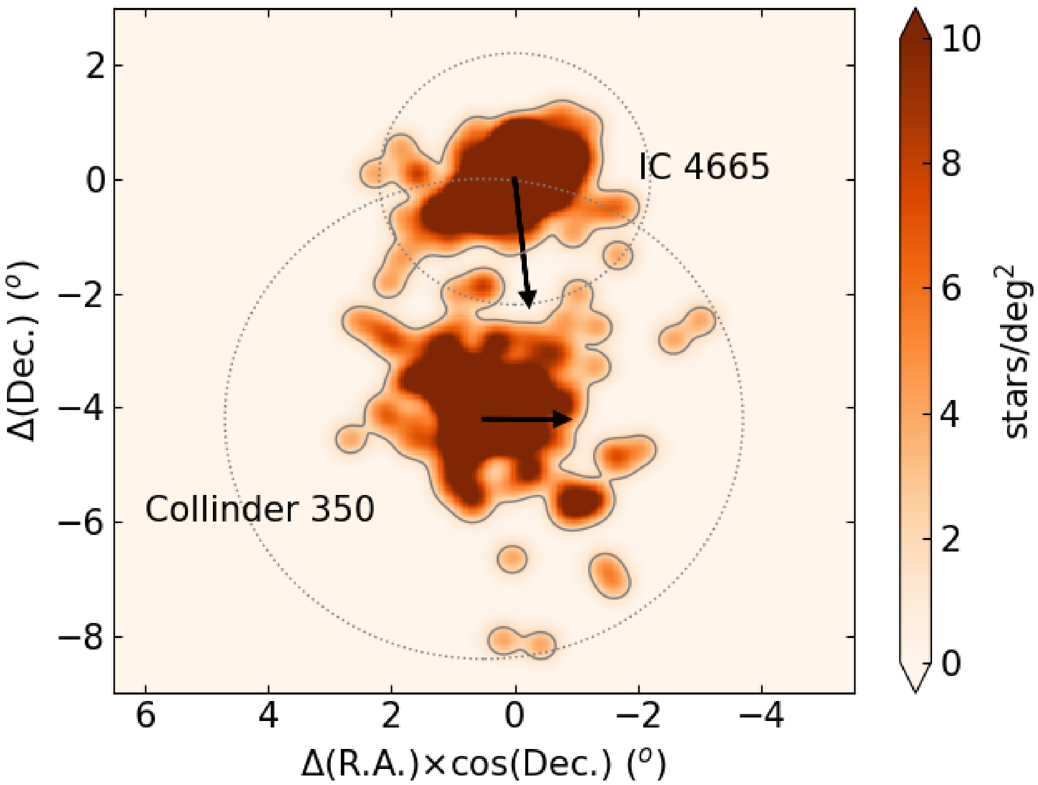
The SCYON editor team: Angela Adamo, Martin Netopil, and Ernst Paunzen

I'm very excited to contribute to the newsletter, which is a key instrument to keep the star cluster community updated on the latest results and discoveries. The star cluster field is rapidly expanding, we live in a moment of great technological advancements both in terms of facilities (Gaia mission, JWST, large and sensitive IFU spectrographs on ground-based facilities) and computationally. Star clusters can be studied as single entities or as populations. They are not only amazing stellar systems, interesting on their own, they also play a fundamental role as tracers of galaxy assembly. While our approaches are widely different and focus on diverse physical aspects and properties, none of them are mutually exclusive. The SCYON should be regarded as a tool to bring together all our knowledge and build-up a holistic view of cluster formation and evolution from the smallest physical scales attainable and across cosmic time. I am looking forward to work with Martin and Ernst and to receive inputs from the community on how to improve and update the SCYON.
Best wishes, Angela

CONTENTS

Picture of the issue:

The following figure is taken from Piatti & Malhan (2022, MNRAS 511, 1, L1), showing first evidence of an on-going collision between two star clusters (IC 4665 and Collinder 350). The paper abstract can be found in the section "Dynamical properties of star clusters".



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.

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

Clustered star formation across cosmic time

Star cluster feedback and early evolution

Gaia-ESO Survey: Role of magnetic activity and starspots on pre-main-sequence lithium evolution

E. Franciosini [1], E. Tognelli [2], S. Degl'Innocenti [3,4], and 24 co-authors
([1]) INAF - Osservatorio Astrofisico di Arcetri, Florence, Italy; ([2]) CEICO, Institute of Physics of the Czech Academy of Sciences, Praha, Czechia; ([3]) Department of Physics "E. Fermi", University of Pisa, Pisa, Italy; ([4]) INFN, Section of Pisa, Pisa, Italy

It is now well-known that pre-main-sequence models with inflated radii should be taken into account to simultaneously reproduce the colour-magnitude diagram and the lithium depletion pattern observed in young open star clusters. We tested a new set of pre-main-sequence models that include radius inflation due to the presence of starspots or to magnetic inhibition of convection. We used five clusters observed by the Gaia-ESO Survey that span the age range ∼10-100 Myr, in which these effects could be important. The Gaia-ESO Survey radial velocities were combined with astrometry from Gaia EDR3 to obtain clean lists of high-probability members for the five clusters. A Bayesian maximum likelihood method was adopted to fit the observed cluster sequences to theoretical predictions to derive the best model parameters and the cluster reddening and age. Models were calculated with different values of the mixing length parameter (α_{ML} = 2.0, 1.5 and 1.0) for the cases without spots or with effective spot coverage $\beta_{spot} = 0.2$ and 0.4. The models were also compared with the observed lithium depletion patterns. To reproduce the colour-magnitude diagram and the observed lithium depletion pattern in Gamma Vel A and B and in 25 Ori, both a reduced convection efficiency, with $\alpha_{ML} = 1.0$, and an effective surface spot coverage of about 20% are required. We obtained ages of $18^{+1.5}_{-4.0}$ Myr and $21^{+3.5}_{-3.0}$ Myr for Gamma Vel A and B, respectively, and $19^{+1.5}_{-7.0}$ Myr for 25 Ori. However, a single isochrone is not sufficient to account for the lithium dispersion, and an increasing level of spot coverage as mass decreases seems to be required. On the other hand, the older clusters (NGC 2451 B at $30^{+3.0}_{-5.0}$ Myr, NGC 2547 at $35^{+4.0}_{-4.0}$ Myr, and NGC 2516 at 138^{+48}_{-42} Myr) are consistent with standard models (i.e. $\alpha_{ML} = 2.0$ and no spots) except at low masses: a 20% spot coverage appears to reproduce the sequence of M-type stars better and might explain the observed spread in lithium abundances. The quality of Gaia-ESO data combined with Gaia allows us to gain important insights on pre-main-sequence evolution. Models including starspots can provide a consistent explanation of the cluster sequences and lithium abundances observed in young clusters, although a range of starspot coverage is required to fully reproduce the data.

Accepted by: Astronomy & Astrophysics
https://ui.adsabs.harvard.edu/abs/2021arXiv211111196F/abstract

Catastrophic Cooling in Superwinds. II. Exploring the Parameter Space

A. Danehkar [1], M. S. Oey [1], W. J. Gray [1]

([1]) Department of Astronomy, University of Michigan, Ann Arbor, MI, USA

Superwinds and superbubbles driven by mechanical feedback from super star clusters (SSCs) are common features in many star-forming galaxies. While the adiabatic fluid model can well describe the dynamics of superwinds, several observations of starburst galaxies revealed the presence of compact regions with suppressed superwinds and strongly radiative cooling, i.e., catastrophic cooling. In the present study, we employ the non-equilibrium atomic chemistry and cooling package MAIHEM, built on the FLASH hydrodynamics code, to generate a grid of models investigating the dependence of cooling modes on the metallicity, SSC outflow parameters, and ambient density. While gas metallicity plays a substantial role, catastrophic cooling is more sensitive to high mass-loading and reduced kinetic heating efficiency. Our hydrodynamic simulations indicate that the presence of a hot superbubble does not necessarily imply an adiabatic outflow, and vice versa. Using CLOUDY photoionization models, we predict UV and optical line emission for both adiabatic and catastrophic cooling outflows, for radiation-bounded and partially density-bounded models. Although the line ratios predicted by our radiation-bounded models agree well with observations of star-forming galaxies, they do not provide diagnostics that unambiguously distinguish the parameter space of catastrophically cooling flows. Comparison with observations suggests the possibility of minor density bounding, non-equilibrium ionization, and/or observational bias toward the central outflow regions.

Accepted by: Astrophysical Journal

https://ui.adsabs.harvard.edu/abs/2021ApJ...921...91D/abstract

. . . .

Subaru Hyper Suprime-Cam Survey of Cygnus OB2 Complex - I: Introduction, Photometry and Source Catalog

S. Gupta [1], J. Jose [1], S. More [2], and 11 co-authors

([1]) Indian Institute of Science Education and Research (IISER) Tirupati, India; ([2]) Inter University Centre for Astronomy and Astrophysics, Pune, India

Low mass star formation inside massive clusters is crucial to understand the effect of cluster environment on processes like circumstellar disk evolution, planet and brown dwarf formation. The young massive association of Cygnus OB2, with a strong feedback from massive stars, is an ideal target to study the effect of extreme environmental conditions on its extensive low-mass population. We aim to perform deep multi-wavelength studies to understand the role of stellar feedback on the IMF, brown dwarf fraction and circumstellar disk properties in the region. We introduce here, the deepest and widest optical photometry of 1.5° diameter region centred at Cygnus OB2 in r_2, i_2, z and Y-filters using Subaru Hyper Suprime-Cam (HSC). This work presents the data reduction, source catalog generation, data quality checks and preliminary results about the pre-main sequence sources. We obtain 713,529 sources in total, with detection down to $\sim$ 28 mag, 27 mag, 25.5 mag and 24.5 mag in r_2, i_2, z and Y-band respectively, which is $\sim$ 3 - 5 mag deeper than the existing Pan-STARRS and GTC/OSIRIS photometry. We confirm the presence of a distinct pre-main sequence branch by statistical field subtraction of the central $18'$ region. We find the median age of the region as $\sim 5 \pm 2$ Myrs with an average disk fraction of $\sim$ 9%. At this age, combined with $A_V \sim$ 6 - 8 mag, we detect sources down to a mass range $\sim$ 0.01 - 0.17 $M_\odot$. The deep HSC catalog will serve as the groundwork for further studies on this prominent active young cluster.

Accepted by: Monthly Notices of the Royal Astronomical Society

https://ui.adsabs.harvard.edu/abs/2021arXiv210911009G/abstract

A Comprehensive Study of the Young Cluster IRAS 05100+3723: Properties, Surrounding Interstellar Matter, and Associated Star Formation

R. K. Yadav [1], M. R. Samal [2], E. Semenko [1], and 13 co-authors

([1]) National Astronomical Research Institute of Thailand (NARIT), Sirindhorn AstroPark, T. Donkaew, A. Maerim, Chiangmai 50180, Thailand; ([2]) Physical Research Laboratory, Navrangpura, Ahmedabad, Gujarat 380009, India

We present a comprehensive multiwavelength investigation of a likely massive young cluster 'IRAS 05100+3723' and its environment with the aim to understand its formation history and feedback effects. We find that IRAS 05100+3723 is a distant (∼3.2 kpc), moderate mass (∼500 $M_\odot$), young (∼3 Myr) cluster with its most massive star being an O8.5V-type. From spectral modeling, we estimate the effective temperature and log g of the star as ∼33,000 K and ∼3.8, respectively. Our radio continuum observations reveal that the star has ionized its environment forming an HII region of size ∼2.7 pc, temperature ∼5,700 K, and electron density ∼165 cm^{-3}. However, our large-scale dust maps reveal that it has heated the dust up to several parsecs (∼10 pc) in the range 17-28 K and the morphology of warm dust emission resembles a bipolar HII region. From dust and 13CO gas analyses, we find evidences that the formation of the HII region has occurred at the very end of a long filamentary cloud around 3 Myr ago, likely due to edge collapse of the filament. We show that the HII region is currently compressing a clump of mass ∼2700 $M_\odot$ at its western outskirts, at the junction of the HII region and filament. We observe several 70 μm point sources of intermediate-mass and class 0 nature within the clump. We attribute these sources as the second generation stars of the complex. We propose that the star formation in the clump is either induced or being facilitated by the compression of the expanding HII region onto the inflowing filamentary material.

Accepted by: Astrophysical Journal

https://ui.adsabs.harvard.edu/abs/2021arXiv211109265Y/abstract

Star clusters in the Milky Way and Local group

Stellar Population Astrophysics (SPA) with the TNG: Stock 2, a little-studied open cluster with an eMSTO

J. Alonso-Santiago [1], A. Frasca [1], G. Catnazaro [1], and 14 co-authors
([1]) Osservatorio Astrofisico di Catania (OACT-INAF), Catania, Italy

Stock 2 is a little-studied open cluster that shows an extended main-sequence turnoff (eMSTO). In order to investigate this phenomenon and characterise the cluster itself we performed high-resolution spectroscopy in the framework of the Stellar Population Astrophysics (SPA) project. We employed the High Accuracy Radial velocity Planet Searcher in North hemisphere spectrograph (HARPS-N) at the Telescopio Nazionale Galileo (TNG). We completed our observations with additional spectra taken with the Catania Astrophysical Observatory Spectrograph (CAOS). In total we observed 46 stars (dwarfs and giants), which represent, by far, the largest sample collected for this cluster to date. We provide the stellar parameters, extinction, radial and projected rotational velocities for most of the stars. Chemical abundances for 21 species with atomic numbers up to 56 have also been derived. We notice a differential reddening in the cluster field whose average value is 0.27 mag. It seems to be the main responsible for the observed eMSTO, since it cannot be explained as the result of different rotational velocities, as found in other clusters. We estimate an age for Stock 2 of 450±150 Ma which corresponds to a MSTO stellar mass of $\approx$2.8 $M_\odot$. The cluster mean radial velocity is around 8.0 $\mathrm{km\,s^{-1}}$. We find a solar-like metallicity for the cluster, [Fe/H]=$-$0.07±0.06, compatible with its Galactocentric distance. MS stars and giants show chemical abundances compatible within the errors, with the exceptions of Barium and Strontium, which are clearly overabundant in giants, and Cobalt, which is only marginally overabundant. Finally, Stock 2 presents a chemical composition fully compatible with that observed in other open clusters of the Galactic thin disc.

Accepted by: Astronomy & Astrophysics
https://ui.adsabs.harvard.edu/abs/2021arXiv210913959A/abstract

. . . .

A genuine Large Magellanic Cloud age gap star cluster

A. E. Piatti [1,2]
([1]) Instituto Interdisciplinario de Ciencias Básicas (ICB), CONICET UNCUYO, Mendoza, Argentina; ([2]) Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Buenos Aires, Argentina

We confirm the existence of a second Large Magellanic Cloud (LMC) star cluster, KMHK 1592, with an age that falls in the middle of the so-called LMC star cluster age gap, a long period of time ($\sim$ 4 - 11 Gyr) where no star cluster had been uncovered, except ESO 121-SC 03. The age (8.0±0.5 Gyr) and the metallicity ([Fe/H]=$-$1.0±0.2 dex) of KMHK 1592 were derived from the fit of theoretical isochrones to the intrinsic star cluster colour-magnitude diagram sequences, which were unveiled using a robust star-by-star membership probability procedure. Because of the relative low brightness of the star cluster, deep GEMINI GMOS images were used. We discuss the pros and cons of three glimpsed scenarios that could explain the presence of both LMC age gap star clusters in the outskirts of the LMC, namely: in-situ star cluster formation, capture from the Small Magellanic Cloud, or accretion of a small dwarf galaxy.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2022arXiv220109926P/abstract

Stellar mass segregation as separating classifier between globular clusters and ultra-faint dwarf galaxies

H. Baumgardt [1], J. Faller [1], N. Meinhold [1], C. McGovern-Greco [1], M. Hilker [2]
([1]) The University of Queensland, Brisbane, Australia; ([2]) ESO, Garching, Germany

We have determined the amount of stellar mass segregation in over 50 globular clusters and ultra-faint dwarf galaxy candidates based on deep HST and ground-based photometry. We find that the amount of mass segregation in globular clusters is strongly correlated with their relaxation time and that all clusters with relaxation times of the order of their ages or longer have little to no mass segregation. For each cluster, the amount of mass segregation seen is fully compatible with the amount expected by dynamical evolution from initially unsegregated clusters, showing that globular clusters formed without primordial mass segregation among their low-mass stars. Ultra-faint dwarf galaxy candidates split into two groups, star clusters which follow the same trend between relaxation time and amount of mass segregation as globular clusters and dark-matter dominated dwarf galaxies that are unsegregated despite having relaxation times smaller than a Hubble time. Stellar abundance and velocity dispersion data, where available, confirm our classification. After classification of the ultra-faint dwarf galaxy candidates, we find that outer halo star clusters have average densities inside their half-light radii of $0.03\ \mathrm{M}_\odot/\mathrm{pc}^3 < \rho_h < 1\ \mathrm{M}_\odot/\mathrm{pc}^3$, while dwarf galaxies have stellar densities of $0.001\ \mathrm{M}_\odot/\mathrm{pc}^3 < \rho_h < 0.03\ \mathrm{M}_\odot/\mathrm{pc}^3$. The reason for this separation in density is most likely a combination of the initial conditions by which the systems formed and the requirement to withstand external tidal forces.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2022MNRAS.510.3531B/abstract

. . . .

Metallicity of the globular cluster NGC 6388 from high resolution spectra of more than 160 giant stars

E. Carretta [1], A. Bragaglia [1]
([1]) INAF-Osservatorio di Astrofisica e Scienza dello Spazio di Bologna, Bologna, Italy

NGC 6388 is one of the most massive Galactic globular clusters (GC) and it is an old, metal-rich, Galactic bulge cluster. By exploiting previous spectroscopic observations we were able to bypass the uncertainties in membership related to the strong field stars contamination. We present the abundance analysis of 12 new giant stars with UVES spectra and 150 giants with GIRAFFE spectra acquired at the ESO-VLT. We derived radial velocities, atmospheric parameters and iron abundances for all stars. When combined to previous data, we obtain a grand total of 185 stars homogeneously analysed in NGC 6388 from high-resolution spectroscopy. The average radial velocity of the 185 stars is 81.2±0.7, rms = 9.4 km/s. We obtain an average metallicity [Fe/H]=−0.480 dex, rms = 0.045 dex (35 stars) and [Fe/H]=−0.488 dex, rms = 0.040 dex (150 stars) from the UVES and GIRAFFE samples, respectively. Comparing these values to internal errors in abundance, we exclude the presence of a significant intrinsic metallicity spread within the cluster. Since about a third of giants in NGC 6388 is claimed to belong to the “anomalous red giants” in the HST pseudo-colour map defining the so-called type-II GCs, we conclude that either enhanced metallicity is not a necessary requisite to explain this classification (as also suggested by the null iron spread for NGC 362) or NGC 6388 is not a type-II globular cluster.

Accepted by: Astronomy & Astrophysics
https://ui.adsabs.harvard.edu/abs/2021arXiv211112721C/abstract

The Gaia-ESO Survey: Target selection of open cluster stars

A. Bragaglia [1], E. Alfaro [2], E. Flaccomio [3], and 37 co-authors

([1]) INAF-Osservatorio di Astrofisica e Scienza dello Spazio di Bologna, Bologna, Italy; ([2]) Instituto de Astrofísica de Andalucía-CSIC, Granada, Spain; ([3]) INAF–Osservatorio Astronomico di Palermo, Palermo, Italy

The Gaia-ESO Survey (GES) is a public, high-resolution spectroscopic survey with FLAMES@VLT. GES targeted in particular a large sample of open clusters (OCs) of all ages. The different kinds of OCs are useful to reach the main science goals, which are the study of the OC structure and dynamics, the use of OCs to constrain and improve stellar evolution models, and the definition of Galactic disc properties (e.g. metallicity distribution). GES is organised in 19 working groups (WGs). We describe here the work of three of them, WG4 in charge of the selection of the targets within each cluster), WG1 responsible for defining the most probable candidate members, and WG6 in charge of the preparation of the observations. As GES has been conducted before Gaia DR2, we could not make use of the Gaia astrometry to define cluster members. We made use of public and private photometry to select the stars to be observed with FLAMES. Candidate target selection was based on ground-based proper motions, radial velocities, and X-ray properties when appropriate, and it was mostly used to define the position of the clusters' evolutionary sequences in the colour-magnitude diagrams. Targets for GIRAFFE were selected near the sequences in an unbiased way. We used available information on membership only for the few UVES stars. We collected spectra for 62 confirmed OCs (a few more were taken from the ESO archive). Among them are very young clusters, where the main targets are pre-main sequence stars, clusters with very hot and massive stars currently on the main sequence, intermediate-age and old clusters where evolved stars are the main targets. The selection of targets was as inclusive and unbiased as possible and we observed a representative fraction of all possible targets, thus collecting the largest, most accurate, and most homogeneous spectroscopic data set on ever achieved.

Accepted by: Astronomy & Astrophysics

https://ui.adsabs.harvard.edu/abs/2021arXiv211211974B/abstract

. . . .

UOCS VII. Blue Straggler Populations of Open Cluster NGC 7789 with UVIT/AstroSat

K. Vaidya [1], A. Panthi [1], M. Agarwal [1], and 4 co-authors

([1]) Department of Physics, Birla Institute of Technology and Science Pilani, Rajasthan, India

NGC 7789 is a ∼1.6 Gyr old, populous open cluster located at ∼2000 pc. We characterize the blue straggler stars (BSS) of this cluster using the Ultraviolet (UV) data from the UVIT/AstroSat. We present spectral energy distributions (SED) of 15 BSS candidates constructed using multi-wavelength data ranging from UV to IR wavelengths. In 8 BSS candidates, a single temperature SED is found to be satisfactory. We discover hot companions in 5 BSS candidates. The hot companions with Teff ∼11750-15500 K, R ∼0.069-0.242 $R_\odot$, and L ∼0.25-1.55 $L_\odot$, are most likely extremely low mass (ELM) white dwarfs (WDs) with masses smaller than ∼0.18 $M_\odot$, and thereby confirmed post mass transfer systems. We discuss the implication of this finding in the context of BSS formation mechanisms. Two additional BSS show excess in one or more UV filters, and may have a hot companion, however, we are unable to characterize them. We suggest that at least 5 of the 15 BSS candidates (33%) studied in this cluster have formed via the mass transfer mechanism.

Accepted by: Monthly Notices of the Royal Astronomical Society

https://ui.adsabs.harvard.edu/abs/2022arXiv220108773V/abstract

Deriving ages and horizontal branch properties of integrated stellar populations

I. Cabrera-Ziri [1,2,3], C. Conroy [3]

([1]) Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Heidelberg, Germany; ([2]) Astrophysics Research Institute, Liverpool John Moores University, Liverpool, UK; ([3]) Center for Astrophysics - Harvard & Smithsonian, Cambridge, USA

A major source of uncertainty in the age determination of old (∼10 Gyr) integrated stellar populations is the presence of hot horizontal branch (HB) stars. Here, we describe a simple approach to tackle this problem, and show the performance of this technique that simultaneously models the age, abundances and HB properties of integrated stellar populations. For this we compare the results found during the fits of the integrated spectra of a sample of stellar population benchmarks, against the values obtained from the analysis of their resolved CMDs. We find that the ages derived from our spectral fits for most (26/32) of our targets are within 0.1 dex to their CMDs values. Similarly, for the majority of the targets in our sample we are able to recover successfully the flux contribution from hot HB stars (within ∼0.15 dex for 18/24 targets) and their mean temperature (14/24 targets within ∼30%). Finally, we present a diagnostic that can be used to detect spurious solutions in age, that will help identify the few cases when this method fails. These results open a new window for the detailed study of globular clusters beyond the Local Group.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2021arXiv211207562C/abstract

. . . .

The Galactic metallicity gradient shown by open clusters in the light of radial migration

M. Netopil [1], İ. Akkaya Oralhan [2], H. Çakmak [3], R. Michel [4], Y. Karataş [3]

([1]) Kuffner Observatory, Vienna, Austria; ([2]) Department of Astronomy and Space Sciences, Science Faculty, Erciyes University, Kayseri, Turkey; ([3]) Department of Astronomy and Space Sciences, Science Faculty, Istanbul University, Fatih, Turkey; ([4]) Observatorio Astronómico Nacional, Universidad Nacional Autónoma de México, Ensenada, México

During the last years and decades several individual studies and large-scale spectroscopic surveys significantly improved our knowledge of the Galactic metallicity distribution based on open clusters. The availability of Gaia data provided a further step forward in our knowledge. However, still some open issues remain, for example the influence of radial migration on the interpretation of the observed gradients. We used spectroscopic metallicities from individual studies and from the APOGEE survey to compile a sample of 136 open clusters, with a membership verification based on Gaia DR2. Additionally, we present photometric metallicity estimates of 14 open clusters in a somewhat outer Galactic region. Eight age groups allow us to study the evolution of the metallicity gradient in detail, showing within the errors an almost constant gradient of about -0.06 dex kpc^{-1}. Furthermore, using the derived gradients and an analysis of the individual objects, we estimate a mean migration rate of 1 kpc Gyr^{-1} for objects up to about 2 Gyr. Here, the change of the guiding radius is clearly the main contributor. For older and dynamically hotter objects up to 6 Gyr we infer a lower migration rate of up to 0.5 kpc Gyr^{-1}. The influence of epicyclic excursions increases with age and contributes already about 1 kpc to the total migration distance after 6 Gyr. A comparison of our results with available models shows good agreement. However, there is still a lack of a suitable coverage of older objects, future studies are still needed to provide a better sampling in this respect.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2022MNRAS.509..421N/abstract

Precise distances from OGLE-IV member RR Lyrae stars in six bulge globular clusters

R. A. P. Oliveira [1], S. Ortolani [2,3,4], B. Barbuy [1], and 6 co-authors

([1]) Universidade de São Paulo, IAG, São Paulo, Brazil; ([2]) Università di Padova, Dipartimento di Fisica e Astronomia, Padova, Italy; ([3]) INAF-Osservatorio Astronomico di Padova, Padova, Italy; ([4]) Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo", Padova, Italy

Context. RR Lyrae stars are useful standard candles allowing one to derive accurate distances for old star clusters. Based on the recent catalogues from OGLE-IV and Gaia Early Data Release 3 (EDR3), the distances can be improved for a few bulge globular clusters. Aims. The aim of this work is to derive an accurate distance for the following six moderately metal-poor, relatively high-reddening bulge globular clusters: NGC 6266, NGC 6441, NGC 6626, NGC 6638, NGC 6642, and NGC 6717. Methods. We combined newly available OGLE-IV catalogues of variable stars containing mean I magnitudes, with Clement's previous catalogues containing mean V magnitudes, and with precise proper motions from Gaia EDR3. Astrometric membership probabilities were computed for each RR Lyrae, in order to select those compatible with the cluster proper motions. Applying luminosity-metallicity relations derived from BaSTI α-enhanced models (He-enhanced for NGC 6441 and canonical He for the other clusters), we updated the distances with relatively low uncertainties. Results. Distances were derived with the I and V bands, with a $5-8\%$ precision. We obtained 6.6 kpc, 13.1 kpc, 5.6 kpc, 9.6 kpc, 8.2 kpc, and 7.3 kpc for NGC 6266, NGC 6441, NGC 6626, NGC 6638, NGC 6642, and NGC 6717, respectively. The results are in excellent agreement with the literature for all sample clusters, considering the uncertainties. Conclusions. The present method of distance derivation, based on recent data of member RR Lyrae stars, updated BaSTI models, and robust statistical methods, proved to be consistent. A larger sample of clusters will be investigated in a future work.

Accepted by: Astronomy & Astrophysics

https://ui.adsabs.harvard.edu/abs/2021arXiv211013943O/abstract

. . . .

DECam photometry reveals extra-tidal stars around the Milky Way globular cluster NGC 6864 (M75)

A. E. Piatti [1,2]

([1]) Instituto Interdisciplinario de Ciencias Básicas (ICB), CONICET-UNCUYO, Mendoza, Argentina; ([2]) Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires, Argentina

Globular clusters are prone to lose stars while moving around the Milky Way. These stars escape the clusters and are distributed throughout extended envelopes or tidal tails. However, such extra-tidal structures are not observed in all globular clusters, and yet there is no structural or dynamical parameters that can predict their presence or absence. NGC 6864 is an outer halo globular cluster with reported no observed tidal tails. We used Dark Energy Camera (DECam) photometry reaching $\sim$ 4 mag underneath its main sequence turnoff to confidently detect an extra-tidal envelope, and stellar debris spread across the cluster outskirts. These features emerged once robust field star filtering techniques were applied to the fainter end of the observed cluster main sequence. NGC 6864 is associated to the Gaia-Enceladus dwarf galaxy, among others 28 globular clusters. Up-to-date, nearly 64% of them have been targeted looking for tidal tails and most of them have been confirmed to exhibit tidal tails. Thus, the present outcomes allow us to speculate on the possibility that *Gaia*-Enceladus globular clusters share a common pattern of mass loss by tidal disruption.

Accepted by: Monthly Notices of the Royal Astronomical Society

https://ui.adsabs.harvard.edu/abs/2021MNRAS.tmp.2926P/abstract

Optical Observations of star clusters NGC 1513 and NGC 4147; white dwarf WD1145+017 and K band imaging of star forming region Sh2-61 with the 3.6 meter Devasthal Optical Telescope

R. Sagar [1,2], R. K. S. Yadav [2], S. B. Pandey [2], and 3 co-authors

([1]) Indian Institute of Astrophysics, Bangalore, India; ([2]) Aryabhatta Research Institute of Observational Sciences, Manora Peak Nainital, India

The UBVRI CCD photometric data of open star cluster NGC 1513 are obtained with the 3.6-m Indo-Belgian Devasthal optical telescope (DOT). Analyses of the GAIA EDR3 astrometric data have identified 106 possible cluster members. The mean proper motion of the cluster is estimated as $\mu\alpha \cos\delta = 1.29 \pm 0.02$ and $\mu\delta = -3.74 \pm 0.02$ mas yr^{-1}. Estimated values of reddening E(B-V) and distance to the NGC 1513 are 0.65±0.03 mag and 1.33±0.1 kpc respectively. An age of 225 ± 25 Myr is assigned to the cluster by comparing theoretical isochrones with deep observed cluster sequence. Using observations taken with the 3.6-m DOT, values of distance and age of the galactic globular cluster NGC 4147 are estimated as 18.2±0.2 Kpc and 14±2 Gyr respectively. The optical observations of planetary transit around white dwarf WD1145+017 and K-band imaging of star-forming region Sharpless Sh 2-61 demonstrate observing capability of 3.6-m DOT. Optical and near-infrared observations of celestial objects and events are being carried out routinely with the 3.6-m DOT. They indicate that the performance of the telescope is at par with those of other similar telescopes located elsewhere in the world. We therefore state that this observing facility augurs well for multi-wavelength astronomy including study of astrophysical jets.

Accepted by: Journal of Astrophysics & Astronomy

https://ui.adsabs.harvard.edu/abs/2022arXiv220108285S/abstract

. . . .

Revisiting a detached stellar structure in the outer northeastern region of the Small Magellanic Cloud

A. E. Piatti [1,2]

([1]) Instituto Interdisciplinario de Ciencias Básicas (ICB), CONICET-UNCUYO, Mendoza, Argentina; ([2]) Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires, Argentina

The outer northeastern region of the Small Magellanic Cloud (SMC) is populated by a shell-like overdensity whose nature was recently investigated. We analyzed twenty catalogued star clusters projected onto it from Survey of the MAgellanic Stellar History data sets. After carrying out a cleaning of field stars in the star cluster colour-magnitude diagrams (CMDs), and deriving their astrophysical properties from the comparison between the observed and synthetic CMDs, we found that four objects are not genuine star clusters, while the remaining ones are young star clusters (11, age ∼ 30-200 Myr) and intermediate-age (5, age ∼ 1.7-2.8 Gyr) star clusters, respectively. The resulting distances show that intermediate-age and some young star clusters belong to the SMC main body, while the remaining young star clusters are nearly 13.0 kpc far away from those in the SMC, revealing that the shell-like overdensity is more extended along the line-of-sight than previously thought. We also found a clear age trend and a blurred metallicity correlation along the line-of-sight of young clusters, in the sense that the farther a star cluster from the SMC, the younger, the more metal rich, and the less massive it is. These young clusters are also affected by a slightly larger interstellar reddening than the older ones in the shell-like overdensity. These outcomes suggest that the shell-like overdensity can possibly be another tidally perturbed/formed SMC stellar structure from gas striped off its body, caused by the interaction with the Large Magellanic Cloud or the Milky Way.

Accepted by: Monthly Notices of the Royal Astronomical Society

https://ui.adsabs.harvard.edu/abs/2021MNRAS.tmp.2895P/abstract

A possible solution to the Milky Way's binary-deficient retrograde stellar population. Evidence that ω Centauri has formed in an extreme starburst

M. Marks [1], P. Kroupa [2,3], J. Dabringhausen [3]

([1]) Erzbischöfliches Clara-Fey-Gymnasium Bonn-Bad Godesberg, Bonn, Germany; ([2]) Helmholtz-Institut für Strahlen- und Kernphysik, University of Bonn, Bonn, Germany; ([3]) Charles University in Prague, Faculty of Mathematics and Physics, Astronomical Institute, Praha, Czech Republic

The fraction of field binaries on retrograde orbits about the Milky Way is significantly lower compared to its prograde counterpart. Chemical and dynamical evidence suggests that the retrograde stellar population originates from ω Centauri, which is either the most massive globular cluster (GC) of the Milky Way or the putative core of a former dwarf galaxy. Star formation conditions required to produce the retrograde binary population are constrained assuming that the retrograde stellar population originates from ω Centauri's progenitor. We match the observed low binary fraction with dynamical population synthesis models, including a universal initial binary population and dynamical processing in star clusters, making use of the publicly available binary population synthesis tool BiPoS1. Results. It is found that either the GC progenitor of ω Centauri must have formed with a stellar density of ≈ 108 M_{sun} pc^{-3} or the ω Centauri dwarf galaxy's progenitor star cluster population must have formed in an extreme starburst with a star formation rate exceeding 1000 M_{sun} yr^{-1} and probably a top-heavy embedded-cluster mass function with suppressed low-mass cluster formation. The separation and mass ratio distribution for retrograde field binaries are predicted for comparison with future observations. A viable solution for the deficiency of binaries on retrograde orbits is presented, and star formation conditions for ω Centauri as well as orbital parameter distributions for the Milky Way's retrograde binary population are predicted. The dwarf galaxy origin for ω Centauri is tentatively preferred within the present context.

Accepted by: Astronomy & Astrophysics

https://ui.adsabs.harvard.edu/abs/2021arXiv211200753M/abstract

Deep V and I CCD photometry of young star cluster NGC 1893 with the 3.6m DOT

N. Panwar [1], A. Kumar [1,2], S. B. Pandey [1]

([1]) Aryabhatta Research Institute of Observational Sciences, Manora Peak, Nainital, India; ([2]) School of Studies in Physics and Astrophysics, Pandit Ravishankar Shukla University, Chattisgarh, India

Young star clusters consisting of massive stars are the ideal sites to study the star formation processes and influence of massive stars on the subsequent star formation. NGC 1893 is a young star cluster associated with the Hii region Sh2-236. It contains about five 'O'-type stars and several early 'B'-type stars. It is located at a moderate distance of $\sim$ 3.25 kpc and has a reddening, E(B-V) $\sim$ 0.4 mag. To characterize the young low-mass stellar population in the central portion of the cluster, we carried out deep V I band observations of the region using the 4K$\times$4K CCD IMAGER mounted on the 3.6-m Devasthal Optical Telescope. Our analysis shows that the present data are deep enough to detect stars below V$\sim$24 mag. We found optical counterparts of $\sim$ 220 candidate members, including young stars and unclassified cluster members from Caramazza et al. (2008). We estimated the membership probabilities of the Gaia sources (mostly bright stars with G $<$ 19 mag) located within the cluster radius using the Gaia EDR3. Toward the fainter end, we used the optical color-magnitude diagram (CMD) to select the cluster members from a sample of young stars. The locations of young stars on the CMD show that a majority of them are low-mass stars with age $<$ 10 Myr. The unclassified member candidates and X-ray sources from Caramazza et al. (2012) are also found to be young low-mass stars. In total, we identified $\sim$ 425 young stars with age $<$ 10 Myr, and 110 of these are new. Most of these stars appear kinematic members of the cluster. By examining the CMD for the stars in the cluster region, we suggest that the cluster has insignificant contamination due to field stars in the pre-main sequence zone of the CMD. The slope of the mass function in the mass range $0.2 \leq M/M_{\odot} \leq 2.5$ is found to be $\Gamma = -1.43 \pm 0.15$, consistent with those of other star-forming complexes. The spatial distribution of the young stars as a function of mass suggests that toward the cluster center, most of the stars are massive.

Accepted by: Journal of Astrophysics & Astronomy

https://ui.adsabs.harvard.edu/abs/2021arXiv211111796P/abstract

FSR 1776: A new globular cluster in the Galactic bulge?

B. Dias [1], T. Palma [2,3], D. Minniti [4,5], and 6 co-authors

([1]) Instituto de Alta Investigación, Universidad de Tarapacá, Casilla, Arica, Chile; ([2]) Universidad Nacional de Córdoba, Observatorio Astronómico de Córdoba, Córdoba, Argentina; ([3]) Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Ciudad Autónoma de Buenos Aires, Argentina; ([4]) Departamento de Ciencias Físicas, Facultad de Ciencias Exactas, Universidad Andrés Bello, Las Condes, Santiago, Chile; ([5]) Vatican Observatory, Vatican City State, Italy

Recent near-IR surveys have uncovered a plethora of new globular cluster (GC) candidates towards the Milky Way bulge. These new candidates need to be confirmed as real GCs and properly characterized. We investigate the physical nature of FSR 1776, a very interesting star cluster projected towards the Galactic bulge. This object was originally classified as an intermediate-age open cluster and has recently been re-discovered independently and classified as a GC candidate (Minni 23). Firstly, we aim at confirming its GC nature; secondly we determine its physical parameters. The confirmation of the cluster existence is checked using the radial velocity (RV) distribution of a MUSE datacube centred at FSR 1776. The cluster parameters are derived from isochrone fitting to the RV-cleaned colour-magnitude diagrams (CMDs) from visible and near-infrared photometry taken from VVV, 2MASS, DECAPS, and Gaia altogether. The predicted RV distribution for the FSR 1776 coordinates, considering only contributions from the bulge and disc field stars, is not enough to explain the observed MUSE RV distribution. The extra population (12% of the sample) is FSR 1776 with an average RV of $-103.7 \pm 0.4 \sim \mathrm{km\,s^{-1}}$. The CMDs reveal that it is 10±1 Gyr old and metal-rich population with $[\mathrm{Fe/H}]_{phot} \approx +0.2{\pm}0.2$, $[\mathrm{Fe/H}]_{spec} =\sim +0.02 \pm 0.01 \sim (\sigma\ =\ 0.14$ dex), located at the bulge distance of 7.24±0.5 kpc with $\mathrm{A_V} \approx 1.1$ mag. The mean cluster proper motions are $(\langle\mu_\alpha\rangle, \langle\mu_\delta\rangle) = (-2.3 \pm 1.1, -2.6 \pm 0.8)\ \mathrm{mas\,yr^{-1}}$. FSR 1776 is an old GC located in the Galactic bulge with a super-solar metallicity, among the highest for a Galactic GC. This is consistent with predictions for the age-metallicity relation of the bulge, being FSR 1776 the probable missing link between typical GCs and the metal-rich bulge field. High-resolution spectroscopy of a larger field of view and deeper CMDs are now required for a full characterization.

Accepted by: Astronomy & Astrophysics

https://ui.adsabs.harvard.edu/abs/2022A%26A...657A..67D/abstract

The Villafranca catalog of Galactic OB groups. II. From Gaia DR2 to EDR3 and ten new systems with O stars

J. Maíz Apellániz [1], R. H. Barbá [2], R. Fernández Aranda [1,3,4], and 4 co-authors

([1]) Centro de Astrobiología, CSIC-INTA, Madrid, Spain; ([2]) Departamento de Astronomía, Universidad de La Serena, La Serena, Chile; ([3]) Universidad Complutense de Madrid, Spain; ([4]) University of Crete, Greece; ([5]) Instituto de Astrofísica de Andalucía, CSIC, Spain

This is the second paper of a series on Galactic OB groups that uses astrometric and photometric data from Gaia and spectral classifications from GOSSS and LiLiMaRlin. The previous paper was based on Gaia DR2, this is based on Gaia EDR3. The two aims of this paper are to revise the results for the sample from paper I using Gaia EDR3 data and to expand the sample of analyzed stellar groups to 26, from Villafranca O-001 to Villafranca O-026. We use GOSSS to select Galactic stellar groups with O stars and an updated version of the method in paper 0 of this series, combining Gaia EDR3 G+GBP+GRP photometry, positions, proper motions, and parallaxes to assign memberships and measure distances. We present 99 spectra from GOSSS and 32 from LiLiMaRlin for stars in the analyzed groups or in their foreground. We derive distances to the 26 stellar groups with unprecedented precision and accuracy, with total uncertainties $<1\%$ within 1 kpc and of $\sim3\%$ around 3 kpc, values that are almost 4x better than for Gaia DR2. We provide homogeneous spectral types for 110 stars and correct a number of errors in the literature, especially for objects in the Orion nebula cluster. For each of the groups we discuss its membership and present possible runaway/walkaway stars. At least two groups, Villafranca O-O12 S and Villafranca O-014 NW, are orphan clusters in which the most massive stars have been ejected by dynamical interactions, leaving objects with a capped mass function. The existence of such clusters has important consequences for the study of the IMF, the distribution of SNe across the Galaxy, and the population and dynamics of isolated compact objects. We fit PMS isochrones to four clusters to derive ages of 2.0 ± 0.5 Ma for the sigma Orionis cluster, 4 ± 2 Ma for NGC 2264, 5.0 ± 0.5 Ma for NGC 2362, and 8 ± 2 Ma for the gamma Velorum cluster.

Accepted by: Astronomy & Astrophysics

https://ui.adsabs.harvard.edu/abs/2021arXiv211001464M/abstract

Star cluster populations in the local universe

Emission-line Wings Driven by Lyman Continuum in the Green Pea Analog Mrk 71

L. Komarova [1], M. S. Oey [1], M. R. Krumholz [2], and 3 co-authors

([1]) Astronomy Department, University of Michigan, Ann Arbor, MI, USA; ([2]) Research School of Astronomy and Astrophysics, Australian National University, Canberra, Australia

We propose that the origin of faint, broad emission-line wings in the Green Pea (GP) analog Mrk 71 is a clumpy, LyC and/or Lyα-driven superwind. Our spatially-resolved analysis of Gemini-N/GMOS-IFU observations shows that these line wings with terminal velocity > 3000 km/s originate from the super star cluster (SSC) Knot A, and propagate to large radii. The object's observed ionization parameter and stellar surface density are close to their theoretical maxima, and radiation pressure dominates over gas pressure. Together with a lack of evidence for supernova feedback, these imply a radiation-dominated environment. We demonstrate that a clumpy, radiation-driven superwind from Knot A is a viable model for generating the extreme velocities, and in particular, that Lyman continuum and/or Lyα opacity must be responsible. We find that the Mrk 71 broad wings are best fitted with power laws, as are those of a representative extreme GP and a luminous blue variable star, albeit with different slopes. This suggests that they may share a common wind-acceleration mechanism. We propose that high-velocity, power-law wings may be a distinctive signature of radiation feedback, and of radiatively-driven winds, in particular.

Accepted by: Astrophysical Journal

https://ui.adsabs.harvard.edu/abs/2021ApJ...920L..46K/abstract

. . . .

Haro 11 - Untying the knots of the nuclear starburst

M. Sirressi [1], A. Adamo [1], M. Hayes [1], and 7 co-authors

([1]) Department of Astronomy and Oskar Klein Centre; Stockholm University; Stockholm, Sweden

Star formation is a clustered process that regulates the structure and evolution of galaxies. We investigate this process in the dwarf galaxy Haro 11, forming stars in three knots (A, B, C). The exquisite resolution of HST imaging allows us to resolve the starburst into tens of bright star clusters. We derive masses between 10^5 and 10^7 $M_\odot$ and ages younger than 20 Myr, using photometric modeling. We observe that the clustered star formation has propagated from knot C (the oldest) through knot A (in between) towards knot B (the youngest). We use aperture-matched ultraviolet and optical spectroscopy (HST + MUSE) to independently study the stellar populations of Haro 11 and determine the physical properties of the stellar populations and their feedback in 1 kpc diameter regions. We discuss these results in light of the properties of the ionised gas within the knots. We interpret the broad blue-shifted components of the optical emission lines as outflowing gas ($v_{max} \sim 400$ km/s). The strongest outflow is detected in knot A with a mass-rate of $\dot{M}_{out} \sim 10\,M_\odot$/yr, ten times higher than the star-formation in the same region. Knot B hosts a young and not fully developed outflow, whereas knot C has likely been already evacuated. Because Haro 11 has properties similar to high-redshift unresolved galaxies, our work can additionally aid the understanding of star formation at high redshift, a window that will be opened by upcoming facilities.

Accepted by: Monthly Notices of the Royal Astronomical Society

https://ui.adsabs.harvard.edu/abs/2022MNRAS.510.4819S/abstract

Luminosity functions of globular clusters in five nearby spiral galaxies using HST/ACS images

L. Lomelí-Núñez [1], Y. D. Mayya [1], L. H. Rodríguez-Merino [1], P. A. Ovando [1], D. Rosa-González [1]

([1]) Instituto Nacional de Astrofísica Óptica y Electrónica, Tonantzintla, Puebla, Mexico

We here present the luminosity function (LF) of globular clusters (GCs) in five nearby spiral galaxies using the samples of GC candidates selected in Hubble Space Telescope mosaic images in F435W, F555W and F814W filters. Our search, which surpasses the fractional area covered by all previous searches in these galaxies, has resulted in the detection of 158 GC candidates in M81, 1123 in M101, 226 in NGC4258, 293 in M51 and 173 in NGC628. The LFs constructed from this dataset, after correcting for relatively small contamination from reddened young clusters, are log-normal in nature, which was hitherto established only for the Milky Way (MW) and Andromeda among spiral galaxies. The magnitude at the turn-over (TO) corresponds to M_V(TO)=-7.41 ± 0.14 in four of the galaxies with Hubble types Sc or earlier, in excellent agreement with M_V(TO)=-7.40 ± 0.10 for the MW. The TO magnitude is equivalent to a mass of $\sim3\times10^5$ $M_\odot$ for an old, metal-poor population. M_V(TO) is fainter by $\sim$1.16 magnitude for the fifth galaxy, M101, which is of Hubble type Scd. The TO dependence on Hubble type implies that the GCs in early-type spirals are classical GCs, which have a universal TO, whereas the GC population in late-type galaxies is dominated by old disk clusters, which are in general less massive. The radial density distribution of GCs in our sample galaxies follows the Sérsic function with exponential power-law indices, and effective radii of 4.0-9.5 kpc. GCs in the sample galaxies have a mean specific frequency of 1.10 ± 0.24, after correcting for magnitude and radial incompleteness factors.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2022MNRAS.509..180L/abstract

Star clusters at high redshift

Dynamical properties of star clusters

The VISCACHA survey – IV. The SMC West Halo in 8D

B. Dias [1], M.C. Parisi [2,3], M. Angelo [4], and 18 co-authors

([1]) Instituto de Alta Investigación, Sede Esmeralda, Universidad de Tarapacá, Iquique, Chile; ([2]) Observatorio Astronómico, Universidad Nacional de Córdoba, Córdoba, Argentina; ([3]) Instituto de Astronomía Teórica y Experimental (CONICET-UNC), Córdoba, Argentina; ([4]) Centro Federal de Educação Tecnológica de Minas Gerais, Nepomuceno, Brazil

The structure of the Small Magellanic Cloud (SMC) is very complex, in particular in the periphery that suffers more from the interactions with the Large Magellanic Cloud (LMC). A wealth of observational evidence has been accumulated revealing tidal tails and bridges made up of gas, stars and star clusters. Nevertheless, a full picture of the SMC outskirts is only recently starting to emerge with a 6D phase-space map plus age and metallicity using star clusters as tracers. In this work, we continue our analysis of another outer region of the SMC, the so-called West Halo, and combined it with the previously analysed Northern Bridge. We use both structures to define the Bridge and Counter-bridge trailing and leading tidal tails. These two structures are moving away from each other, roughly in the SMC-LMC direction. The West Halo form a ring around the SMC inner regions that goes up to the background of the Northern Bridge shaping an extended layer of the Counter-bridge. Four old Bridge clusters were identified at distances larger than 8 kpc from the SMC centre moving towards the LMC, which is consistent with the SMC-LMC closest distance of 7.5 kpc when the Magellanic Bridge was formed about 150Myr ago; this shows that the Magellanic Bridge was not formed only by pulled gas, but it also removed older stars from the SMC during its formation. We also found age and metallicity radial gradients using projected distances on sky, which are vanished when we use the real 3D distances.

Accepted by: Monthly Notices of the Royal Astronomical Society

https://ui.adsabs.harvard.edu/abs/2022arXiv220111119D/abstract

. . . .

θ^1 Ori C as a medieval bully: a possible very recent ejection in the Trapezium

J. Maíz Apellániz [1], M. Pantaleoni González [1,2], R. H. Barbá [3]

([1]) Centro de Astrobiología, CSIC-INTA, Madrid, Spain; ([2]) Departamento de Astrofísica y Física de la Atmósfera, Universidad Complutense de Madrid, Madrid, Spain; ([3]) Departamento de Astronomía, Universidad de La Serena, La Serena, Chile

We use Gaia EDR3 astrometry to propose that a dynamical interaction between the multiple system θ^1 Ori C and θ^1 Ori F ejected the latter as a walkaway star ∼1100 years ago (without deceleration) or somewhat later (with a more likely deceleration included). It is unclear whether the final 3-D velocity of θ^1 Ori F will be large enough to escape the Orion nebula cluster.

Accepted by: Research Notes of the AAS

https://ui.adsabs.harvard.edu/abs/2021RNAAS...5..232M/abstract

Residual velocities of Small Magellanic Cloud star clusters

A. E. Piatti [1,2]
([1]) Instituto Interdisciplinario de Ciencias Básicas (ICB), CONICET UNCUYO, Mendoza, Argentina; ([2]) Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Buenos Aires, Argentina

We analyzed the largest Small Magellanic Cloud (SMC) cluster sample (32) with proper motions and radial velocity measurements, from which we obtained their space velocity components. By adopting as a reference the recent best-fitted rotating disc of SMC star clusters as a function of the position angle, we computed their residual velocity vectors, and compared their magnitudes (ΔV) with that of a cluster with residual velocity components equal to the velocity dispersions along the three inde- pendent SMC rotating disc axes of motion (ΔV = 60 km/s). We found that clusters that belong to SMC tidally induced structures have ΔV > 50 km/s, which suggests that space velocities of clusters in the process of escaping the rotating disc kinematics, are measurably different. Studied clusters pertaining to a northern branch of the Mag- ellanic Bridge, the main Magellanic Bridge, the Counter-Bridge and the West halo give support to these findings. NGC 121, the oldest known SMC cluster, does not belong to any SMC tidal feature, and has ΔV = 64 km/s, slightly above the boundary between bound and kinematically perturbed clusters.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2021MNRAS.508.3748P/abstract

. . . .

First evidence of a collision between two unrelated open clusters in the Milky Way

A. E. Piatti [1,2], **K. Malhan** [3,4]
([1]) Instituto Interdisciplinario de Ciencias Básicas (ICB), CONICET-UNCUYO, Mendoza, Argentina; ([2]) Consejo Nacional de Investigaciones Científicas y Técnicas, Buenos Aires, Argentina; ([3]) The Oskar Klein Centre for Cosmoparticle Physics, Department of Physics, Stockholm University, Stockholm, Sweden; ([4]) Max-Planck-Institut für Astronomie, Heidelberg, Germany

We report the first evidence of an on-going collision between two star clusters in our Galaxy, namely IC 4665 and Collinder 350. These are open clusters located at a distance of ∼330 pc from the Sun and ∼100 pc above the Galactic plane, and they both have prograde motions with only a small difference in their velocities (Collinder 350 moves ∼5 km/s faster than IC 4665); as inferred from ESA/Gaia based catalogue. Interestingly, the two clusters are physically separated by only 36 pc in space; a distance that is smaller than the sum of their respective radii. Furthermore, the clusters exhibit signatures of elongated stellar density distributions, and we also detect an onset of an inter-cluster stellar bridge. Moreover, the orbit analysis suggests that the younger cluster IC 4665 (age=53 Myr) must have formed at a distance > 500 pc away from Collinder 350 (age=617 Myr). These findings together imply that the two clusters do not represent merging of two objects in a binary system, rather, what we are witnessing is an actual collision between two independently formed star clusters. This collision phenomenon provides a unique opportunity to explore new aspects of formation and evolution theory of star clusters.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2021arXiv211203786P/abstract

Escape from the Bermuda cluster: orphanization by multiple stellar ejections

J. Maíz Apellániz [1], M. Pantaleoni González [1,2], R. H. Barbá [3], M. Weiler [4]

([1]) Centro de Astrobiología, CSIC-INTA, Madrid, Spain; ([2]) Departamento de Astrofísica y Física de la Atmósfera, Universidad Complutense de Madrid, Madrid, Spain; ([3]) Departamento de Astronomía, Universidad de La Serena, La Serena, Chile; ([4]) Departament de Física Quàntica i Astrofísica, Institut de Ciències del Cosmos (ICCUB). Universitat de Barcelona (IEEC-UB), Barcelona, Spain

Dynamical interactions in young stellar clusters can eject massive stars early in their lives and significantly alter their mass functions. If all of the most massive stars are lost, we are left with an orphan cluster. We study the Bermuda cluster (Villafranca O-014 NW), the most significant young stellar group in the North America and Pelican nebulae, and the massive stars that may have been ejected from it to test if it has been orphaned. We use Gaia EDR3 parallaxes and proper motions to search for walkaway and runaway stars in the vicinity of the North America and Pelican nebulae. The candidates are analyzed with a combination of spectroscopy and photometry to assess their nature and their trajectories are traced back in time to determine at what time they left the Bermuda cluster. We detect three ejection events, dubbed the Bajamar, Toronto, and HD 201 795 events, that expelled (a minimum of) 5, 2, and 2 systems, respectively, or 6, 3, and 3 stars if we count the individual components in spectroscopic/eclipsing binaries. The events took place 1.611±0.011 Ma, 1.496±0.044 Ma, and 1.905±0.037 Ma ago, respectively, but our analysis is marginally consistent with the first two being simultaneous. We detect bow shocks in WISE images associated with four of the ejected systems and their orientation agrees with that of their relative proper motions with respect to the cluster. Combining the three events, the Bermuda cluster has lost over 200 $M_\odot$, including its three most massive stars, so it can be rightfully considered an orphan cluster. One consequence is that the present-day mass function of the cluster has been radically altered from its top-heavy initial value to one compatible with a Kroupa-like function. Another one is that the cluster is currently expanding with a dynamical time scale consistent with the cause being the ejection events. A scenario in which the Bermuda cluster was formed in a conveyor belt fashion over several hundreds of ka or even 1 Ma is consistent with all the observables.

Accepted by: Astronomy & Astrophysics

https://ui.adsabs.harvard.edu/abs/2021arXiv211001484M/abstract

Hunting for open clusters in Gaia EDR3: 664 new open clusters found with OCfinder

A. Castro-Ginard [1,2], C. Jordi [1], X. Luri [1], and 6 co-authors

([1]) Leiden Observatory, Leiden University, Leiden, the Netherlands; ([2]) Dept. Física Quàntica i Astrofísica, Institut de Ciències del Cosmos (ICCUB), Universitat de Barcelona (IEEC-UB), Barcelona, Spain

The improvements in the precision of the published data in Gaia EDR3 with respect to Gaia DR2, particularly for parallaxes and proper motions, offer the opportunity to increase the number of known open clusters in the Milky Way by detecting farther and fainter objects that have so far go unnoticed. Our aim is to keep completing the open cluster census in the Milky Way with the detection of new stellar groups in the Galactic disc. We use Gaia EDR3 up to magnitude $G = 18$ mag, increasing in one unit the magnitude limit and therefore the search volume explored in our previous studies. We use the OCfinder method to search for new open clusters in Gaia EDR3 using a Big Data environment. As a first step, OCfinder identifies stellar statistical overdensities in the five dimensional astrometric space (position, parallax and proper motions) using the DBSCAN clustering algorithm. Then, these overdensities are classified into random statistical overdensities or real physical open clusters using a deep artificial neural network trained on well-characterised G, $G_{BP}-G_{RP}$ colour-magnitude diagrams. We report the discovery of 664 new open clusters within the Galactic disc, most of them located beyond 1 kpc from the Sun. From the estimation of ages, distances and line-of-sight extinctions of these open clusters, we see that young clusters align following the Galactic spiral arms while older ones are dispersed in the Galactic disc. Furthermore, we find that most open clusters are located at low Galactic altitudes with the exception of a few groups older than 1 Gyr. We show the success of the OCfinder method leading to the discovery of a total of 1 310 open clusters (joining the discoveries here with the previous ones based on Gaia DR2), which represents almost 50% of the known population. Our ability to perform Big Data searches on a large volume of the Galactic disc, together with the higher precision in Gaia EDR3, enable us to keep completing the census with the discovery of new open clusters.

Submitted to: Astronomy & Astrophysics

https://ui.adsabs.harvard.edu/abs/2021arXiv211101819C/abstract

Simulation formation/evolution of cluster populations

BIPOS1 - a computer programme for the dynamical processing of the initial binary star population

J. Dabringhausen [1], M. Marks [2], P. Kroupa [1,3]

([1]) Astronomicky ustav, Universita Karlova, Prague, Czech Republic; ([2]) Erzbischöfliches Clara-Fey-Gymnasium Bonn-Bad Godesberg, Bonn, Germany; ([3]) Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Bonn, Germany

The first version of the Binary Population Synthesizer (BIPOS1) is made publicly available. It allows to efficiently calculate binary distribution functions after the dynamical processing of a realistic population of binary stars during the first few Myr in the hosting embedded star cluster. Instead of time-consuming N-body simulations, BIPOS1 uses the stellar dynamical operator $\Omega_{dyn}^{\rho_{ecl}}\left(\log_{10}\left(E_b\right), t\right)$, which determines the fraction of surviving binaries depending on the binding energy of the binaries, E_b. The Ω-operator depends on the initial star cluster density, ρ_{ecl}, as well as the time, t, until the residual gas of the star cluster is expelled. BIPOS1 has also a galactic-field mode, in order to synthesize the stellar population of a whole galaxy. At the time of gas expulsion, the dynamical processing of the binary population is assumed to efficiently end due to the subsequent expansion of the star cluster. While BIPOS1 has been used previously unpublished, here we demonstrate its use in the modelling of the binary populations in the Orion Nebula Cluster, in OB associations and as an input for simulations of globular clusters.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2022MNRAS.510..413D/abstract

. . . .

Rebounding Cores to Build Star Cluster Multiple Populations

G. Parmentier [1], A. Pasquali [1]

([1]) Astronomisches Rechen-Institut, Zentrum fuer Astronomie der Universitaet Heidelberg, Heidelberg, Germany

We present a novel approach to the riddle of star cluster multiple populations. Stars form from molecular cores. But not all cores form stars. Following their initial compression, such 'failed' cores re-expand, rather than collapsing. We propose that their formation and subsequent dispersal regulate the gas density of cluster-forming clumps and, therefore, their core and star formation rates. Clumps for which failed cores are the dominant core type experience star formation histories with peaks and troughs. In contrast, too few failed cores results in smoothly decreasing star formation rates. We identify three main parameters shaping the star formation history of a clump: the star and core formation efficiencies per free-fall time, and the time-scale on which failed cores return to the clump gas. The clump mass acts as a scaling factor. We use our model to constrain the density and mass of the Orion Nebula Cluster progenitor clump, and to caution that the star formation histories of starburst clusters may contain close-by peaks concealed by stellar age uncertainties. Our model generates a great variety of star formation histories. Intriguingly, the chromosome maps and O-Na anti-correlations of old globular clusters also present diverse morphologies. This prompts us to discuss our model in the context of globular cluster multiple stellar populations. More massive globular clusters exhibit stronger multiple stellar population patterns, which our model can explain if the formation of the polluting stars requires a given stellar mass threshold.

Accepted by: Astrophysical Journal
https://ui.adsabs.harvard.edu/abs/2021arXiv211014470P/abstract

Preparing the next gravitational million-body simulations: Evolution of single and binary stars in Nbody6++GPU, MOCCA and McLuster

A. W. H. Kamlah [1,2], A. Leveque [3], R. Spurzem [2,4,5], and 9 co-authors

([1]) Max-Planck-Institut für Astronomie (MPIA), Heidelberg, Germany; ([2]) Astronomisches Rechen-Institut (ARI), Zentrum für Astronomie, Heidelberg, Germany; ([3]) Nicolaus Copernicus Astronomical Centre of the Polish Academy of Sciences (CAMK), Warsaw, Poland; ([4]) National Astronomical Observatories and Key Laboratory of Computational Astrophysics (NAOC), Chinese Academy of Sciences, Beijing, China; ([5]) Kavli Institute for Astronomy and Astrophysics (KIAA), Beijing, China

We present the implementation of updated stellar evolution recipes in the codes Nbody6++GPU, MOCCA and McLuster. We test them through numerical simulations of star clusters containing 1.1×10^5 stars (with 2.0×10^4 in primordial hard binaries) performing high-resolution direct N-body (Nbody6++GPU) and Monte-Carlo (MOCCA) simulations to an age of 10 Gyr. We compare models implementing either delayed or core-collapse supernovae mechanisms, a different mass ratio distribution for binaries, and white dwarf natal kicks enabled/disabled. Compared to Nbody6++GPU, the MOCCA models appear to be denser, with a larger scatter in the remnant masses, and a lower binary fraction on average. The MOCCA models produce more black holes (BHs) and helium white dwarfs (WDs), whilst Nbody6++GPU models are characterised by a much larger amount of WD-WD binaries. The remnant kick velocity and escape speed distributions are similar for the BHs and neutron stars (NSs), and some NSs formed via electron-capture supernovae, accretion-induced collapse or merger-induced collapse escape the cluster in all simulations. The escape speed distributions for the WDs, on the other hand, are very dissimilar. We categorise the stellar evolution recipes available in Nbody6++GPU, MOCCA and Mcluster into four levels: the one implemented in previous Nbody6++GPU and MOCCA versions (level A), state-of-the-art prescriptions (level B), some in a testing phase (level C), and those that will be added in future versions of our codes.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2021MNRAS.tmp.3435K/abstract

Black hole mergers in compact star clusters and massive black hole formation beyond the mass-gap

F. P. Rizzuto [1], T. Naab [1], R. Spurzem [2,3,4], and 4 co-authors

([1]) Max-Planck Institute for Astrophysics (MPIA), Garching, Germany; ([2]) Astronomisches Rechen-Institut (ARI), Zentrum für Astronomie, Heidelberg, Germany; ([3]) National Astronomical Observatories and Key Laboratory of Computational Astrophysics (NAOC), Chinese Academy of Sciences, Beijing, China; ([4]) Kavli Institute for Astronomy and Astrophysics (KIAA), Peking University, Beijing, China

We present direct N-body simulations, carried out with Nbody6++GPU, of young and compact low metallicity star clusters with 1.1×10^5 stars, a velocity dispersion of ~ 10 km s^{-1}, a half mass radius $R_h = 0.6$ pc, and a binary fraction of 10% including updated evolution models for stellar winds and pair-instability supernovae (PISNe). Within the first tens of megayears of evolution, each cluster hosts several black hole (BH) merger events which nearly cover the complete mass range of primary and secondary BH masses for current LIGO/Virgo/Kagra gravitational wave detections. The importance of gravitational recoil is estimated statistically. We present several possible formation paths of massive BHs above the assumed lower PISNe mass-gap limit ($45M_{\odot}$) into the intermediate-mass BH (IMBH) regime ($> 100M_{\odot}$) which include collisions of stars and BHs as well as the direct collapse of stellar merger remnants with low mass cores. The stellar evolution updates result in the early formation of higher mass stellar BHs than for the previous model. The resulting higher collision rates with massive stars support the rapid formation of massive BHs. For models assuming a high accretion efficiency for star-BH mergers, we present a first-generation formation scenario for GW190521-like events, a merger of two BHs in the PISN mass-gap, which is dominated by star-BH mergers. This IMBH formation path is independent of gravitational recoil and therefore conceivable in dense stellar systems with low escape velocities. One simulated cluster even forms an IMBH binary ($153M_{\odot}$, $173M_{\odot}$) which is expected to merge within a Hubble time.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2021arXiv210811457R/abstract

Simulation star cluster formation/dynamical evolution

Grouped star formation: converting sink particles to stars in hydrodynamical simulations

K. Y. Liow [1], S. Rieder [1,2], C. L. Dobbs [1], S. E. Jaffa [3,4]

([1]) School of Physics and Astronomy, University of Exeter, Exeter, UK; ([2]) RIKEN Center for Computational Science, Chuo-ku, Kobe, 650-0047, Hyogo, Japan; ([3]) Centre for Astrophysics Research, University of Hertfordshire, Hatfield, Hertfordshire, UK; ([4]) Advanced Research Computing, University College London, London, UK

Modelling star formation and resolving individual stars in numerical simulations of molecular clouds and galaxies is highly challenging. Simulations on very small scales can be sufficiently well resolved to consistently follow the formation of individual stars, whilst on larger scales sinks that have masses sufficient to fully sample the IMF can be converted into realistic stellar populations. However, as yet, these methods do not work for intermediate scale resolutions whereby sinks are more massive compared to individual stars but do not fully sample the IMF. In this paper, we introduce the grouped star formation prescription, whereby sinks are first grouped according to their positions, velocities, and ages, then stars are formed by sampling the IMF using the mass of the groups. We test our grouped star formation method in simulations of various physical scales, from sub-parsec to kilo-parsec, and from static isolated clouds to colliding clouds. With suitable grouping parameters, this star formation prescription can form stars that follow the IMF and approximately mimic the original stellar distribution and velocity dispersion. Each group has properties that are consistent with a star-forming region. We show that our grouped star formation prescription is robust and can be adapted in simulations with varying physical scales and resolution. Such methods are likely to become more important as galactic or even cosmological scale simulations begin to probe sub-parsec scales.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2021arXiv211205158L/abstract

Merger rate density of stellar-mass binary black holes from young massive clusters, open clusters, and isolated binaries: Comparisons with LIGO-Virgo-KAGRA results

S. Banerjee [1,2]

([1]) Helmholtz-Instituts für Strahlen- und Kernphysik (HISKP), University of Bonn, Bonn, Germany; ([2]) Argelander-Institut für Astronomie (AIfA), University of Bonn, Bonn, Germany

I investigate the roles of cluster dynamics and massive binary evolution in producing stellar-remnant binary black hole (BBH) mergers over the cosmic time. To that end, dynamical BBH mergers are obtained from long-term direct N-body evolutionary models of $\sim 10^4 M_\odot$, pc-scale young massive clusters (YMC) evolving into moderate-mass open clusters. Fast evolutionary models of massive isolated binaries yield BBHs from binary evolution. Population synthesis in a Model Universe is then performed, taking into account observed cosmic star formation and enrichment histories, to obtain BBH-merger yields from these two channels observable at the present day and over cosmic time. The merging BBH populations from the two channels are combined by applying a proof-of-concept Bayesian regression chain, taking into account observed differential intrinsic BBH merger rate densities from the second gravitational-wave transient catalog (GWTC-2). The analysis estimates an OB-star binary fraction of $f_{\rm Obin} \gtrsim 90\%$ and a YMC formation efficiency of $f_{\rm YMC} \sim 10^{-2}$, being consistent with recent optical observations and large scale structure formation simulations. The corresponding combined Model Universe present-day, differential intrinsic BBH merger rate density and the cosmic evolution of BBH merger rate density both agree well with those from GWTC-2. The analysis also suggests that despite significant "dynamical mixing" at low redshifts, BBH mergers at high redshifts ($z_{\rm event} \gtrsim 1$) could still be predominantly determined by binary-evolution physics. Caveats in the present approach and future improvements are discussed. [Published by Physical Review D]

Accepted by: The Physical Review

https://ui.adsabs.harvard.edu/abs/2022PhRvD.105b3004B/abstract

The impact of primordial binary on the dynamical evolution of intermediate massive star clusters

L. Wang [1,2], A. Tanikawa [3], M. S. Fujii [1]

([1]) Department of Astronomy, School of Science, The University of Tokyo, Tokyo, Japan; ([2]) RIKEN Center for Computational Science, Chuo-ku, Kobe, Hyogo, Japan; ([3]) Department of Earth Science and Astronomy, The University of Tokyo, Japan

Observations found that star clusters contain a large fraction of binaries. Tight binaries are an important heating source that influences the long-term dynamical evolution of star clusters. However, due to the limitation of N-body tool, previous theoretical modelling for globular clusters (GCs) by using direct N-body simulations have not investigated how a large fraction of primordial binaries affect their long-term evolution. In this work, by using the high-performance N-body code, PeTar, we carry out star-by-star models for intermediate massive GCs (N=100000) with the primordial binary fraction varying from 0 to 1. We find that when a stellar-mass black hole (BH) subsystem exists, the structural evolution of GCs (core and half-mass radii) only depends on the properties of massive primordial binaries, because they affect the number of BH binaries (BBHs), which dominate the binary heating process. Low-mass binaries including double white dwarf binaries (BWDs) have almost no influence on the dynamics. Meanwhile, only gravitational wave (GW) mergers from BBHs are strongly affected by dynamical interactions, while low-mass mergers from BWDs show no difference in the isolated environment (field) and in GCs. Low-mass binaries become important only after most BHs escape and the core collapse of light stars occurs. Our result suggests that for N-body modelling of GCs with a black hole subsystem dominating binary heating, it is not necessary to include low-mass binaries. These binaries can be studied separately by using standalone binary stellar evolution codes. This way can significantly reduce the computing cost.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2021MNRAS.tmp.2929W/abstract

The formation and early evolution of embedded star clusters in spiral galaxies

S. Rieder [1,2], C. Dobbs [1], T. Bending [1], K.Y. Liow [1], J. Wurster [1,3]

([1]) School of Physics and Astronomy, University of Exeter, Exeter, United Kingdom; ([2]) Riken Center for Computational Science, Chuo-ku, Kobe, Hyogo, Japan; ([3]) Scottish Universities Physics Alliance (SUPA), School of Physics and Astronomy, University of St. Andrews, St. Andrews, United Kingdom

We present Ekster, a new method for simulating star clusters from birth in a live galaxy simulation that combines the smoothed-particle hydrodynamics (SPH) method Phantom with the N-body method PeTar. With Ekster, it becomes possible to simulate individual stars in a simulation with only moderately high resolution for the gas, allowing us to study whole sections of a galaxy rather than be restricted to individual clouds. We use this method to simulate star and star cluster formation in spiral arms, investigating massive GMCs and spiral arm regions with lower mass clouds, from two galaxy models with different spiral potentials. After selecting these regions from pre-run galaxy simulations, we re-sample the particles to obtain a higher resolution. We then re-simulate these regions for 3 Myr to study where and how star clusters form. We analyse the early evolution of the embedded star clusters in these regions. We find that the massive GMC regions, which are more common with stronger spiral arms, form more massive clusters than the sections of spiral arms containing lower mass clouds. Clusters form both by accreting gas and by merging with other proto-clusters, the latter happening more frequently in the denser GMC regions.

Accepted by: Monthly Notices of the Royal Astronomical Society
https://ui.adsabs.harvard.edu/abs/2021arXiv211109720R/abstract

Miscellaneous

Investigation of the Prompt SNe Ia progenitor nature through the analysis of the chemical composition of globular clusters and circumgalactic clouds

I. A. Acharova [1], M. E. Sharina [2], E. A. Kazakov [1]

([1]) Department of Physics, Southern Federal University, Rostov-on-Don, Russia; ([2]) Astrophysical Observatory, Russian Academy of Sciences, Nizhny Arkhyz, Russia

A method is proposed for determining the properties of type Ia supernovae from short-lived precursors – Prompt SNIa. This method is based on the assumption that this subtype of type Ia supernovae exploded into low-metallicity globular clusters (GCs), and is responsible for the enrichment of the high-metallicity subgroup of GCs and circumgalactic clouds (CGCs) with the iron peak elements. We justify that CGCs are the formation places of GCs of both subgroups. The accuracy of the method depends, first, on the number of GCs, the spectra of which have been studied in detail; second, on the number of chemical elements, the abundances of which have been worked out. Only those elements are of interest for this method that are produced in supernova explosions and are not produced at the previous stage of the stellar evolution. Our estimates of nucleosynthesis in low-metallicity supernova GCs are in the best agreement with the following Prompt SNIa model: Single Degenerate Pure Deflagration Models of white dwarfs (WDs) burning with masses in the range from 1.30 $M_\odot$ to 1.31 $M_\odot$ if carbon explodes in the centre of a WD with a low central density from $0.5 \cdot 10^9 g/cm^3$ to $10^9 g/cm^3$.

Accepted by: Monthly Notices of the Royal Astronomical Society

https://ui.adsabs.harvard.edu/abs/2022arXiv220106481A/abstract

. . . .

Assessment of [Fe/H] determinations for FGK stars in spectroscopic surveys

C. Soubiran [1], N. Brouillet [1], C. Casamiquela [1]

([1]) Laboratoire d'astrophysique de Bordeaux, Univ. Bordeaux, CNRS, Pessac, France

The number of stars with a measured value of [Fe/H] is considerably increasing thanks to spectroscopic surveys. However different methodologies, inputs and assumptions used in spectral analyses lead to different precisions in [Fe/H] and possibly to systematic differences that need to be evaluated. It is essential to understand the characteristics of each survey to fully exploit their potential, in particular if the surveys are combined. The purpose of this study is to compare [Fe/H] determinations from the largest spectroscopic surveys (APOGEE, GALAH, the Gaia ESO survey, RAVE, LAMOST, SEGUE) to other catalogues taken as reference. Offsets and dispersions of the residuals are examined as well as their trends with other parameters. We use reference samples providing independent determinations of [Fe/H] which are compared to those from the surveys for common stars. The distribution of the residuals is assessed through simple statistics that measures the offset between two catalogues and the dispersion representative of the precision of both catalogues. When relevant, linear fits are performed. A large sample of FGK-type stars with [Fe/H] based on high-resolution, high signal to noise spectroscopy was built from the PASTEL catalogue to provide a reference sample. We also use FGK members in open and globular clusters to assess the internal consistency of [Fe/H] of each survey. The agreement of median [Fe/H] values for clusters observed by different surveys is discussed. All the surveys overestimate the low metallicities, and some of them also underestimate the high metallicities. They perform well in the most populated intermediate metallicity range, whatever the resolution. In most cases the typical precision that we deduce from the comparisons is in good agreement with the uncertainties quoted in the catalogues. Some exceptions to this general behaviour are discussed.

Accepted by: Astronomy & Astrophysics

https://ui.adsabs.harvard.edu/abs/2021arXiv211207545S/abstract

Jobs

Research positions at the American University of Sharjah (AUS), United Arab Emirates

Applicants are invited to apply for research positions to work with Dr. Randa Asa'd at the American University of Sharjah (AUS), on projects related to spectroscopic studies of stellar clusters aiming to trace the chemical enrichment history of their host galaxies.

The research positions include (I) Postdoctoral position and (II) Research Assistant position (minimum requirement: Bachelor in physics with relevant research experience - current PhD students can apply through their supervisors to do part of their training at AUS).

Applicants are expected to have experience in stellar spectroscopy and excellent programming skills in Python.

To apply, please send a single PDF file containing a (I) cover letter, (II) statement of research experience and interest relevant to this position (max. 2 pages), (III) curriculum vitae (including the contact information of 3 references), and (IV) publication list to `raasad@aus.edu`

Application deadline: 1 May 2022

Randa Asa'd, Ph.D
Associate Professor
Physics Department
American University of Sharjah

Conferences

Illuminating Galaxy Formation with Ancient Globular Star Clusters and Their Progenitors

13–18 March, 2022
Aspen, USA
https://www.as.utexas.edu/~mbk/aspen2022/index.html

. . . .

EAS 2022, Special Session SS15, The Renaissance of Open Cluster Science with Gaia

29 June, 2022
Valencia, Spain
https://eas.unige.ch/EAS2022/session.jsp?id=SS15

. . . .

Cool Stars, Stellar Systems, and the Sun (CS21)

4–9 July, 2022
Toulouse, France
https://coolstars21.github.io/

. . . .

UV Insights to Massive Stars and Young Stellar Clusters

2–3 August, 2022
Busan, Republic of Corea
https://busan2021fm4.org/

. . . .

Wheel of Star Formation

12–16 September, 2022
Prague, Czech Republic
https://janfest2020.asu.cas.cz/