ESF workshop

"The World of Clusters"

Padova (Italy)

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Book of abstracts & Posters

SESSION 1 : stellar populations in clusters

C. Aerts, K. Zwintz, S. Saesen, M. Briquet

Title: Asteroseismology of Stellar Clusters

Abstract. After a brief introduction into the techniques of asteroseismology, we highlight what this research field so far delivered for the study and understanding of clusters, with specific emphasis on the derivation of interior physical properties of the member stars and seismic ages of the clusters. We consider the whole range from young to old clusters and review the achievements so far, point to some challenges, and look out for future prospects considering the benefits to expect from future surveys such as the one to be delivered by the Gaia mission.

N. Bastian/H:Lamers

Title: The origin of multiple stellar populations in clusters

Abstract. I will present a new model to explain the observed anomalies of globular clusters (GCs), i.e. light element abundance variations, multiple main sequences, turn-offs, etc. This model does not invoke multiple episodes of star formation and does not suffer from the mass budget problem which plagues other theories. The model conforms to known properties of massive clusters forming today (i.e. gas free at a young age, < 2 Myr, and no extended SFHs), and can explain all/most of the observed abundance trends and quantised He abundances. Additionally, I will show results from a collection of photometric and spectroscopic studies that show that no massive (10^4 Msun - 10^8 Msun) young clusters (10 < age/Myr <500) observed to date have any ongoing star formation within them. This places strong constraints on the origin of multiple populations in GCs.

W. Chantereau & T. Decressin

Title: Uncover the formation of globular clusters

Abstract. Globular clusters have long been seen as the result of the evolution a large population of stars with similar age and chemical composition. However due to spectroscopic studies we find that these clusters harbour (at least) two chemically distinct population of low-mass stars. While first generation stars have similar properties as fields stars, second population stars display a unique pattern which testifies an intra-cluster pollution by a first generation of more massive stars. In thi talk I will show how the presence of a high number of second generation stars can be used to recover some of the initial conditions that take place during the formation of globular clusters.

E. Corsaro.

Title: Asteroseismology of the Open Clusters NGC 6791, NGC 6811, and NGC 6819 from 19 Months of Kepler Photometry

Abstract. Oscillations in cluster stars are important for gaining a deeper understanding about stellar structure and evolution. We present the results from a detailed ensemble study of solar-like oscillations in 115 red giants in the three open clusters, NGC 6791, NGC 6811, and NGC 6819, based on photometric data covering more than 19 months with NASA's Kepler space telescope. We discuss the so-called asteroseismic diagrams of the asymptotic parameters \delta\nu_02, \delta\nu_01, and epsilon, which show clear correlation with fundamental stellar properties such as mass and radius. When the stellar populations from the clusters are compared, we see evidence for a difference in mass of the red giant branch stars and possibly a difference in structure of the red clump stars, from our measurements of the small separations \delta\nu_02 and \delta\nu_01. Ensemble échelle diagrams and linewidths of radial modes as a function of the large frequency separation \Delta\nu of the clusters NGC 6791 and NGC 6819 are also shown, together with the correlation between the linewidths of the radial modes of oscillation and the T_{eff} of the stars. Lastly, we distinguish between red giant branch and red clump stars through the measurement of the period spacing of mixed dipole modes in 53 stars among all the three clusters to verify the stellar classification from the color-magnitude diagrams. These seismic results also allow us to identify a number of special cases, including evolved blue stragglers and binaries, as well as stars in late He-core burning phases, which can be potentially interesting targets for detailed theoretical modeling.

M. T. Costado, E. J. Alfaro, A. J. Delgado, A. A. Djupvik & J.Màız-Apellaniz

Title: Study of stellar clusters containing massive stars

Abstract. Most stars form in clusters, but the percentage of stars born in dense stellar systems is currently matter of controversy and depends very much on the own definition of cluster. The cluster definition and hence the morphologies of individual clusters appear to vary significantly from region to region, as well as with age, which suggests that either, star formation in clusters is not universal and may depend on the local environment, or that all clusters form with the same morphology but early dynamical evolution quickly modifies the structure of the phase space distribution. In addition, young populated clusters containing massive stars are excellent labs for the study of the formation of the massive stellar component of the Galactic disk. Three main scenarios have been proposed for the formation of high-mass stars (M > 7-8 M): a) monolithic collapse of proto-stellar nuclei; b) competitive accretion inside the proto-cluster molecular cloud; and c) coalescence of proto-stellar nuclei and low-mass stars in very dense atmospheres. Both scientific questions: a) cluster formation and b) formation of high mass stars in clusters are intimately connected via the structural description of the phase space distribution of cluster stars and their Mass Function (MF). Models of static clusters with di erent initial spatial and kinematic distributions show how the spatial distribution dynamically evolves with time, allowing a

characterization of their dynamical state from snapshots of their spatial distribution. Four are the main variables (and their distribution with mass and position) needed for a reliable characterization of the cluster dynamical state: a) Mass segregation parameter; b) Mapping of surface density for di erent ranges of masses; c) Q morphological parameter based on the minimum spanning tree graph and its variation with mass and cluster age, and d) MF of the cluster members. Two years ago, the Stellar System Group of IAA has begun an observational programme of stellar clusters containing massive stars, whose main objective is to answer the two scientific questions. In order to perform this study we need to measure the main physical variables of the cluster, determine cluster membership and mass and age of cluster members. The obtaining of this is best carried out through determination of the Spectral Energy Distribution (SED) of stars in the field, from multiband UBVRIH + JHK s photometry. In this workshop, we want to present some results for clusters currently under study.

H.J.G.L.M. Lamers

Title: The evolution of the stellar mass function of star clusters.

Abstract. The stellar mass function of star clusters evolves due to stellar evolution and dynamical effects such as tidal stripping, and shocks. Before mass-segregation is established, dynamical effects can remove stars of all masses. However once a cluster is mass-segregated, low mass stars are lost preferentially. I will discuss the evolution of the mass function , the relevant time-scales and its dependence on the initial conditions. The predictions can be used for interpretation and comparison with GAIA observations. The observed mass functions of Galactic open clusters and globular clusters are compared with the predictions. I will show that these can be used to reconstruct the initial conditions and the cluster evolution.

A. Lanzafame

Title: Lithium abundance, activity and rotation in Open Clusters and Young Loose Associations

Abstract. Stellar lithium abundance, activity and rotation evolve in time. Their intrinsic scatter observed in open clusters has so far hindered their usage as precise age estimators, but correlations between them are expected and have been investigated quite extensively. There are indeed observational evidences that fast-rotators tend to suffer lower lithium depletion than slow-rotators, but, apart from this gross distinction, the relationship between the two remains rather uncertain. It is also known that rotation and activity are correlated, but the nature of their scatter in open clusters of given age remains an open issue. Amongst others, effects due to the stellar ambient on the rotation at an early stage of evolution as well as noise induced by surface inhomogeneities on the lithium line flux and age spreads have been suggested as causes of the observed scatter. Comparisons between open clusters and young loose associations as well as simultaneous spectroscopy and photometry can give some constraints on the proposed causes. Here a study case on the comparison between the Pleiades and the AB Dor young loose association is presented.

E. Moraux

Title: The low mass IMF in clusters and the effect of dynamical evolution

Abstract. After discussing the uncertainties inherent to the IMF determination, I will present recent results obtained in young open clusters down to the substellar and planetary mass domain. The global picture seems to indicate that the IMF may be universal, although this is still under debate below 20-30 Mjup.

I will then show that the cluster dynamical evolution may affect the shape of the mass function, especially in the lower mass part, and even at young ages. This needs to be taken into account carefully if we want to test the universality of the IMF.

J. Montalban

Title: Asteroseismology of Red Giants

Abstract. Since the detection of non-radial solar-like oscillation modes in red giants with the CoRoT satellite, a great effort has been done to study the asteroseismic properties of red giants. Their link with stellar global parameters such as mass, radius and evolutionary state, but also their potential to provide information on core extra-mixing, transport of angular momentum, and helium abundance. In this contribution I'll present a survey of the most relevant theoretical and observational results.

G. Piotto

Title: Extrasolar planets in Clusters

Abstract. The current status of the search of extrasolar planets is reviewed, focusing on the clusters. Differences among frequencies of planets around stars in clusters and in the field are discussed.

O. Straniero

Title: Asymptotic Giant Branch stars in intermediate age clusters

Abstract. Spectroscopic and photometric observations of AGB stars belonging to intermediate age clusters (1 to 3 Gyrs) represent one of the most challenging test for the theory of AGB evolution and nucleosynthesis. Their masses (1.3 to 2.5 M_\odot) coincides with those of the stars responsible for the Galactic production of the s process main and strong components, which include about an half of all the elements heavier than Fe. In addition, these stars may evolve into C stars (N type) and most of them are semiregular or regular long-period variables (Myras). High-resolution, near-infrared spectra of NGC 1846 and NCG 1978, as obtained by means of Phoenix at Gemini South telescope, have been used to constrain the efficiency of the third dredge up, i.e. the physical process responsible for the surface enrichments of carbon and heavy elements, and of some non- convective mixing processes (sometime called extra- or deep-mixing process). Due to the non-linearity of the hydro-dynamical equations describing

these processes, theoretical predictions of their efficiencies are rather uncertain. Further constraints to the models of AGB stars can be obtained by extending such kind of studies on a wider range of wavelengths, by searching for chemical tracers of the internal nucleosynthesis. We will discuss how to carry on this task in the framework of the future developments of instruments and telescopes.

A. Weiss

Title: Star clusters - laboratories of stellar structure theory

Abstract. Clusters of coeval stars with initially identical chemical composition are among the most relevant objects against which results of stellar evolution can be tested. Depending on the cluster's age, the morphology of the colour-magnitude diagram and the surface composition are influenced by different physical effects. Many of them are not well understood, such that the descriptions used in stellar structure theory can be tested and possibly calibrated. I will review examples of such cases, demonstrating how valuable star clusters are as laboratories for the theory. I will also briefly discuss the consequences of the fact that globular cluster appear to have multiple populations and therefore no longer constitute classical simple stellar populations.

Nami Mowlavi

Title: The discovery of a new class of variable stars in NGC 3766

Abstract. I will present the new class of variable stars discovered in the open cluster NGC 3766, highlighting the fact that the discovery was made possible thanks to their belonging to an open cluster, and presenting the puzzles raised by the discovery. I will also briefly mention the potential contribution of Gaia to our understanding of those stars.

SESSION 2: clusters and their environment

E. J. Alfaro & C. Román-Zuñiga

Title: Density or mass, which control the early stages of the star formation process?

Abstract. How do stellar clusters form is a one of the key questions for understanding the physical mechanisms that drive the transformation of cold molecular gas into stars in different environments. In particular, the spatial distribution of recently formed stars in clusters is an important source of information on the physical conditions of the original gas cloud and on the early dynamical evolution of the cluster stars (see Parker et al. last works). In this context, one of the critical questions is weather the mass segregation observed in most young clusters is primordial, i.e. associated to the density structure of the cloud, or represents the product of a rapid dynamical evolution once the cores collapsed. To this aim, we have analyzed the population of dense cores in the Pipe cold molecular cloud, based on the catalogue tailored by Román-Zuñiga and collaborators. Mass-Core Function (MCF) and Density-Core Function (DCF) can be very well represented by a lognormal plus a high-mass power-law tail for the mass, and a lognormal distribution for the density. Fitted model parameters are similar to those estimated by Herschel team for other core populations associated to nearby star forming regions, suggesting that Pipe's cores are quite well representative of the pre-stellar core population in the solar neighbourhood. Spatial distribution of the cores shows a high degree of structure with Q value well below 0.80 (value separating radial from fractal 2D spatial distributions) and 3D fractal dimension very similar to those estimated for the density distribution of most nearby molecular clouds (2.6-2.7). The estimated robust mass-segregation parameter (med) shows that most massive cores are distributed close each other, but clustered in three different groups. This segregation is seen clearly enhanced when segregation parameter is density. All this suggests that the pre-stellar core distribution mimics the internal structure of the molecular cloud, and that at this stage this structure is mainly driven by core-density and not by core-mass.

S. Blanco Cuaresma

Title: Testing the chemical tagging with old Open Clusters

Abstract: De Silva et al. 2007 demonstrated the chemical homogeneity of two open clusters and one moving group together with the uniqueness of their abundance patterns. These findings open the possibility of using the technique of chemical tagging to identify common formation sites in the disk as proposed by Freeman & Bland-Hawthorn 2002. In order to apply this technique to high resolution spectra we have developed our own spectral analysis code, which we have used for the analysis of old Open Clusters observed by NARVAL spectrograph (Bernard Lyot Telescope located at the Pic du Midi in the French Pyrenees). We present the astrophysical parameters (AP) and abundances determined for those clusters and we compare the performance of two of the most popular methods for abundance analysis: synthetic spectral fitting (SSF) and equivalent widths method (EW).

H. Bouy

Title: Dynamical Analysis of Nearby Clusters

Abstract: Combining archival and new wide field observations from the ground, and using high precision astrometric software, we are studying the properties of nearby clusters. The achieved accuracy is comparable to that of Gaia at the faint end (~0.3mas/yr) over tens of squares degrees and up to i~23mag. Combined with new multi-dimensional statistical methods using both the astrometry and multi-wavelength photometry of the DANCe catalogues and designed for censored data, we derive membership probabilities for several millions sources in each cluster targeted by our study. We report the results for the Pleiades cluster, and increase the number of high probability members by a factor of 2 with respect to the most recent studies.

V. DeBattista

Title: Migration in disk galaxies

Abstract. I review the theory and evidence for stellar migration in disk galaxies and the consequences for star clusters.

V. D'Orazi

Title: Disentangling the complexity of globular clusters: a chemical approach

Abstract. The canonical paradigm of globular clusters (GC) as the best example of a simple stellar population has been dramatically disproved. The evidence that most (all?) Galactic globular clusters show multiple stellar populations has been provided us from the extensive photometric and spectroscopic studies carried out in the last decade. In particular, high-quality , high-resolution spectroscopic studies have revealed the presence of internal inhomogeneities in the proton-capture elements for GC stars (e.g., C, N, Na, O), from the main-sequence all the way up to the red-giant branch: this finding uniquely indicates that at least two different episodes of star formation are required within each GC.
In this talk, I will focus on the results gathered from the spectroscopic studies, reviewing the current status of the field and discussing some of the most debated issues, related to cluster formation and early-stage evolution.

M. Gieles

Title Formation & disruption of clusters

Abstract. The processes leading to the formation and disruption of clusters are reviewed.

R. Gratton

Title: Multiple populations in globular clusters: a clue to second

parameter problem?

Abstract. Observations in the last years have shown that globular clusters host multiple stellar populations characterized by different chemical composition. We reconsider the old issue of the horizontal branch second parameter taking this datum into consideration. We show that consideration of cluster ages and of the helium abundance variations related to the multiple population scenario allows to explain most features related to the second parameter issue. However, an additional parameter might be required to explain some residual scatter.

S. Martell

Title: Globular cluster stars in the Galactic halo

Abstract. I will discuss recent work involving Galactic halo stars that appear, chemically, to have formed within globular clusters. The presence of these stars outside of globular clusters carries interesting implications for the role of in situ star formation in Galactic halo assembly. I will describe how the Galactic orbits of these stars provide further confirmation of their origin within clusters. Large observational projects like the Gaia-ESO survey and the upcoming GALAH survey are likely to find more migrant stars like these, as well as stars accreted from dwarf galaxies, which will provide dramatic new insights into the formation history of the Milky Way.

R. Parker

Title: The dynamical state of star clusters and the influence of binaries.

Abstract. I will discuss the dynamical evolution of star-forming regions and highlight the initial conditions that lead to bound (later open) star clusters, and those that lead to unbound associations. The distinction is important because bound clusters are less likely to contribute stars to the Galactic field, as opposed to unbound associations. I will present a new method of distinguishing these two scenarios based on the spatial structure of the stars and the level of dynamical mass segregation. I will discuss the influence of binary stars on the evolution of clusters, and how we can potentially use them to infer the dominant star formation event that populates the field. Finally, I will highlight the potential for GAIA to help us determine this dominant mode of star formation.

A. Recio-Blanco

Title: Fluorine abundances and the puzzle of globular cluster chemical history

SESSION 3: Clusters as tracers of the galactic evolution

A. Bragaglia

Title: Old clusters of the Milky Way disk

Abstract. I will present an overview of the properties of the open clusters from an observer's point of view. The main topics treated will be the metallicity distribution of the disk as defined by the clusters and the determination of distance and age, stressing the importance of homogeneity and concentrating on the old population. I will only briefly discuss the possibility of multiple populations, commonly found in globulars, also in old and massive open clusters.

A. Ferguson

Title: Globular Clusters throughout the Local Group

Abstract. Wide-field surveys conducted over the past decade have allowed an improved census of the globular cluster population in a number of Local Group galaxies. I will discuss some of these results, focusing in particular on the outer halo globular cluster population of M31.
With roughly 100 clusters now known to lie beyond 30 kpc, M31 provides an ideal laboratory in which to study remote star clusters and gain insight into how these enigmatic populations have assembled.

D. Gouliermis

Title: Exploring the topology of clustered star formation

Abstract. The way stars are spatially distributed forming clusters and larger structures conceals the works of the star formation process itself. Many resolved star-forming regions in our Galaxy and the Magellanic Clouds reveal a picture of stellar clustering, according to which compact stellar groups represent the centers of recent star formation located in larger loose young stellar structures of older or comparable ages. Two modes of clustered star formation, producing both gravitationally bound and unbound clusterings, seem to work in these regions resulting to a variety of young stellar topologies. We discuss the stellar topologies in star-forming regions of the Magellanic Clouds and present popular methods developed for their depiction. In our discussion we use the template of the brightest HII complex in the Small Magellanic Cloud, NGC 346/N66, with its rich stellar sample as revealed by the Hubble Space Telescope. These data along with simulated stellar distributions allow us to characterize accurately well-established methods used for the quantification of stellar clustering and its hierarchical behavior, in an attempt to disentangle the star formation mechanism that produced this magnificent stellar complex.

Brigitte Rocca-Volmerange

Title: The crucial role of cold stars to model galaxy evolution with Gaia

Abstract: Clusters are crucial for fitting synthetic Single Stellar Populations (SSPs), basic building-blocks of galaxy evolution models. Gaia will observe their radial velocities and metal evolution signatures at high resolution with the RVS and their spectrophotometry at low resolution with the BP/RP instruments. By comparing to the low resolution BP/RP library (Tsalmantsa et al, 2009), we shall present the coherence with high resolution stellar libraries used in the evolutionary code PEGASE (www.iap.fr/pegase) to interpret RVS data, underlining the role of cold star populations

G.Tautvasiene

Title:CNO abundances in clusters

Abstract. During the last decades, an increasing amount of work has been done in studying the chemical composition of evolved stars of the Galactic field and stellar clusters. Among the fundamental questions to which investigations of evolved stars should help to find an answer is a mechanism of transport of processed material to the stellar surface in low mass stars. Post-main sequence stars with masses below 2–2.5 M_{Sun} exhibit signatures of material mixing that require challenging modelling beyond the standard stellar theory. Carbon and nitrogen abundances are among most useful quantitative indicators of mixing processes in evolved stars. Because of the first dredge-up abundances of ^{12}C decrease while abundances of ^{13}C and ^{14}N increase. Depending on stellar mass, metallicity and evolutionary state, these alterations are growing. Carbon and nitrogen abundances, C/N, and especially the carbon isotope ratios $^{12}C/^{13}C$ are key tools for stellar evolution studies. It is well known that low-mass stars experience the first dredge-up at the bottom of the giant branch. However, detailed analyses of chemical composition of evolved stars provide compelling evidences for extra-mixing processes in stellar atmospheres which cause quite large alterations of carbon and nitrogen abundances. Theoretical models suggest that these alterations become efficient on the red giant branch when stars reach the so-called luminosity bump, and depend on stellar evolutionary stage, mass, metallicity, rotation, magnetic activity and other parameters and processes. Carbon isotope ratios are key tools for stellar evolution studies. $^{12}C/^{13}C$ ratios are already investigated in quite a large sample of so-called Galactic red clump stars. Stellar clusters are even better tools for the study of stellar and Galactic evolution since they have formed at all epochs and their ages, distances and metallicities are more accurately derived than for the field stars. Stellar clusters are excellent laboratories for investigations of stellar evolution as well. Since cluster members were initially of approximately identical chemical composition, all changes in stellar atmospheres of evolved stars are related to internal and external processes of stellar evolution.

An overview will be provided on observational and theoretical analyses of evolved low mass giants in the Galactic field and stellar clusters.

SESSION 4: Clusters in the surveys pre and post Gaia

C. Allen, X. Hernandez and M.A. Jimenez

Title: Gaia and the dark matter versus modified gravity controversy

Abstract. We have been studying fragile dynamical structures in our Galaxy to test whether they follow Newtonian dynamics or whether they conform to modified gravity theories. The outer parts of globular clusters are suitable for these tests. We find, first, that the velocity dispersio profiles in a sample of globular clusters cannot be fitted with Newtonian models, but conform to modified gravity predictions. Second, we find clear extratidal features in a number of globular clusters with accurately determined Newtonian tidal radii. Lastly, the density profiles in globular clusters as well as other spherical halos are better described by MONDIAn gravity than by Newtonian dynamics. Another class of objects suitable for these tests are wide binaries, believed to be the result of dissolved clusters. In particular, the distribution of separations of wide binaries indicates a non-Newtonian evolution. All these tests are, however, quite subtle, and Gaia will be able to contribute decisively to resolve the controversy. Some concrete examples of the role that Gaia is likely to play in this matter will be discussed.

R. Blomme

Title: Massive-star clusters in the Gaia-ESO Survey

Abstract. We report on the preliminary analysis of GES data from five clusters containing massive stars (NGC 3293, NGC 6705, NGC 4815, Be 81, Carina nebula). We determine stellar parameters for all massive stars in these clusters and, where possible, we compare these to literature values. We also study the run of micro-turbulence for the A-star population. The repeat observation is used to investigate binarity and the radial velocity information to study cluster membership.

T. Cantat-Gaudin

Title: GES open clusters as tracers of the chemical gradient

Abstract

J. Drew

Title: Galactic Plane Open clusters in IPHAS, UVEX and VPHAS+

Abstract: A description of the photometric data being gathered via these surveys will given, along with some words on the imminent major release of IPHAS r,i,H-alpha photometry. Some examples of applications of these surveys to open-cluster science will also be presented, illustrating the value of the unlimited field and photometric uniformity these surveys provide.

P. Donati

Title: Progress in BOCCE and connections with GES

Abstract. Open Clusters are very good tracers of the Galactic disc properties. They span different ages, metallicities, and distances hence they can be used to study the properties of the Galactic Disc and their evolution with time. In this talk I describe the Bologna Open Cluster Chemical Evolution (BOCCE) project, which aims at studying the Galactic Disc by using a sample of OCs analysed in a self-consistent and homogeneous way. Accurate photometry and high-resolution spectroscopy are fundamental to determine the cluster parameters (namely age, distance, reddening, and metallicity). Recent photometric observations allowed to significantly improve the BOCCE database. On the spectroscopic side, the legacy of the ongoing Gaia ESO Survey, targeting both Milky way field stars and stars in 100 OCs, will greatly enhance our knowledge on the OCs properties.

P. Frinchaboy

Title: Chemical Abundances of Star Clusters and the Galaxy with APOGEE

Abstract. The Sloan Digital Sky Survey III/ Apache Point Observatory Galactic Evolution Experiment (SDSS-III/APOGEE) is an infrared (H-band) high-resolution (R ~ 22,500) survey of the 100,000 stars in the Galaxy. The APOGEE survey will observe most of the globular clusters in the north and will target hundreds of open clusters, especially low latitude reddened clusters. To take avantage of this powerful uniform dataset, the Open Cluster Chemical Analysis and Mapping (OCCAM) Survey aims to 1) produce a comprehensive, uniform infrared-based dataset for hundreds of open clusters, and 2) constrain key Galactic dynamical and chemical parameters. We present early APOGEE and OCCAM results from cluster analysis, notably the Galactic abundance gradient using APOGEE DR10 data. We will also present directions for the SDSS-IV/APOGEE-2 project that is currently in the planning stages, which aims to observe up to 500,000 stars in both hemispheres.

L. Magrini

Title: Chemical signatures in Open Clusters: tools to understand the mechanisms of disk formation

Abstract. We present abundance ratios of three old and intermediate-age open clusters, namely NGC~6705, NGC~4815, and Trumpler~20, all located in the inner part of the Galactic disk at R$_{GC}\sim$7~kpc, and observed during the first six months of the Gaia-ESO Survey (GES). We compared cluster abundances with those of solar neighborhood dwarf stars and of inner-disk/bulge giant stars obtained in a fully homogeneous way in the same period by GES. The main results can be summarised in: i) cluster members are chemical homogeneous in most of the analysed elements; ii) each cluster has a unique abundance patterns, different than the field population with the same metallicity; iii) the abundance patterns are signatures of the

birthplace of clusters and can be used to constrain the effect of stellar migration and to investigate the history of the Galactic disk.

A. Moitinho & A. Krone-Martins

Title: UPMASK: Unsupervised Photometric Membership Assignment in Stellar Clusters

Abstract. One of the most long-lasting problems in the study of stellar clusters is the photometric assignment of cluster memberships in contaminated fields. Although several approaches exist for attacking this problem, they usually involve the adoption of complex theoretical models for the photometric data (isochrones) and/or the selection and use of control fields, which introduce well known biases. We have developed a data-driven, fully automated and unsupervised method to perform membership assignment in Stellar Clusters using photometric and spatial data, which is independent from theoretical models or empirical reference lines, as well as from the adoption of observational control fields. Our method is based on an terative solution, and relies on Principal Component Analysis, clustering algorithms and kernel density estimations. Optionally, it also allows the user to take into account error models and missing data. We present a description of the method, results obtained with its application to a set of realistic simulations as well as results obtained from analysis of real data of selected Open Clusters.

L. Sampedro

Title: Chasing Cluster Members in the GES catalog

Abstract. We present the preliminary results obtained applying a new geometrical methodology (Sampedro et al. 2013, in prep.) to the GES catalogs, aiming at determining the potential members of a stellar cluster, in a N-dimension space. The N-variables have to satisfy the condition of being more densely distributed for the cluster members than for the field stars, as positions, proper motions, radial velocities, parallaxes, metallicities, abundances or combinations of thereof. As the number of input variables can be set, this geometric method makes the analysis more flexible, addressing the member identification problem from different perspectives. The first step of the method consists in the normalization of the variables where the outliers determination is a crucial step. Once the variables are normalized, a Ndistance between every star and the cluster center is computed. By the application of a parametric method, where the distances are approximated as two gaussians functions, it turns out possible the determination of the gaussian parameter estimations along with the star classification at the same time. To check this methodology, 243 mock catalogs, made up of field stars and cluster members, were simulated. The results (Sampedro et al. 2013, in prep.) show that the methodology can, not only recover more than the 95%, of the simulated cluster members, but also the misclassificated stars are lower than the 8%, in most of the simulated configurations

R. Sordo

Title:GES open clusters as stellar evolution probes

Abstract GES dataset, with its homogeneously derived chemical abundances, offers a unique opportunity to test stellar evolutionary models. The selected Open Clusters span crucial ages from the stellar evolution point of view, with observations covering both the upper main sequence and evolved star While there is a general agreement among stellar models, still there are open issues, concerning for example the treatment of the mixing or the calibration of Red Clump as function of age and metallicity. It is of the uttermost importance to test prediction of models on different evolutionary stages at the same time, and at varying ages and chemistry. In this talk, we set up the framework of our tests and present preliminary results on a set of Open Clusters.

S. Randich

Title:The promise of the Gaia-ESO Survey for open cluster science

Abstract.

M. Valentini

Title: Corot Red Giants in the GES

Abstract. Nowadays big spectroscopic surveys as the Gaia-ESO survey are providing unique stellar databases for better investigating the formation and evolution of our Galaxy. Great attention must be devoted to the accuracy of the basic stellar properties derived by those surveys: large uncertainties in stellar parameters lead to large uncertainties in abundances, distances and ages. Asteroseismology recently demonstrated to provide accurate and precise mass and radius for dwarf and giants stars that present solar-like pulsations. Therefore it is possible to determine log(g), distance and ages with greater accuracy and precision. The CoRoT space mission offers a large, relatively bright and homogeneous sample of solar like oscillating giants spread across nearly 15,000 pc of the Galactic disk. This unique sample is an useful benchmark for testing pipelines adopted by GES and, thanks to the chemo-dynamical informations provided by spectroscopy, it can be used for mapping and dating the Galactic disc.

SESSION 5 Scientific Communication

R. Doran

C.Boccato

POSTERS

P1: D. Bossini, A. Miglio, M. Salaris, L. Girardi, J. Montalbán, A. Bressan, P. Marigo + APOKASC

Title: AGB bump: a calibrator for core mixing.

Abstract. In this poster, we propose a test to estimate the size of the extra mixing region in the core of helium-burning stars by comparing the luminosity of the AGB bump found in observations (Kepler) and predicted by models. The efficiency of convection in stars affects many aspects of their evolution and its uncertainty remains one of the key open questions in stellar modeling. The size of the mixed core in models in the helium-burning phase is still uncertain and affect for instance the lifetime of this evolutionary phase and the C/O central profile at the end of he-burning. An important observable related to the HB and AGB evolution its the luminosity of the AGB bump (AGBb) In particular the luminosity when it occurs depends on the location in mass of the helium-burning shell at its first ignition and thus the extension of the mixing region. In our preliminary considerations we focus on the treatment of central mixing considering the effects of overshooting (treated á la Herwig 2005) and we consider models computed by MESA star. We plan to extend this study using other mixing treatments and results from other codes: PARSEC, BASTI, and ATON. One of main purposes of this work is calibrate the method to investigate central mixing in stars of other objects, like Globular Clusters and dwarf Galaxies.

P2: K. Biazzo, P. Francois, L. Pasquini, P. Bonifacio, R. Palsa

Title: Lithium in the old metal-poor open cluster NGC 2243

Abstract. We present recent results on lithium abundance measurements we obtained for stars in the old (5 Gyr) and metal-poor ([Fe/H]=-0.54+-0.10 dex) open cluster NGC 2243, which is located towards the Galactic anti-center at the distance R_G=10.76 kpc. The lithium element in old populations is of a paramount importance to investigate the mixing mechanisms acting in the stellar interiors, the chemical evolution of the Galaxy, the Big Bang nucleosynthesis. We measured lithium abundance of NGC 2243 members from high-resolution spectra obtained with FLAMES@VLT. The detailed analysis of this element in NGC 2243 allowed us to determine whether the Li dip extends to low metallicities and to perform a comparisons with populations of similar metallicity. In particular, we found that the Li dip is well defined and close to the turnoff of

the cluster and we determined a mass of the Li dip center of 1.06 Msun, which is smaller than that observed in solar metallicity and metal-rich clusters. This finding confirms the conclusion that the mass of the stars in the Li dip strongly depends on stellar metallicity. Moreover, the mean Li abundance of the cluster is log_n(Li)=2.70 dex, which is similar to the Li of the interstellar medium in the Small Magellanic Cloud and to the primordial Li abundance deduced from WMAP measurements, but higher than that observed in 47 Tuc, which leads to contradictory results. Future high-quality Gaia data, with unprecedented precision on membership, proper motion, distance, and age, will allow us to put strong constraints on lithium evolution models of our Galaxy and to better understand our findings.

P3: B. Fernandes, J. Gregorio-Hetem, T. Montmerle

Title: The nature of X-ray sources associated to young clusters around Sh2-296

Abstract. Aiming to unravel the star formation activity in the Canis Major R1 (CMaR1) star-forming Galactic region, we have studied the young (< 5 Myr) clusters associated to the arc-shaped ionized nebula Sh2-296. Based on our X-ray data complemented by optical and near-IR data, we discovered, near to GU CMa, a stellar cluster that is older by at least a few Myr than the previously known cluster, around Z CMa, where star formation is still very active. We suggest that the CMa R1 region has undergone at least two distinct star formation episodes. Multi-object optical spectroscopy of our X-ray sources nearby Z CMa and GU CMa has been performed with Gemini telescopes to confirm the existence of a mixed population from both older and younger clusters around the edge of Sh2-296. In the present work we show the results obtained for the stellar clusters located to the East of Z CMa, where we acquired spectra for optical counterparts candidates of 45 X-ray sources. Spectraltype determination was based on comparison with standard spectra library for late-type stars and fitting the continuum and TiO bands. Most of our sample is low-mass young stars, having K7 to M0 spectral types. Typical features of young stars were inspected to confirm the nature of the sample that is mainly classified as T Tauri stars (TTs), since their spectra show the Li I (670,8 nm) line, one of the indicators of youth. The equivalent width of Halpha measured at 10% of the total flux was used to separate Classical TTs (CTTs) from weak-line TTs (WTTs). Among 50 young stars candidates, 14% are classified as CTTs; 22% are WTTs, and 52% are post-TTs. One object is classified as Herbig Be star and 5 are emissionline stars, which nature remains to be revealed. The presence of a large number of post-TTs among our sample is consistent with the mixing of populations that we discovered previously. However the present results correspond to a small fraction (~15%) of the entire sample of X-ray sources we have detected with MM-Newton around Sh2-296. In order to have a more representative set of spectra, additional GMOS observations have been performed, as well as new proposal to use FLAMES at VLTESO has been submitted. Another ongoing project is dedicated to study the relation of the X-ray properties of our sample compared to the optical spectral classification obtained in the present work.

P4: A. Ruelas-Mayorga

Title: CCD Photometry of the Globular Cluster NGC 6093

Abstract. We present B, V, R and I CCD photometry of the globular cluster NGC 6093. The observations were obtained during two observing seasons (2006 and 2007) at the Observatorio Astronomico Nacional de San Pedro Martir in Baja California, Mexico. We present colour-magnitude diagrams for NGC 6093 in several combinations of magnitudes and colour-indices (B vs B-V (1622 stars), V vs B-V (1622 stars), V vs V-I (2320 stars), I vs V-I (2320 stars), R vs R-I (2513 stars), and I vs R-I (2513 stars)). In all the colour-magnitude diagrams we detect very clearly the top end of the main sequence, the giant branch, the asymptotic giant branch and the horizontal branch. There is a number of stars located in the space between the top end of the main sequence and the horizontal branch which could be identified as blue stragglers, however at present we have not been able to establish whether in fact these stars belong to the cluster or are field stars. We calculated the metal abundance of this cluster and it resulted in: $[Fe/H]=-1.84 \pm 0.20$ showing that NGC 6093 is a globular cluster with a low metal abundance, its age is of the order 12.54×10^9 yrs, showing, as expected, that an old globular cluster must not have a high metal abundance. We obtained the value of the colour excess of this cluster in two colours: $E(B-V)= 0.15 \pm 0.03$ and $E(V-I)=0.22 \pm 0.03$. The value we obtained for the distance modulus of this cluster is $(m-M)_0=14.94 \pm 0.14$ which implies a distance of 9.71 ± 0.37 kpc.

P5: C. Martinez

Title: Open cluster evolution and the search for the Sun's siblings.

Abstract. The high eccentricities and inclinations observed for the orbits of the Edgeworth-Kuiper belt objects as well as the radioactive isotopes found in the meteorite fossil record are some of the imprints found in the solar system that suggest the Sun was born in an open cluster 4.6 Gyrs ago. In this work, we study the evolution and migration of this open cluster along its orbit through the galaxy. We first aim to understand the distribution of plausible initial positions and velocities of the birth cluster, using the present day location and motion of the Sun as a constraint. Starting from these possible birth locations we want to follow the dynamical evolution of the cluster along its orbit through the Galaxy in order to derive the present day phase space distribution of the Sun's siblings. Our ultimate goal is to understand how the Gaia data (combined with chemical tagging) can be used to find the remnants of the Sun's birth cluster.
For the study of the evolution of the Sun's birth cluster through the Milky Way, we took into account internal processes in the cluster, i.e. stellar evolution and gravitational dynamics among particles. The galaxy was modeled taking into account the contribution of a central bar and spiral arms. We show how the current phase space of the Sun's siblings changes when varying the galaxy parameters; more specifically, how their final distribution is affected by resonances produced by the bar and the spirals arms.

P6: C. Munoz, D. Geisler, S. Villanova

Title: The Origin and Chemical Evolution of the Exotic Globular Cluster NGC3201

Abstract.: NGC3201 is a globular cluster (GC) which shows very peculiar kinematic characteristics including an extreme radial velocity and a highly retrograde orbit, strongly suggesting an extraGalactic origin. Our aims are to study NGC3201 in the context of multiple populations (MPs), hoping to constrain possible candidates for the self-enrichment by studying the chemical abundance pattern, as well as adding insight into the origin of this intriguing cluster. We present a detailed chemical abundance analysis of eight red giant branch (RGB) stars using high resolution spectroscopy. We measured 29 elements and found [Fe/H]=-1.53+/-0.01, we cannot rule out a metallicity spread of ~0.12 dex, and an alpha-enhancement typical of halo GCs. However significant spreads are observed in the abundances of all light elements except for Mg. We confirm the presence of an extended Na-O anticorrelation. n-capture elements generally are dominated by the r-process, in good agreement with the bulk of Galactic GCs. The total (C+N+O) abundance is slightly supersolar and requires a small downward correction to the isochrone age, yielding 11.4 Gyr. Kinematically, NGC3201 appears likely to have had an extraGalactic origin but its chemical evolution is similar to most other, presumably native, Galactic GCs

P7: T. Silva

Title: A comparative study of 21 young stellar clusters

Abstract. Several embedded clusters are found in the Galaxy. Depending on the formation scenario, most of them can evolve to unbounded groups that are dissolved within 10Myr to 20Myr. A systematic study of young stellar clusters that show distinct characteristics provide interesting information on the evolutionary phases during the preBmain sequence. To identify and to understand these phases we performed a comparative study of 21 young stellar clusters. NearBinfrared data from 2MASS were used to determine the structural and fundamental parameters based on surface stellar density maps, radial density profile, and colourBmagnitude diagrams. The cluster members were selected according to their membership probability, which is based on the statistical comparison with the cluster proper motion. Additional members were selected on the basis of a decontamination procedure that was adopted to distinguish field stars found in the direction of the cluster area. We obtained age and mass distributions by comparing preBmain sequence models with the position of cluster members in the colourBmagnitude diagram. The mean age of our sample is ~ 5 Myr, where 57% of the objects is found in the 4 B 10 Myr range of age, while 43% is < 4 Myr old. Their low E(BBV) indicate that the members are not suffering high extinction (AV < 1 mag), which means they are more likely young stellar groups than embedded clusters. Relations between structural and fundamental parameters were used to verify differences and similarities that could be found among the clusters. The parameters of most of the objects show the same trends or correlations. Comparisons with other young clusters show similar relations among mass, radius, and density. Our sample tends to have larger radius and lower volumetric density than embedded clusters. These differences are compatible with the mean age of our sample, which we consider intermediate between the embedded and the exposed phases of the stellar clusters evolution.

P8: C. Soubiran, U. Heiter, M. Netopil, E. Paunzen

Title: The metallicity of Open Clusters : photometry and spectroscopy.

Abstract. The existing literature is reviewed to present an overview of the status and current limitations of OC metallicities.

P8: T. Pijloo

Title: Clusters in the EGAPS data

Abstract We determine the initial conditions of the Galactic Globular Clusters by coupling cluster evolution code Evolve Me A Cluster of StarS (EMACSS) to the Markov Chain Monte Carlo code emcee hammer.