Stellar Clusters & Associations

A RIA Workshop on Gaia

Abstracts Book

Edited by

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Introduction

This booklet contains the abstracts of all the Workshop contributions. Invited and oral contributions are ordered according to the daily schedule, and posters by alphabetical order.

Figures preceding the posters also indicate the localization of the panels where they are to be posted. Posters will be present the five days of the meeting.

Part II

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1 Gaia Status & Performances

Timo Prusti[1]
[1] European Space Agency, ESTEC

Abstract

Gaia is an ESA mission performing astrometry, photometry and spectroscopy of about one billion objects in our Milky Way Galaxy and beyond. The prime industrial contractor, EADS Astrium in Toulouse, is in the middle of qualification and production phase integrating the satellite and payload for launch in early 2013. The presentation will give a brief summary of the status of the spacecraft, operational ground segment elements and the launcher. The scientific performance estimates have been consolidated over the last months when more and more design values of hardware have been updated with the true values from tests. The latest performance estimates have been recently put up in the Gaia web-site (www.rssd.esa.int/Gaia) and will be summarized in the presentation.

2 What the spatial distribution of stars can tell us about star formation, clusters, and the IMF

Eli Bressert[1]
[1] ESO / University of Exeter / Harvard-Smithsonian CfA

Abstract

We present the results of two recent studies regarding the clustering properties of young stars. First, we discuss a global study of young stellar object (YSO) surface densities in star forming regions based on a comprehensive collection of Spitzer Space Telescope surveys, which encompasses nearly all star formation in the solar neighbourhood. We show that the distribution of YSO surface densities is a smooth distribution, being adequately described by a lognormal function from a few to 10^3 YSOs/pc^2, with a peak at $\sim$ 22 YSOs/pc^2 and a dispersion of $\sim$ 0.85. We do not find evidence for multiple discrete modes of star-formation (e.g. clustered and distributed).
Secondly, we address the issue of whether massive stars exclusively form in large stellar clusters or if they can form (albeit rarely) in relative isolation. Many studies have addressed this question from a variety of angles, however they have all been limited due to the unknown frequency of runaway high-mass stars (i.e. high-mass stars that formed in clusters but have been ejected due to dynamical interactions within the dense cluster cores). We use the VLT-FLAMES Tarantula Survey (PI Evans) to by-pass this limitation. We select O-stars outside the dense cluster R 136 but within 30 Doradus that have the same radial velocity as their surrounding gas, are spatially associated with large gaseous filaments. We find many examples of such stars, which rules out the possibility that they were ejected from R 136 (although some clear runaways are also found). Including deep optical and near-IR imaging rules out large clusters around these stars, showing that high-mass stars can and do form in relative isolation. We briefly discuss the implications of these results concerning star-formation theories, clusters, and the IMF.

3 Young Stellar Clusters and OB associations: same origin or different initial conditions?

Hans Zinnecker[1]
[1] Deutsches SOFIA Institut, University of Stuttgart & NASA Ames

Abstract

I would like to discuss the issue whether young stellar clusters and OB associations are different incarnations of the same original state at different evolutionary stages. In this picture, associations were born as clusters with have expanded and became unbound after a bound embedded cluster lost much of its gas mass (binding mass). My own view is different: clusters and associations have been different from birth - with different initial conditions in molecular clouds (cf. Clarke et al. 2008, MNRAS). Gaia observations of proper motions of clusters and associations can discriminate between these two theories and solve a key question of the star formation process.

4 Properties of cluster-forming regions from star cluster early evolution modelling

Genevieve Parmentier[1]
[1] Argelander Institut für Astronomie

Abstract

The mass-radius relation of cluster-forming regions is crucial to the fate and properties of the star clusters they form. In this contribution I highlight how, through the tidal field impact upon exposed star clusters, the mass-radius relation determines whether cluster infant-mortality is mass-independent or not. While the observational constrain of a time-invariant slope for the power-law young cluster mass function is robustly satisfied by cluster-forming regions with a constant mean volume density, a constant mean surface density is conducive to the preferential destruction of high mass clusters. Besides, the very nature of the cluster-forming region mass-radius relation is tightly connected to our abilities to reconstruct galaxy star formation histories from their systems of surviving star clusters, and to model the mass-metallicity relation of old globular clusters in a cluster self-enrichment framework.
I will emphasize that observational mass-radius data-sets of dense gas regions must be handled with caution since they may constitute an imprint of the technique/tracer used to map them rather than reflect cluster formation conditions.
Furthering the argument of a constant mean volume density for cluster-forming regions, I will show how it allows to understand: (i) why the star cluster mass function is steeper than the molecular cloud mass function; (ii) the presence of a massive star formation limit in the mass-size space of molecular structures.

5 The formation of star clusters

Pavel Kroupa[1]
[1] Argelander Institut für Astronomie

Abstract

Direct computations of star-cluster formation give an important insight on the dynamical structures that form and are getting ever more sophisticated. One major but necessary simplification is to either ignore feedback from the young stars, or to treat it in a very simplified manner. A dominant physical mechanism in star formation is, however, feedback, as is for example suggested by the existence of a most-massive-star – star-cluster mass relation. Star formation appears to be inherently self-regulated. Another approach to probe our understanding of cluster formation is to consider existing older clusters and compute backwards to their likely initial conditions. The present-day binary-star population and mass-to-light ratio are essential dynamical tools in doing so.

6 The Initial Mass function seen by the UKIDSS Galactic Clusters Survey

Nicolas Lodieu[1]
[1] Instituto de Astrofísica de Canarias (IAC), Tenerife

Abstract

In this contribution, we present the mass functions obtained in several open clusters and star-forming regions targeted by the UKIRT Infrared Deep Sky Survey (UKIDSS) Galactic Clusters Survey (GCS). We will describe the photometric search using the five infrared filters employed by the GCS as well as the astrometric selection using 2MASS as first epoch. We will compare the mass functions derived in the Pleiades (125 Myr), the IC 4665 pre-main sequence cluster (27 Myr), the Upper Sco (5 Myr) association and the sigma Orionis (1-5 Myr) region.

7 The substellar mass function of open clusters

Estelle Moraux[1]
[1] Institut de Planetologie et d'Astrophysique de Grenoble

Abstract

In this talk, I will review results we obtained for the substellar mass function in various open clusters and star forming regions using both optical and NIR wide field imaging surveys. Down to 30 $M_{\rm Jup}$, the IMF seems to be universal while it is not so clear at lower masses. I will also discuss how the mass function is affected by the cluster dynamical evolution and how we can trace back the IMF using N-body numerical simulations.

8 The low-mass Initial Mass Function in the Orion Nebula Cluster based on HST/NICMOS III imaging

Morten Andersen[1]
[1] European Space Agency, RSSD, ESTEC

Abstract

Nearby young embedded star clusters are ideal environments to determine the Initial Mass Function (IMF).
Their proximity and youth enable characterization of the cluster content deep into the brown dwarf regime.
To obtain the IMF for the cluster as a whole and to identify any mass segregation in the low-mass content of the cluster, sensitive, large field of view observations are necessary.
Here we present deep HST/NICMOS III F110W (J) and F160W (H) band imaging of a 26'x33', corresponding to 3.1x3.8 pc, non-contiguous field towards the Orion Nebula Cluster.
The data are sensitive to objects down to 10 $M_{\rm Jup}$ and cover a larger area than previous deep high spatial resolution studies.
The main aim is to determine the ratio of low–mass stars to brown dwarfs for the cluster out to a radial distance 1.5 pc.
Objects are de-reddened to the isochone in the colour magnitude diagram and the individual object masses are determined.
We calculate the ratio of low-mass stars to brown dwarfs as a function of distance from the cluster center and discuss the evidence for mass segregation of the low-mass cluster content.

9 The present-day mass function of the Quintuplet cluster

Benjamin Huβmann[1]
[1] Argelander Institut für Astronomie, Universität Bonn

Abstract

The three young, massive star clusters found in the galactic centre region (Young Nuclear Cluster, Arches and Quintuplet cluster) are among the six most massive, open clusters in our galaxy with masses similar to low-mass, extragalactic starburst clusters. As the extreme conditions for star formation in this region are likely comparable to the ones found in the HII regions in starburst galaxies these clusters serve as templates for extragalactic starburst clusters. These clusters constitute unique laboratories for stellar evolution, as they contain large numbers of stars in the entire mass range and therefore sample the present day mass function (PDMF) up to the most massive stars. The Quintuplet cluster with an age of about 4 Myr displays the lowest spatial density of the three Galactic centre clusters. In order to derive an unbiased sample of cluster stars and determine the mass function correctly, cluster and field stars have to be discerned out to radii where the member density drops below the field star density. We used proper motion measurements to establish a membership sample. The cluster stars were selected based on their individual proper motion, which was determined by comparing two high precision astrometric VLT/NACO datasets with a time baseline of 5 years. From this selection of cluster members the PDMF of the Quintuplet cluster is derived for the first time.

10 Embedded clusters

João Alves[1]
[1] University of Vienna

Abstract

Star formation configures our Universe and observations suggest most stars originate in clusters. But why? And why is the IMF an "universal" product? In this talk I will review briefly the current cluster formation scenarios, their successes and shortcomings, and based on observational evidence I will suggest a new scenario for cluster formation. In this new scenario massive stars form first and play a critical role on the formation of a cluster, effectively synchronizing the collapse of an ensemble of dense cores in a molecular cloud clump. "It is not that massive stars are found in clusters; it's clusters that are found around massive stars". Alas, Gaia cannot observe embedded clusters, but it can certainly address cluster formation questions by observing young stars emerging for the first time at optical wavelengths. Some of these questions will be discussed.

11 Dissecting high-mass star-forming regions; tracing back their complex formation history

Arjan Bik[1]
[1] Max-Planck-Institute for Astronomy

Abstract

The formation and early evolution of high-mass stars happens in clustered and highly complex environments, where the forming stars and the molecular cloud are mutually interacting. To study the stellar population of high-mass star-forming regions, are pursuing a program aiming at a spectroscopic classification of all the high- and intermediate mass cluster members of a well selected sample of 10 galactic young clusters as well as to study the interaction between the stars and their environment.
I will present results of this survey obtained with the integral field spectrograph SINFONI at the VLT as well as multi object spectrograph LUCIFER at the LBT. Supporting multi-wavelength data (mid-infrared, sub-mm and radio) are added to obtain a complete picture of the regions. The first results show that properties like distance and ages of the clusters can be derived. Additionally, the multi-wavelength datasets of the regions and their environment result in a detailed assessment of the formation history of the targeted regions and shows that multiple generations of star formation are present in every cluster.

12 Clusters within Clusters: A Spitzer & Chandra view of the YSO population in RCW 38.

Elaine Winston[1]
[1] European Space Agency (ESA-ESTEC)

Abstract

The majority of young stars are believed to form in clustered environments. The effect this has on their circumstellar environments will depend on the star formation history and structure of the cluster itself.
In this talk I will present Spitzer and Chandra observations of the relatively nearby RCW 38 region of massive star formation. At a distance of 1.7 kpc, and containing an estimated 20 - 40 OB stars, RCW 38 is one of the richest nearby star forming regions, after Orion, with an estimated cluster membership in excess of 1000 members.
Previous studies have focused on the central core surrounding IRS2, the central O5.5 binary.
Here, I will use the mid-IR observations to identify young stellar objects with circumstellar emission in an extended region surrounding the core. I will utilise the elevated X-ray emission of young stars to locate diskless young members in the X-ray observation.
Using multi-epoch Spitzer observations I will also present a preliminary study of the variable young stars in the cluster.
Through a study of the spatial distribution of the YSOs I will present evidence of structure and subclustering in the region, particularly among the most massive stars and show how they help shape the circumstellar environments of their lower mass neighbours. I will comment on a new very young core of star formation in the region identified with Spitzer. I will examine the gas to dust ratio relative to that of the ISM and show that they are consistent, and dissimilar to results found in lower mass clusters, indicating that environment can play a role in the processing of dust in these clouds.

13 From distant to resolved very young star clusters: a solution for the observed NIR excess

Angela Adamo[1]
[1] Stockholm University

Abstract

A recent study of young massive clusters (YMCs) in a special type of dwarf galaxies has revealed extraordinary young cluster populations. These galaxies are commonly called luminous blue compact galaxies (BCGs) because they appear rather compact and have high B band luminosities suggesting that high star formation rates (SFRs) are operating within them. The age distributions of the YMCs suggest that the starburst episode in Haro 11, ESO 185 - IG13, and Mrk 930 started not later than 30 - 40 Myr ago. A peak of cluster formation only 3 - 4 Myr old is observed, unveiling a unique sample of clusters still partially embedded. A considerable fraction of clusters (30 - 50 %), mainly younger than 10 Myr, shows an observed flux excess between 0.8 and 2.2 μm. This so-called near-infrared (NIR) excess is impossible to reproduce even with the most recent spectral synthesis models (that include a self-consistent treatment of the photoionized gas). The origin of the NIR excess, which still remains unexplained, challenges our understanding of the cluster formation process under extreme conditions. I have used these

YMCs as an important source of information for the very early evolution phase of star clusters. In all the three host galaxies, the analysis is most likely limited to the optically brightest objects, i.e., systems that are only partially embedded by their natal cocoons (since deeply embedded clusters are probably too faint to be detected). I will discuss possible explanations for this NIR excess addressing IR studies of both extragalactic young star clusters and resolved massive star forming regions in the Milky Way and in the nearby Magellanic Clouds.

14 Searching for IMF variations in resolved stellar populations

Kevin Covey[1]
[1] Department of Astronomy, Cornell University

Abstract

The initial mass function (IMF) succinctly characterizes a stellar population, provides a statistical measure of the end result of the star-formation process, and informs our understanding of the structure and dynamical evolution of stellar clusters, the Milky Way, and other galaxies. Detecting variations in the form of the IMF could provide powerful insights into the processes that govern the formation and evolution of stars, clusters, and galaxies. In this contribution, we review measurements of the IMF in resolved stellar populations, and critically assess the evidence for systematic IMF variations. Studies of the field, local young clusters and associations, and old globular clusters suggest that the vast majority were drawn from a "universal" IMF, suggesting no gross systematic variations in the IMF over a range of star formation environments, and much of cosmic time. After highlighting Galactic environments whose 'non-standard' IMFs deserve continued study, we will conclude by summarizing the increased sensitivity to IMF variations that will be provided by next generation sky surveys, such as Gaia and the Large Synoptic Survey Telescope.

15 The VISTA survey of Orion

Monika Petr-Gotzens[1]
[1] ESO - Garching

Abstract

The world's largest near-infrared survey facility, VISTA, has recently been brought into operation on Cerro Paranal. As part of the Science Verification Programme of VISTA, we have carried out a wide-field imaging survey in five broad-band filters (ZYJHKs) covering a 30 square degree area around the Orion Belt stars. The observations have mapped young stars and brown dwarfs in various environments and at different stages of their evolution, from embedded 1 Myr old clusters to $\sim$ 10 Myr old populations distributed throughout the wide-spread OB-association Ori OB1a.
Approximately 3.2 million sources, including several thousand brown dwarf candidates, have been detected in the survey, which has typical limiting magnitudes of H$\sim$ 19.4, Z$\sim$ 22.6. In this contribution I will outline the characteristics of the VISTA-Orion survey, and highlight examples of the numerous scientific applications facilitated by our survey.
Such will include the search for young very low-mass stars and brown-dwarfs, the study of variations in the substellar IMF, or the photometric selection of the lowest temperature objects, i.e. candidate T-dwarfs.

16 Properties of the young embedded cluster in Tr 14 - N4 in other embedded population in northern NGC 3372

Mauricio Tapia[1]
[1] Instituto de Astronomía, UNAM-Ensenada

Abstract

Deep narrow-band images centred on the Br gamma at 2.17 μm and molecular hydrogen 2.12 μm lines as well as broad-band JHK near-infrared images are presented of the mid-infrared source Tr 14 - N4, located some 4.5 arcmin to the east of the open cluster Tr 14 in the Carina Nebula. The observations were made with PANIC attached to the Baade 6.5 m Magellan Telescope at Las Campanas Observatory. These were supplemented by archive Spitzer/IRAC images. An embedded young compact cluster of approximate size 46 arcsec is revealed. This is composed of more than forty medium-to-low mass stars. Its luminosity is dominated by two high-mass YSOs and their properties are derived from 1.2 to 11 μm photometry. The presence of mass outflows is evinced by several small H_2 emission nebulae close to the tip of what appears to be a cavity delineated by ionized gas emission. The characteristics of the scattered embedded population and possible outflows in the dark cloud associated with Car I and is also discussed.

17 Gaia and sigma Orionis from 20 $M_\odot$ to 3 $M_{\rm Jup}$: the most precise and complete IMF with a parallax determination?

José Antonio Caballero[1]
[1] Centro de Astrobiología (CAB - CSIC)

Abstract

The sigma Orionis cluster ($\tau \sim 3$ Myr, d ~ 385 pc) in the Ori OB1b association (the Orion Belt) is to date the star-forming region with the largest number of confirmed brown dwarfs and substellar objects below the deuterium burning mass limit (i.e. isolated planetary-mass objects, IPMOs). The most massive star, sigma Ori Aa, just in the cluster centre, is the $\sim$20 $M_\odot$-mass O9.5V star that illuminates the Horsehead Nebula, while the least massive object yet reported, S Ori 70, is only around 3 $M_{\rm Jup}$. In the middle, there is a continuum of stars and substellar objects of all types (including magnetically active B2Vp stars, Herbig-Haro objects, FU Ori or T Tauri brown dwarfs) that makes the cluster a cornerstone in the study of the initial mass function, disc presence, X-ray emission or accretion at all mass domains.
However, the derived masses strongly depend on the actual heliocentric distance to the cluster. I will explain why sigma Orionis and its distance determination are so important, and how Gaia will be able to solve this dilemma and others (e.g. velocity dispersion and contamination by nearby young population from proper motion analyses).

TUESDAY, May 24^{th}

09:00 - 09:35	**Sϕren Larsen** (Invited) Cluster Systems in other Galaxies
09:35 - 09:55	**Simon Murphy** Revealing the Chamaeleon: The Epsilon and Eta Cha Associations
09:55 - 10:15	**Sami Dib** The Dependence of the Star Formation Efficiency on Metallicity in Protocluster Forming Regions
10:15 - 10:35	**L. Clifton Johnson** Stellar Clusters in M 31 from PHAT: Survey Overview, Cluster Identification Techniques, and First Results
10:35 - 10:55	**Dan Weisz** The Panchromatic Hubble Andromeda Treasury (PHAT): Characterizing Cluster Properties Through Resolved Stars in M 31
10:55 - 11:30	Coffee Break
11:30 - 12:05	**Simon Goodwin** (Invited) What Gaia could tell us about the formation and early evolution of star clusters
12:05 - 12:25	**Richard de Grijs** Observational and numerical constraints on early star cluster evolution
12:25 - 12:45	**Mark Gieles** Dynamical evolution of star clusters
12:45 - 13:05	**Diederik Kruijssen** The dynamical state of stellar substructure in star-forming regions
13:05 - 13:25	**Christoph Olczak** Dynamics in young star clusters: from planets to massive stars
13:25 - 15:30	Lunch
15:30 - 16:05	**Nate Bastian** (Invited) Disruption and Destruction Mechanisms
16:05 - 16:25	**Wolfgang Brandner** Massive Stellar Content of Starburst Clusters in M 31's giant HII regions
16:25 - 16:45	**Michiel Cottaar** Stellar dynamics of Westerlund 1
16:45 - 17:05	**Izaskun San Román** Unlocking the Formation History of M 33 as Revealed by its Star Clusters
17:05 - 17:30	Coffee Break
17:30 - 18:05	**Sofia Feltzing** (Invited) Spectroscopic & Photometric Surveys
18:05 - 18:25	**Hervé Bouy** DANCE: Dynamical Analysis of Nearby ClustErs
18:25 - 18:45	**Preben Grosbol** A NIR view on young stellar clusters in nearby spirals
18:45 - 19:05	**Jan Pflamm-Altenburg** On the large-scale distribution of massive stars

18 Cluster Systems in Other Galaxies

Sϕren Larsen[1]
[1] Astronomy Institute, University of Utrecht

Abstract

I will review the salient characteristics of cluster populations in other galaxies, with particular emphasis on young star clusters and a comparison with the (known) open cluster population of the Milky Way.
It is now clear that young globular cluster-like objects can still form at the present epoch, even in relatively quiescent spiral discs.
Comparison with other nearby spiral galaxies, like M 83 and NGC 6946, suggests that the Milky Way should host about 20 clusters with masses above 100000 $M_{\odot}$ and ages younger than about 200 Myr. No such clusters have been found, however. I will discuss the important roles of selection and evolutionary effects that may account for many of the apparent differences between cluster populations in different galaxies.

19 Revealing the Chamaeleon: The Epsilon and Eta Cha Associations

Simon Murphy[1]
[1] Research School of Astronomy & Astrophysics, Australian National University

Abstract

The deep southern sky surrounding the Chamaeleon dark clouds is rich in low-mass pre-main sequence stars. Of particular interest to many are the Post T Tauri Stars of ages < 10 Myr, associated with the Eta Cha open cluster and nearby Epsilon Cha association. We have begun a program to better understand these two stellar aggregates, their kinematics and origins. This has initially led to the discovery of the putative low-mass stellar halo surrounding Eta Cha. Such a halo is consistent with a dynamical origin for the current configuration of the cluster, rather than an abnormally top-heavy IMF. From deep photometric and proper motion surveys we are now identifying and characterising many more PTTS in the region between the two clusters. The goal of this work is to break the kinematic degeneracy between the two groups, as well as investigating the disk and accretion properties of ejected halo members, whose dynamical histories should have been much more vigorous than stars in the cluster cores. Like much work in this field, Gaia will revolutionize the study of these two clusters, enabling deeper and more precise kinematic surveys than possible from the ground today.

20 The Dependence of the Star Formation Efficiency on Metallicity in Protocluster Forming Regions

Sami Dib[1]
[1] Imperial College London

Abstract

In this talk, I will describe very recent results which describe the dependence of the star formation efficiency in a protocluster clump on metallicity (Dib et al. http://arxiv.org/abs/1102.3839). The model describes the co-evolution of the mass function of gravitationally bound cores and of the IMF in a protocluster clump. Dense cores are generated uniformly in time at different locations in the clump, and contract over lifetimes that are a few times their free fall times. The cores collapse to form stars that power strong stellar winds (for Mstar $> 5\ M_{\odot}$) whose cumulative kinetic energy evacuates the gas from the clump and quenches further core and star formation. This sets the final star formation efficiency, SFEf. The dependence on metallicity comes from the dependence on metallicity of the stellar winds. Models are run with metallicities in the range $Z/Z_{\odot}$=[0.1,2]. We find that the SFEf decreases strongly with increasing metallicity. The SFEf-metallicity relation is well described by a decaying exponential whose exact parameters depend weakly on the value of the core formation efficiency. I will discuss how the SFEf-metallicity relations depends on the clump mass and the implications of these results for the relationship between the exponent of the mass function of the protocluster clumps and that of the young clusters mass function. I will also discuss how these results can be tested on galactic scales and their implications for cosmic chemical evolution.

21 Stellar Clusters in M 31 from PHAT: Survey Overview, Cluster Identification Techniques, and First Results

L. Clifton Johnson[1]
[1] University of Washington

Abstract

The Panchromatic Hubble Andromeda Treasury (PHAT) is an on-going HST multi-cycle program aimed at mapping the resolved stellar content for one-third of M 31, with wavelength coverage from the ultraviolet through the near-IR. The resultant data will make for one of the largest and most complete catalogs of resolved stellar clusters to date. In this talk, I will provide an overview of the current status of PHAT observations and present preliminary results from the PHAT cluster survey, including derived cluster properties for our year 1 sample and a comparison to previous cluster studies in M 31. Even with only 20% of the data in hand, the sensitivity of HST has allowed us to identify hundreds of new clusters that push well into intermediate and low mass regimes, which were previously only accessible in the Magellanic Clouds and in select, targeted regions of M 31 and M 33. I will conclude by discussing the future science planned using the PHAT cluster dataset.

22 The Panchromatic Hubble Andromeda Treasury (PHAT): Characterizing Cluster Properties Through Resolved Stars in M 31

Dan Weisz[1]
[1] University of Washington

Abstract

The Panchromatic Hubble Andromeda Treasury (PHAT) is an HST multi-cycle program aimed at mapping the resolved stellar populations for a large portion of M 31. We anticipate this program will produce UV through near-IR photometry of more than 100 million resolved stars and at least 1000 stellar clusters. In this talk, I will present first year results based on color-magnitude diagram (CMDs) of stellar clusters from the PHAT program. Some of the highlights include significantly improved methods of crowded field stellar photometry, comparisons with CMDs from previous surveys of M 31, and derived ages and masses of clusters from our multi-wavelength CMDs. In addition, I will compare cluster characteristics derived from resolved stars and integrated light. Finally, I will outline in-progress science programs making use of M 31 stellar clusters including the studies of the cluster and stellar initial mass functions and the effects of stochasticity on observed cluster luminosities.

23 What Gaia could tell us about the formation and early evolution of star clusters

Simon Goodwin[1]
[1] Department of Physics & Astronomy, The University of Sheffield

Abstract

A picture of star formation is emerging in which stars form in a hierarchical distribution and then rapidly dynamically evolve into star clusters and then into associations, or directly into associations. The ability of Gaia to probe the 3D distribution of stars as well as their kinematics will be crucial in determining if this model is correct and the details of past evolution, it will also allow us to probe the differences in the initial conditions of different regions. Gaia will also find and quantify binary and multiple systems which can provide a significant clue to the past dynamical evolution of many regions where initial kinematical information will have been erased.

24 Observational and numerical constraints on early star cluster evolution

Richard de Grijs[1]
[1] Kavli Institute for Astronomy and Astrophysics, Peking University

Abstract

Exciting recent developments in theory and observations call for renewed scrutiny of the early evolution of star clusters spanning a large range of parameter space. First, using a large ensemble of N-body simulations of moderately sized (N=1000), cool, fractal clusters, we find that cool, clumpy clusters dynamically mass segregate on timescales of < 0.5 Myr. This implies that the notion of "primordial mass segregation" may be obsolete. The cluster properties also change rapidly on very short timescales: young clusters may undergo core collapse on timescales of < 1 Myr, when a dense core containing massive stars is hardened because of energy losses to a halo of lower-mass stars. The form of the initial velocity distribution will also affect the degree of mass segregation. If it is radius dependent, the outer parts of a cluster would expand without undergoing collapse. In addition, we use high-resolution Hubble Space Telescope imaging observations of the young ($\sim$ 15-25 Myr) star cluster NGC 1818 in the Large Magellanic Cloud to derive an estimate for the binary fraction of F stars ($1.3 <$ Mstar$/M_{\odot} < 1.6$). Our new study provides the strongest constraints yet on the (close to) initial binary fraction in a low metallicity environment ([Fe/H] = -0.4). We find that our novel artificial-star-test method is sensitive to binaries with mass ratios, $q > 0.4$. For binaries with F-star primaries and mass ratios $q > 0.4$, the binary fraction is 0.35. This suggests a total binary fraction for F stars of 0.55 to unity, depending on assumptions about the form of the mass-ratio distribution at low q, which is consistent with the field and lower-density clusters. This suggests that, at least among intermediate-mass stars, metallicity down to [Fe/H] = -0.4 does not suppress fragmentation and binary formation, and the binarity of these stars is at least as high as at solar metallicity. We therefore strongly argue for inclusion of realistic binary fractions in simulations aimed at following early star cluster evolution.

25 Dynamical evolution of star clusters

Mark Gieles[1]
[1] Institute of Astronomy, University of Cambridge

Abstract

There are several internal and external factors that play a role in the evolution of star clusters. Here we focus on two dominant effects, namely close encounters between stars (relaxation) and mass-loss of the member stars through stellar winds and supernovae explosions. Since the former operates on the relaxation time-scale of the cluster and the latter on the stellar evolution time-scale of the stars it is often assumed that the combined effect is complicated. In this contribution we show that the interplay between stellar evolution and 2-body relaxation is in fact quite simple. The result is an overall expansion of clusters, which is more important for low mass clusters, such that after some time the radii of clusters depend very little on their masses, even if all clusters have the same (surface) density initially. Several predictions are made for the relation between mass, radius, age and galactocentric position that can be compared to empirical cluster samples.

26 The dynamical state of stellar substructure in star-forming regions

Diederik Kruijssen[1]
[1] Astronomical Institute Utrecht

Abstract

The fraction of star formation that results in bound star clusters is influenced by the density spectrum in which stars are formed and by the response of the stellar structure to gas expulsion. In this contribution, I report on an analysis of simulations of turbulent fragmentation in star-forming regions, aiming to assess the dynamical properties of the resulting population of stars and (sub)clusters. When considering only the gravitational potential of the stars and ignoring the gas, we find that the identified subclusters are close to virial equilibrium. This virial state is a consequence of the low gas fractions within the subclusters, caused by gas accretion and the accretion-induced shrinkage of the subclusters. Because the subclusters are gas-poor, up to a length scale of 0.1 - 0.2 pc at the end of the simulation, they are only weakly affected by gas expulsion. We extend this result to star cluster scales, and suggest that the absence of gas indicates that the early disruption of star clusters due to gas expulsion (infant mortality) plays a smaller role than anticipated, and is potentially restricted to star-forming regions with low ambient gas densities. We propose that in dense star-forming regions, the tidal shocking of young star clusters by the surrounding gas clouds could be responsible for the early disruption. This 'cruel cradle effect' would work in addition to disruption by gas expulsion. Observational input from Gaia will be essential to distinguish between and quantify both mechanisms, and I will suggest possible methods through which can be done.

27 Dynamics in young star clusters: from planets to massive stars

Christoph Olczak[1]
[1] Astronomisches Rechen-Institut, Heidelberg University

Abstract

The young star clusters we observe today are the building blocks of a new generation of stars and planets in our Galaxy and beyond. Despite their fundamental role we still lack knowledge about the initial conditions under which star clusters form and the impact of these often harsh environments on the formation and evolution of their stellar and substellar members.
I will demonstrate the vital role numerical simulations play to uncover both key issues. Using dynamical models of different star cluster environments like NGC 2024, the ONC, and NGC 3603, I will show the huge variety of effects stellar interactions potentially have: they can prevent or trigger planet formation, modify the disk structure, affect the stellar multiplicity, and - fortunately - leave characteristic signatures that can be traced observationally.
Moreover, I will present recent results showing that mass segregation in realistic models of young star clusters occurs very quickly even for spherical systems without substructure. This finding is a critical step to resolve the controversial debate on mass segregation in young star clusters and provides strong constraints on their initial conditions.

28 Disruption and Destruction Mechanisms

Nate Bastian[1]
[1] Institute of Astronomy, University of Cambridge

Abstract

I will review the current theories and observations of the destruction of stellar clusters. The focus will be on young systems, where the current dynamical state of the cluster still retains some memory of the initial conditions of star/cluster formation. In particular, I will discuss the current state of the theory of early rapid destruction (i.e. infant mortality) and how this has been affected by confusion over what exactly constitutes a "cluster". Recent observations suggest that clusters are actually formed near dynamical equilibrium in a pure stellar system, meaning that rapid gas removal as little effect on its evolution. Finally, I will discuss the key constraints that Gaia will place on cluster formation, which in turn will inform our theories of cluster disruption.

29 Massive Stellar Content of Starburst Clusters in M 31's giant HII regions

Wolfgang Brandner[1]
[1] Max-Planck-Institute for Astronomy

Abstract

We report on the first set of LBT/LUCIFER observations of the most massive star forming region in the disk of M 31. Compared to the Milky Way, M 31 offers a complete census of star formation regions and starburst cluster, all located at virtually the same distance. The regions under study have been selected to include the most luminous HII regions as well as still partially embedded star forming regions recently revealed by Spitzer. For the first time we are able to establish the massive stellar content, identify young, massive clusters, and study the nature of still partially embedded luminous infrared sources. The M 31 study is a crucial extension of our effort to establish the properties of Milky Way starburst clusters as templates for extragalactic massive star-forming regions.

30 Stellar dynamics of Westerlund 1

Michiel Cottaar[1], **M. R. Meyer**[1], **M. Andersen**[2] **& P. Espinoza**[3]
[1] Institute for Astronomy, ETH Zurich
[2] European Space Agency, RSSD, ESTEC
[3] Steward Observatory, University of Arizona

Abstract

Using high resolution optical spectroscopy (R=45000) we can constrain the dynamical state of Westerlund 1, perhaps the most massive Population I cluster in the Milky Way.
Our goal is to understand whether massive clusters such as Westerlund 1 emerge bound or

whether they will disperse and contribute significantly to the field star population. Further the cluster will serve as a template for young extragalactic star clusters, where the shape of the initial mass function is estimated from the cluster's dynamic mass to light ratio.
We have obtained 64 optical spectra of a sample of 22 stars in Westerlund 1 using the MIKE spectrograph on the Magellan Clay telescope. All of the stars were observed for two or three epochs to allow us to check for the presence of short period equal mass binaries which can substantially affect the observed single epoch velocity dispersion.
We are left with a sample of ten stars, after removing any stars showing a large variability and the early-type stars for which we do not obtain the necessary precision in the radial velocity. We find that these stars are consistent with being drawn from a velocity distribution characterized by a sigma of 2.8 km/s (best estimate) thought to lie between 1.4 and 7.0 km/s with 96% accuracy, compared to estimates from the virial theorem of ~ 5 km/s. We also plan to compare our results with a new HST census of the stellar population using WFC3 (Andersen et al.) allowing us to compare the virial mass with the photometric mass of the cluster.

31 Unlocking the Formation History of M 33 as Revealed by its Star Clusters

Izaskun San Román[1]
[1] University of Florida

Abstract

Star clusters provide a unique and powerful probe useful for studying the star formation histories of galaxies. In particular, the ages and metallicities of star clusters bear the imprint of the galaxy formation process. M 33 is the only nearby late-type spiral galaxy and it provides a notable connection between the cluster populations of earlier-type spirals and the numerous, nearby later-type dwarf galaxies. Therefore, the star cluster system in M 33 is an ideal laboratory for studying the formation and evolution of galaxies as well as star cluster themselves. However, It is only recently that the entire body of M 33 has been searched for star clusters using wide-field CCD images by our group. We have discovered more than 700 star clusters including 160 new confirmed clusters by HST images. We will present photometry, color-magnitude diagrams and structural parameters of the star cluster system in M 33 based on the largest sample to-date. Through the properties of the star clusters in M 33, we will provide relevant information of the star formation history and composition of the galaxy and we will place it within the context of the galaxy formation process.

32 Spectroscopic & Photometric Surveys

Sofia Feltzing[1]
[1] Lund Observatory, Department of Astronomy and Theoretical Physics, Lund University

Abstract

A review of on-going, up-coming, and proposed spectroscopic and photometric surveys of the Milky Way, including Gaia and related surveys. Special attention would be given to the role of open and globular clusters in those surveys and how the surveys can benefit the cluster community.

33 DANCE: Dynamical Analysis of Nearby ClustErs

Hervé Bouy[1]
[1] Centro de Astrobiología (CAB - CSIC)

Abstract

Using multi-epoch, panchromatic wide field surveys, we are conducting a systematic study of the kinematics and dynamics of young nearby associations. Combining ground based data from various observatories and instruments, and our newly developed software, we reach internal accuracies better than 0.5 mas/yr down to I=19, and $\sim$ 5mas/yr down to I=21. Our survey covers several tenth of square degrees in various associations. In the current talk, I will present the results obtained for the Pleiades cluster.

34 A NIR view on young stellar clusters in nearby spirals

Preben Grosbol[1]
[1] European Southern Observatory

Abstract

Visual studies of very young stellar clusters in spiral galaxies are troubled by high, patchy extinction in spiral arms. In near-infrared (NIR) bands, such problems are greatly reduced allowing more complete samples of clusters to be analyzed. Young clusters in 10 nearby, grand-design, spiral galaxies (within 20 Mpc) were identified using deep JHK images obtained with HAWK-I/VLT. With a linear resolution around 50 pc, the distribution of clusters or cluster complexes could be mapped down to an absolute K magnitude of -10.
Current star formation rates of the galaxies were estimated using clusters with ages < 10 Myr based on their NIR colors. The general distribution of the clusters in relation to the spiral structure is discussed. Further, implications on their aging (rate of destruction) are suggested.

35 On the large-scale distribution of massive stars

Jan Pflamm-Altenburg[1]
[1] Argelander Institut für Astronomie

Abstract

Massive stars are believed to form in star clusters but are also found in the Galactic field. Ejections of massive stars from their birth sites due to close encounters between and due to supernova-disruption of multiple-high-mass star systems are thought to be responsible for the presence of high-mass field stars. So far only individual massive-stars have been traced back to their parent star cluster. But it has not been clarified whether the dynamical processes in star clusters can account for both the spatial large-scale distribution and the number frequency of massive field-stars. Here we present first results of dynamical population synthesis models of massive stars on Galaxy-wide scales. These models will serve as a theoretical basis for the upcoming Gaia space mission in order to derive constraints on the birth places of high-mass stars.

WEDNESDAY, May 25^{th}

09:00 - 09:35	**Ignacio Negueruela** (Invited) High-mass stars in young open clusters
09:35 - 09:55	**Iraklis Konstantopoulos** The Star Cluster Populations of Compact Galaxy Groups
09:55 - 10:15	**David James** Large Scale Synoptic Surveys of Southern Open Clusters: DES, LSST and Gyrochronology
10:15 - 10:35	**David Montes** Spectroscopic surveys of possible late-type stars members of stellar kinematic groups
10:35 - 10:55	**Elena Sabbi** NGC 346: Tracing the Evolution of a Super Star Cluster
10:55 - 11:30	Coffee Break
11:30 - 12:05	**David Barrado Navascués** (Invited) Low Mass Stars, Brown Dwarfs and Planetary Mass Objects in Stellar Associations
12:05 - 12:25	**Loredana Spezzi** Probing the mass accretion process in the Large Magellanic Cloud
12:25 - 12:45	**Antonella Vallenari** Clusters in the SMC
12:45 - 13:05	**Janet Drew** Galactic Plane photometric surveys with Halpha
13:05 - 13:25	**Juan Antonio Fernández Ontiveros** Resolving Young Stellar Clusters in the centre of Nearby Galaxies
13:25 - 15:30	Lunch
15:30 - 16:05	**Floor van Leeuwen** (Invited) Towards observational isochrones from star cluster data
16:05 - 16:25	**Carsten Weidner** Do all O stars form in star clusters?
16:25 - 16:45	**Enrique Pérez Montero** On the equivalent effective temperature of the radiation field in massive young star clusters
16:45 - 17:05	**Catarina Alves de Oliveira** Uncovering the substellar population of nearby young clusters
17:05 - 17:30	Coffee Break
17:30 - 19:05	TERTULIA (Chairperson: **Richard de Grijs**) Birth, Evolution and Death of Stellar Clusters

36 High-mass stars in young open clusters

Ignacio Negueruela[1]
[1] Universidad de Alicante

Abstract

The study of high-mass stars and young open clusters is intimately linked. Most massive stars are found in young open clusters, the natural laboratories to investigate their properties. I will provide a personal selection of current topics of research involving massive stars in young open clusters: the possible existence of an upper limit for the mass of a star; the frequency of binarity amongst high-mass stars; the possibility of several evolutionary pathways (driven by binarity or fast rotation); the relative numbers of blue and red supergiants. I will also review the census of massive young clusters, and discuss their potential as laboratories for further studies.

37 The Star Cluster Populations of Compact Galaxy Groups

Iraklis Konstantopoulos[1]
[1] Penn State University

Abstract

Star clusters are becoming increasingly standard as beacons of star formation (SF) in far away (d $<$ 100 Mpc) systems. Be it either that most stars form in associations, or that clusters simply represent a step in the star formation hierarchy, their link to the overall star formation rate makes them ideal probes of the activity in any system. I will be presenting a study of star cluster populations in seven Compact Galaxy Groups (CGs), which we have been using to infer the state of star formation in their parent systems and the Intra-Group Medium between them. Based on a sample of thousands of clusters, young and old, we derive the star formation history of these CGs. Having established clusters as SF indicators, we use them in a variety of ways such as: to disentangle SF from AGN, as well as to trace the heritage and merger history of Early-Type galaxies. The implications of this project are far-reaching and once again stress the importance of refining our understanding of local clusters and associations. This is especially true if we are to use their faraway counterparts as probes of the state and history of extragalactic environments.

38 Large Scale Synoptic Surveys of Southern Open Clusters: DES, LSST and Gyrochronology

David James[1]
[1] CTIO

Abstract

Recent wide-field (one-few degrees) synoptic surveys on moderate aperture telescopes ($<$1 m facilities), using differential photometry methods, have allowed us to populate the period-colour diagrams of open clusters well enough derive to their distant-independent gyrochronology ages.

These surveys however require enormous effort both in terms of telescope time awarded and subsequent data analyses.
With the dawn of new extremely wide-field, long time-baseline, synoptic-survey programs, on large aperture (4 m class and larger) telescopes, such as the Dark Energy Survey (DES) and the Large Synoptic Survey Telescope (LSST), the next generation differential photometry programs will yield incredible numbers of periods for photometric variables in open clusters. We will discuss the strengths and weaknesses of such surveys, as well as the implications for open cluster research in the next decade.

39 Spectroscopic surveys of possible late-type stars members of stellar kinematic groups

David Montes[1]
[1] Universidad Complutense de Madrid

Abstract

This contribution describes our past and ongoing long-term high resolution spectroscopic surveys of FGKM stars. Accurate estimates of fundamental stellar parameters (Teff, log g, metallicity, [Fe/H], and microturbulent velocity), differential abundance analysis (chemical tagging), rotational velocities as well as radial velocities, Lithium abundance and several chromospheric activity indicators allow us to ascribe the stars to different moving groups and to analyze the chromospheric activity/rotation/age relationships in groups of stars with different ages.
Identification of a significant number of late-type members of these young moving groups would be extremely important for a study of the chromospheric and coronal activity and their age evolution, and could lead to a better understanding of star formation history in the solar neighbourhood discerning between field-like stars (associated with dynamical resonances (bar) or spiral structure) and young coeval stars (debris of star-forming aggregates in the disk).

40 NGC 346: Tracing the Evolution of a Super Star Cluster

Elena Sabbi[1]
[1] Space Telescope Science Institute

Abstract

Young super star clusters are rare in the Local Group, and yet they provide important insights on the process of star formation (SF) in nearby starburst and high-redshift interacting galaxies, formation and disruption of globular clusters, and the formation of massive stars. Among these, NGC 346 is the young ($\sim$ 3 Myr) site of the most intense SF in the Small Magellanic Cloud (SMC), as well as one of the most active regions in the Local Group (LG). Optical broad and narrow-band HST images reveals that NGC 346 experienced different regimes of star formation, and is now hosting a rich population of low mass pre-main sequence stars, mainly concentrated in a number of compact sub-clusters. In the youngest ones, we find a puzzling and intriguing deficiency of massive stars, suggestive of an evolution of the initial mass function (IMF) with time, with the youngest subclusters not having had sufficient time to build the more massive stars yet. The combination of optical ($\sim$V and I) and narrow band ($\sim$Halpha) HST data allowed us to identify the fraction of pre-main sequence stars, that are actively accreting material from

their circumstellar disks. We will discuss how the SF has been progressing - in space and time - in NGC 346, and to what extent disks can survive in the UV radiation field of nearby early O-type stars.

41 Low Mass Stars, Brown Dwarfs and Planetary Mass Objects in Stellar Associations

David Barrado Navascués[1]
[1] LAEFF - INTA

Abstract

Although bright, massive stars dominate stellar associations, swarms of low-mass objects can be found in them. However, their formation mechanism/s, properties and evolution are not well understood. I will review the observational results collected during the last years and briefly discuss the Gaia role it might have in this field.

42 Probing the mass accretion process in the Large Magellanic Cloud

Loredana Spezzi[1]
[1] European Space Agency (ESA-ESTEC)

Abstract

The mass accretion rate (Macc) is a key parameter to constrain the models of both star and planet formation, for it affects both the disk structure and evolution as well as planet formation and migration. In particular, Macc studies in low-metallicity environments are particularly important because the probability of a star hosting a planet depends on stellar metallicity.
We have conducted a multi-wavelenght study of four star forming regions, spanning the age 1 - 14 Myr, located between the 30 Doradus complex and the supernova SN 1987 A in the Large Magellanic Cloud (LMC), where the metallicity is much lower than in our Galaxy. We use a novel self-consistent method to reliably identify pre-main sequence (PMS) objects actively undergoing mass accretion, regardless of their age, and estimate their stellar properties and Macc.
This study allowed us to increase by a factor of five the current sample of PMS stars with a measured Macc. We find that, in the mass range 1-2 $M_{\odot}$, Macc increases almost linearly with the stellar mass and decreases with age significantly slower than observed for galactic PMS stars of the same mass. We argue that the peculiar behavior of the mass accretion process in the LMC might be a consequence of its lower metallicity with respect to the Galaxy. We also investigate the effect of disk photo-evaporation due to the UV radiation from nearby OB-type in out fields.

43 Clusters in the SMC

Antonella Vallenari[1]
[1] INAF - Padua Observatory

Abstract

We present and discuss the age distribution of the clusters in the SMC. The degree of grouping as a function of age in the cluster and field population is studied, using the minimum spannig tree algorithm.

44 Galactic Plane photometric surveys with Halpha

Janet Drew[1]
[1] University of Hertfordshire

Abstract

The VST is being commissioned, and VPHAS+ is likely to start taking data, in UGRI and Halpha within the year. Both this survey and its northern counterpart, IPHAS, provide data that can be used to determine stellar reddenings and indeed sightline extinction - distance curves, complementing what can learned from high resolution spectra only. This talk would illustrate these capabilities.

45 Resolving Young Stellar Clusters in the centre of Nearby Galaxies

Juan Antonio Fernández Ontiveros[1]
[1] Max-Planck-Institut für Radioastronomie (MPIfR)

Abstract

Nearby galaxies are perfect laboratories to explore the physics of young stellar clusters (YSCs) in very different environments. Unveiling their dusty nuclear regions with very high-spatial resolution permits us to investigate YSC systems at their earlier stages, when the evolutionary effects are still not very strong. We present a sample of 6 nearby ($\sim$ 17 Mpc) active galaxies observed with VLT/NaCo adaptive optics in the NIR. This set was then completed with similar resolution data in the mid-IR (VLT/VISIR), optical/UV (HST) and radio (VLA), achieving a very consistent spatial resolution of $\sim$ 0.1" ($\sim$ 10 pc) for a very wide spectral range.
We resolve YSC systems within the central parsecs of the galaxies in the sample. They present diverse morphologies, forming starburst rings with $\sim$ 1 kpc diameter, a compact starburst within the inner 500 pc or a sparse distribution within the central few kpc. The youngest systems ($\sim<$ 7 Myr) show a cluster mass function (CMF) following a single power law with an index of about -2, similar to the case of many interacting and starburst galaxies. In contrast, the oldest system (NGC 1097, $\sim$ 10 Myr) presents a bend in the CMF around 2 x 10^5 $M_\odot$, very close to the peak of the mass function for globular clusters in the Milky Way and nearby galaxies. This bend suggests a selective disruption of the less massive clusters in this galaxy.

Finally, we compared the structural properties measured for all the YSCs in the sample of galaxies with those of globular clusters, nuclear clusters and ultracompact dwarf galaxies (UCDs). All these systems present a tight relation in the mass density – mass diagram, suggesting that their origins, although diverse, are connected by similar mechanisms that operate in a very wide range in mass (10^3–10^8 $M_\odot$).

46 Towards observational isochrones from star cluster data

Floor van Leeuwen[1]
[1] Institute of Astronomy, University of Cambridge

Abstract

Gaia observations will in many ways contribute towards obtaining a set of observational isochrones. By measuring high-accuracy parallaxes and proper motions cluster membership as well as distances can be extremely well established. When complemented with high-accuracy photometry and spectroscopy, this gives access to observational isochrones which are detailed for chemical composition and differential ages. Gaia will provide accurate identifications and distances for a few hundred open clusters, as well as a few of the nearby globular clusters. A first glimpse at what we may be able to discover is already provided through the Hipparcos results for open cluster distances.

47 Do all O stars form in star clusters?

Carsten Weidner[1]
[1] University of St Andrews

Abstract

The question whether or not massive stars can form in isolation or only in star clusters is of great importance for the theory of (massive) star-formation as well as for the stellar initial mass function of whole galaxies (IGIMF-theory). While a seemingly easy question it is rather difficult to answer. Several physical processes (e.g. star-loss due to stellar dynamics or gas expulsion) and observational limitations (e.g. dust obscuration of young clusters, resolution) pose severe challenges to answer this question. In the contribution we will present the current arguments in favour and against the idea that all O stars form in clusters.

48 On the equivalent effective temperature of the radiation field in massive young star clusters

Enrique Pérez Montero[1]
[1] Instituto de Astrofísica de Andalucía - CSIC

Abstract

Properties of unresolved massive young star clusters can be derived by means of the analysis of emission-line spectra of their surrounding ionized gas. In this contribution I will deep into

different techniques of determination of the equivalent effective temperature of the ionizing stars using both optical and mid-IR relative collisional emission-line intensities (i.e. the so-called "softness" parameters). Finally, I will show results about the application of these methods in massive star-forming complexes in the disks of nearby spiral galaxies, helping to determine the radial variation of the hardening of the ionizing radiation in these objects and searching for correlations between these variations and other macroscopic properties of the hosting galaxies.

49 Uncovering the substellar population of nearby young clusters

Catarina Alves de Oliveira[1]
[1] Laboratoire d′Astrophysique de Grenoble

Abstract

The origin of the initial mass function is an important problem in star formation theories. In particular, at the substellar regime the formation processes of brown dwarfs are still debated and no agreed paradigm has yet been reached. Numerical simulations of different formation scenarios are now able to predict observable properties of clusters. The new observational frontier is therefore the detection and characterization of very low mass objects and the lower limit of the IMF in star forming regions, which can be confronted with the model predictions. This is the aim of the WIRCam/CFHT survey, from which I will present the results on the study of the young clusters rho Ophiuchi and IC 348. Deep near-IR imaging surveys of both clusters were used to uncover their low-mass population, after which a major spectroscopic follow-up was conducted (using TNG, GTC, NTT, VLT, Gemini) to ascertain their spectral types and masses, and ultimately, to construct the low-mass end of their IMFs.

50 TERTULIA: Birth, Evolution and Death of Stellar Clusters

Richard de Grijs[1]
[1] Kavli Institute for Astronomy and Astrophysics, Peking University

Abstract

Using our recently improved understanding of star cluster physics, we are now within reach of answering a number of fundamental questions in contemporary astrophysics. Does the formation of the highest-mass star clusters need an external trigger? How does the inferred star-formation efficiency (SFE) compare to equivalent values elsewhere in the same or other galaxies undergoing more quiescent star formation? Despite significant recent theoretical and observational progress, the quantitative importance of triggering and the effects of varying SFEs in cluster formation remain major challenges. Star cluster feedback processes are of fundamental importance for our understanding of the overall energetics and evolution of galactic-disc stellar populations. Cluster winds are as yet poorly understood because it is not possible to treat directed outflows self-consistently (while full 3D radiative transport computations are still beyond reach), but their importance for chemical enrichment of the interstellar medium (ISM) is profound. It may be possible, under the right conditions, for the wind to cool sufficiently within the cluster to generate a second stellar generation. Could this perhaps explain the secondary main sequences (or self-enrichment) observed in some globular clusters? New key questions are emerging rapidly:

What are the survival chances of young, embedded star clusters beyond the first $\sim$ 10 Myr, in the disruptive presence of these large-scale outflows? What is the initial distribution of gravitationally bound cluster masses? This is, of course, linked to the conditions (e.g., the interstellar pressure and density) under which bound objects form, which traces back to the issue of whether star clusters form the top of the hierarchy of star formation. This session will address these and other key emerging questions in the field of star cluster and stellar association formation and evolution.

THURSDAY, May 26^{th}

09:00 - 09:35	**Jorge Peñarrubia** (Invited) Star formation, feedback and the assembly of the Milky Way
09:35 - 09:55	**Thomas Peters** Radiative Feedback in Massive Star and Cluster Formation
09:55 - 10:15	**Maria Messineo** Young massive stellar clusters in the Milky Way: GLIMPSE 9 and Cl 1813 - 178 clusters
10:15 - 10:35	**Andrea Stolte** The survival and dissolution of stars clusters in Galactic nuclei
10:35 - 10:55	**Mario Gennaro** Mass segregation and elongation of the starburst cluster Westerlund 1
10:55 - 11:30	Coffee Break
11:30 - 12:05	**Gerry Gilmore** (Invited) Evolution of the Galactic Disks
12:05 - 12:25	**Alessandro Lanzafame** The rotational evolution of solar-like stars close to the zero age main sequence
12:25 - 12:45	**Sergio Simón Díaz** The IACOB spectroscopic database of Galactic OB stars: synergies for the Gaia era
12:45 - 13:05	**Miriam García** The Quest for Blue Massive Stars: AUTOPOP
13:05 - 13:25	**Angela Bragaglia** Open Clusters as tracers of the Galactic disk
13:25 - 15:30	Lunch
15:30 - 16:05	**Ata Sarajedini** (Invited) Structure of the Halo: "Globular Clusters in Local Group Spiral Galaxies"
16:05 - 16:25	**Corinne Charbonnel** Globular clusters - Multiple populations, early evolution, and contribution to the Galactic halo
16:25 - 16:45	**Doug Geisler** The Nine Lives of omega Cen
16:45 - 17:05	**Maren Hempel** The age of Milky Way and Magellanic Cloud globular clusters from integrated photometry
17:05 - 17:30	Coffee Break
17:30 - 19:05	TERTULIA (Chairperson: **Sofia Randich**) Long Term Surveys preparing and following Gaia. What do we need?

51 Star formation, feedback and the assembly of the Milky Way

Jorge Peñarrubia[1]
[1] IoA, University of Cambridge

Abstract

Despite its unique assembly history, the Milky Way contains detailed information on how galaxies form throughout the Universe. In particular, the Milky Way and its satellite galaxies may be key to solve fundamental issues in the current cosmological paradigm such as the 'angular momentum crisis', the 'missing satellite problem' and the 'core/cusp' problem. In this talk I will review recent theoretical and observational results in this area. I will also discuss the relevance that Gaia will have in testing the current cosmological models.

52 Radiative Feedback in Massive Star and Cluster Formation

Thomas Peters[1]
[1] Institut für Theoretische Astrophysik, Universität Heidelberg

Abstract

Understanding the origin of high-mass stars is central to modern astrophysics. We shed light on this problem with simulations using a novel, adaptive-mesh, ray-tracing algorithm. These simulations consistently follow the gravitational collapse of a massive molecular cloud core, the subsequent build-up and fragmentation of the accretion disk surrounding the nascent star, and, for the first time, the interaction between its intense UV radiation field and the infalling material. We show that ionization feedback can neither stop protostellar mass growth nor suppress fragmentation. We discuss the effects of feedback by ionizing and non-ionizing radiation on the evolution of the stellar cluster. The accretion is not limited by radiative feedback but by the formation of low-mass companions in a process we call "fragmentation-induced starvation". This behavior consistently reproduces the observed relation between the most massive star and the total mass of stars in a cluster. We show that magnetic fields reduce the star formation rate and lead to the formation of more massive stars.

53 Young massive stellar clusters in the Milky Way: GLIMPSE 9 and Cl 1813 - 178 clusters.

Maria Messineo[1]
[1] Max-Planck-Institut für Radioastronomie

Abstract

The recent 2MASS and Spitzer/GLIMPSE surveys have revealed over a thousand candidate stellar clusters, which are hiding behind copious amounts of dust and gas in the Galactic plane. By combining multi-wavelength information (near-, mid-infrared, radio and X data), it is possible to characterize new candidate clusters, and to identify massive clusters. Only a dozen massive ($> 10^4$ $M_\odot$) stellar clusters are currently known in the Milky Way.

I will present examples of multi-wavelength analysis of candidate clusters, and unveil their massive stellar content. GLIMPSE 9 and Cl 1813 - 178 are two newly discovered young massive clusters particularly interesting because are the first known to be likely associated with supernovae remnants, and are located in giant molecular clouds rich of HII regions. Preliminary results of new SINFONI data show a widely spread population of massive stars in these clouds.

54 The survival and dissolution of stars clusters in Galactic nuclei

Andrea Stolte[1]
[1] Argelander Institut für Astronomie, Universität Bonn

Abstract

The Arches and Quintuplet clusters are the nearest examples of star clusters forming in the nuclear region of a galaxy, yet outside the influence zone of the supermassive black hole. In the past two years, high-resolution observations enabled the measurement of the clusters orbital motions and internal velocity dispersions. While numerous predictions from numerical simulations exist concerning the disruption of these young, massive star clusters in the tidal field of the inner Galaxy, the measurement of the orbital and internal velocities provides the first indication of the dynamical stage and stability of these clusters from observations. In this contribution, I will present the dynamical results and discuss the implications for the evolution of star clusters in strong tidal fields.

55 Mass segregation and elongation of the starburst cluster Westerlund 1

Mario Gennaro[1]
[1] Max-Planck-Institut für Astronomie, Heidelberg

Abstract

Westerlund 1 (Wd1) is among the most massive young clusters in the Local Group.
I will present an analysis of the properties of Wd1, based on NTT/SofI near-infrared photometry.
>From comparison with stellar models, we derived an extinction $A\_Ks = 0.91 \pm 0.05$ mag, an age $\tau = 4 \pm 0.5$ Myr and a distance d = 4.0 ± 0.2 kpc, as well as a total mass of M_Wd1 = $\sim$ 5 x 10^4 $M_{\odot}$.
Using spatially dependent completeness corrections we performed a 2D study of the cluster's Mass Function (MF) and, in addition, of the stellar density profiles of the cluster as a function of mass. From both MF slope variations and stellar density, we find strong evidence of mass segregation.
We also confirm previous findings on the elongation of Wd1; assuming an elliptical density profile, we found an axis ratio of a:b = 3:2.
Rapid mass segregation and elongation could be well explained as the results of subclusters merging during the formation of Westerlund 1.

56 Evolution of the Galactic Disks

Gerry Gilmore[1]
[1] Institute of Astronomy, Cambridge University

Abstract

Galactic disks are hard to make in popular cosmologies, yet seem very common. I consider some general features of disks which set a context for detailed evolution models. Identifying the dominant physics and processes which lead to extended old disks provides a context in which discussion of more detailed processes can be fit.

57 The rotational evolution of solar-like stars close to the zero age main sequence

Alessandro Lanzafame[1]
[1] University of Catania

Abstract

We investigate the rotational evolution of solar-like stars approaching and evolving from the zero age main sequence (ZAMS). All observed period distributions in open clusters and young associations available to date are considered. The double zone model, in which the star's radiative core and convective envelope are assumed to rotate as solid bodies, is used to test simple relationships between the core-envelope coupling timescale and rotational properties like the envelope angular velocity or the differential rotation at the core-envelope interface. The trial relationships are tested by fitting the model parameters to available observations via a Monte Carlo Markov Chain method. The synthetic distributions are tested for compatibility with their observational counterparts by mean of the Kolmogorov-Smirnov test. A general satisfactory agreement with the observed evolution of rotational periods is found. However, we find it impossible to reconcile the high fraction of fast rotators in alpha Persei with the rotation period distributions in stellar systems at earlier and later evolutionary stages. We discuss possible local environmental effects (e.g. early removal of circumstellar discs due to UV radiation and winds from nearby high-mass stars), basic parameters uncertainties (e.g. ages), model over-simplyfied assumptions, and likely observational biases.

58 The IACOB spectroscopic database of Galactic OB stars: synergies for the Gaia era

Sergio Simón Díaz[1]
[1] Instituto de Astrofísica de Canarias (IAC)

Abstract

The IACOB survey of Galactic OB stars is a long-term observational project aimed at building the largest homogeneous database of high-resolution, high signal-to-noise ratio, multi-epoch, blue-red (3700 - 7000 A) spectra of northern Galactic OB stars compiled up to date. At present,

the IACOB (v2.0) database has 968 spectra of a total of 187 stars stars with spectral types earlier than B2 and luminosity classes ranging from I (Supergiants, Sgs) to V (Dwarfs). The spectra were obtained with the FIES spectrograph attached to the NOT 2.46 m.
The quantitative spectroscopic analysis of this unique database (by means of modern stellar atmosphere codes), complemented by the invaluable information provided by Gaia (regarding photometry and distances), will make it possible to progress more than considerably in our knowledge about the physical characteristics of Galactic massive stars. In addition, results from this analysis (e.g. tailored synthetic spectral energy distributions provided by the stellar atmosphere codes) will be of great interest for other scientific projects using Gaia observations. In this talk I will present the main characteristics of the IACOB v2.0 database and the first scientific results arising from the analysis of the spectra, making special emphasis of those possible synergies between the IACOB and the forthcoming Gaia observations.

59 The Quest for Blue Massive Stars: AUTOPOP

Miriam García[1]
[1] Instituto de Astrofísica de Canarias (IAC)

Abstract

The important role of metallicity in massive star evolution has resulted in a boom of studies of massive stars in Local Group galaxies.
However, exposure times are prohibitive beyond the Magellanic Clouds and more educated target selection criteria than the classical color-based picks are needed.
AUTOPOP is a highly costumizable modular code written to find OB associations and candidate blue massive stars (BMSs) in Local Group galaxies.
The program follows the path linkage criterion to find spatial aggregations in a photometric catalog and then analyzes the color-magnitude diagram (CMD) of the groups.
The interpretation of the association's CMDs and the determination of evolutionary masses for the members, allow a more insightful choice of candidates for spectroscopy and to spot out potential advanced evolutionary stages.
In this talk we present our results on Local Group galaxies, and the application of AUTOPOP to search for obscured clusters in the Milky Way. We also evaluate the success rate of the method to find BMSs.
Finally, we discuss the role of Gaia in the quest of Local Group blue massive stars.

60 Open Clusters as tracers of the Galactic disk

Angela Bragaglia[1]
[1] INAF - Osservatorio Astronomico di Bologna

Abstract

Open clusters are one of the best tracers of the properties of the thin disk of our Galaxy. In the pre-Gaia era, their properties (e.g., age, distance) can be generally measured with better precision than for field disk stars.
Open clusters can then be used to study the formation and evolution of the Galaxy. I will talk about present shortcomings, discuss how Gaia results will be fundamental for the subject, and what can still be done from the ground, in preparation or as follow-up.

61 Structure of the Halo: "Globular Clusters in Local Group Spiral Galaxies"

Ata Sarajedini[1]
[1] Department of Astronomy, University of Florida

Abstract

I will present the latest work on globular clusters in Local Group galaxies. Beginning with the Milky Way and moving on to M 31 and M 33, the properties of the halos of these galaxies will be described within the context of their globular cluster systems.
As defined here, globular clusters are the oldest clusters in a galaxy, and, as such, probe the earliest formation epochs of their parent systems allowing us to compare the onset of star cluster formation in the three Local Group spirals. In addition, we can compare the relation between age and metal abundance for globular clusters in order to track the details of the chemical enrichment history in Local Group spiral galaxies. This will allow us to probe their assembly history as well by comparing with the properties of dwarf galaxies, which are thought to be the building blocks of larger galaxies such as the Milky Way.

62 Globular clusters - Multiple populations, early evolution, and contribution to the Galactic halo

Corinne Charbonnel[1]
[1] CNRS & Geneva Observatory

Abstract

Recent observational studies have revealed the existence of multiple populations in Galactic globular clusters. This has a severe impact on our understanding of the formation and early evolution of these objects, as well as on the estimate of the fraction of Galactic halo stars that may have originated in massive star clusters. In this talk I will discuss various implications of this new paradigm, based on a dynamical and chemical model of globular clusters that successfully reproduces the observed abundance patterns and the multiple populations of stars in these systems assuming chemical enrichment from fast rotating massive stars.

63 The Nine Lives of omega Cen

Doug Geisler[1]
[1] Universidad de Concepción - Chile

Abstract

We present new FLAMES high resolution spectra of a large number of red giant and subgiant branch stars in the unique object omega Cen. We find evidence for 9 different populations in metallicity.

We also show detailed abundances for a wide range of other elements. These allow us to also investigate the ages and age ranges in the different populations. We discuss the chemical evolution in detail.

64 The age of Milky Way and Magellanic Cloud globular clusters from integrated photometry

Maren Hempel[1]
[1] Pontificia Universidad Católica de Chile

Abstract

How old are galaxies? The answer to this question can be given by the prime witnesses to all major star formation events within a given galaxy - the galaxy's globular clusters. With increasing distance the integrated globular cluster colors become the only feasible probe of stellar populations, although the infamous age-metalicity degeneracy of optical broadband colors presents a tremendous obstacle in such globular cluster studies. Customarily, this degeneracy is lifted by adding either a more age or metalicity sensitive color index, e.g. UV or near-infrared, to the previously used optical photometry. However, very few studies have attempted to apply the method of integrated optical and near-infrared colors to globular clusters who's ages are known from different sources, and hence test the methods age resolving power and accuracy. Here we present the first results of our photometric study on Milky Way and Large Magellanic Cloud globular clusters using their integrated photometry to derive their relative ages, and compare the results with previous age estimates (spectroscopic or resolved photometry).

65 TERTULIA: Long Term Surveys preparing and following Gaia. What do we need?

Sofia Randich[1]
[1] INAF / Osservatorio Astrofisico di Arcetri

Abstract

The Gaia mission will provide data that will bring us into a new domain of cluster research. However, full exploitation of those data will require complementary long term surveys to be carried out.
Whilst a few ground-based surveys are already planned, additional ones will likely be necessary. This TERTULIA aims to a comprehensive discussion of what data and surveys will be needed and on what timescales to allow, along with Gaia, significant steps forward in the different fields of cluster astrophysics.

FRIDAY, May 27^{th}

09:00 - 09:35	**Philippe André** (Invited) Herschel results on nearby protostellar clusters and associations
09:35 - 09:55	**Oleg Gnedin** The rise and fall of globular clusters in hierarchical galaxy formation
09:55 - 10:15	**Javier Alonso García** Unveiling the inner Galactic globular cluster system
10:15 - 10:35	**Roberto Capuzzo Dolcetta** The Milky Way nuclear star cluster
10:35 - 10:55	**Nadejda Kaltcheva** Improved distances to several Galactic OB associations
10:55 - 11:30	Coffee Break
11:30 - 11:50	**Aleks Scholz** Substellar Objects in Nearby Young Clusters (SONYC): Towards an Unbiased Census
11:50 - 12:10	**Boyke Rochau** VLT-MAD observations of the young massive cluster Trumpler 14
12:10 - 12:30	**Siegfried Roeser** A deep all-sky census of the Hyades
12:30 - 12:50	**Jinliang Hou** Probing the evolution of Milky Way disk using Guo Shou Jing telescope of China (LAMOST)
12:50 - 13:10	**Carlos Alberto Guerrero Peña** Speckle photometry of close stellar systems in galactic open star clusters
13:10 - 13:30	**Christophe Becker** Dynamical evolution of Eta Chamealeontis

66 Herschel results on nearby protostellar clusters and associations

Philippe André[1]
[1] Laboratoire AIM, CEA/DSM-CNRS-Université Paris Diderot, IRFU/Service d′Astrophysique, C.E. Saclay

Abstract

The Herschel Space Observatory offers a unique opportunity to improve our understanding of the formation process of stellar clusters and associations.
I will summarize the first results from the Gould Belt survey, one of the largest key projects with Herschel. The immediate objective of this Herschel survey is to obtain complete samples of prestellar cores and Class 0 protostars with well characterized luminosity and mass functions in most nearby (d $<$ 500 pc) clouds.
The main scientific goal is to elucidate the physical mechanisms responsible for the formation of prestellar cores out of the diffuse interstellar medium.
Our early findings confirm the existence of a close relationship between the prestellar core mass function (CMF) and the stellar initial mass function (IMF). The Herschel images also reveal a rich network of filaments in every interstellar cloud and suggest an intimate connection between the filamentary structure of the ISM and the formation process of prestellar cores and protostars. Altogether, the Herschel results favor a scenario in which interstellar filaments and prestellar cores represent two fundamental steps in the star formation process: First, large-scale magneto-hydrodynamic turbulence generates a complex web of filaments in the ISM; second, the densest filaments grow and fragment into prestellar cores (and ultimately protostars) via gravitational instability. In this picture, a (proto)stellar cluster forms when a massive filament becomes globally gravitationally unstable and undergoes large-scale collapse.

67 The rise and fall of globular clusters in hierarchical galaxy formation

Oleg Gnedin[1]
[1] University of Michigan

Abstract

Modern hydrodynamic simulations of galaxy formation are able to predict accurately the rates and locations of the assembly of giant molecular clouds in early galaxies. These clouds could host star clusters with the masses and sizes of real globular clusters. I will describe current state-of-the-art simulations aimed at understanding the origin of the cluster mass function and the age and metallicity distributions. Metallicity bimodality appears to be a natural outcome of hierarchical formation and gradually declining fraction of cold gas in galaxies. Globular cluster formation was most prominent at redshifts z $>$ 3, when massive star clusters contributed as much as 20% of all galactic star formation.

68 Unveiling the inner Galactic globular cluster system

Javier Alonso-García[1]
[1] Pontificia Universidad Católica de Chile

Abstract

A serious limitation in the study of the Galactic inner halo and bulge globular clusters has been the existence of large and differential extinction by foreground dust. We have mapped the differential extinction and removed its effects, using a new dereddening technique, in a sample of 25 clusters in the direction of the inner Galaxy, observed in the optical using the Magellan 6.5 m telescope and the Hubble Space Telescope. We have also observed a sample of 33 inner Galactic globular clusters in the framework of the VVV survey that is currently being conducted with the new Vista 4 m telescope, in infrared bands where the extinction is highly reduced. Using these observations we have produced high quality color-magnitude diagrams of these poorly studied clusters that allow us to determine these clusters relative ages, distances and chemistry more accurately and to address important questions about the formation and the evolution of the inner Galaxy.

69 The Milky Way nuclear star cluster

Roberto Capuzzo Dolcetta[1]
[1] Department of Physics, Sapienza, University of Roma, Italy

Abstract

We present how the observed features of the Milky Way nuclear star cluster around the massive black hole at the galactic center can be explained by orbital decay and merging of globular clusters. Masssive globular clusters decay due to dynamical friction and lose energy and angular momentum such to be confined in the central galactic region, where they merge and for a super star cluster showing a central core very similar to what observed in the MW nuclear cluster, whose size shrinks in time due to 2 body relaxation. These results are supported by sophisticated N body simulations, performed with codes running on composite computational platforms, based on CPUs and Graphic Processing Units.

70 Improved distances to several Galactic OB associations

Nadejda Kaltcheva[1]
[1] University of Wisconsin Oshkosh, USA

Abstract

The results of an extensive photometric uvbyβ investigation of OB associations and young open clusters in the fields of Carina, Norma, Lacerta, Collinder 121 and Monoceros are presented. Homogeneous distances of groups and layers of stars in the studied fields are obtained and certain large scale features of the Galactic disc are studied. We discuss the warp of the disc and an age gradient perpendicular to the galactic plane in Carina, the location of the Sagittarius-Carina

arm as delineated by the bright OB stars in the Norma section of the Milky Way, and suggest an association of stars possibly connected to the Monoceros Loop.

71 Substellar Objects in Nearby Young Clusters (SONYC): Towards an Unbiased Census

Aleks Scholz[1]
[1] Dublin Institute for Advanced Studies

Abstract

The origin of the lowest mass free-floating objects - brown dwarfs and planemos - is one of the major unsolved problems in star formation. Establishing a census of young substellar objects is a fundamental prerequisite for distinguishing between competing theoretical scenarios. Such a census allows us to probe the initial mass function (IMF), binary statistics, and properties of accretion disks. Our SONYC (Substellar Objects in Nearby Young Clusters) survey relies on extremely deep wide-field optical and near-infrared imaging from Subaru and VLT, with follow-up spectroscopy, in combination with Spitzer photometry to probe the bottom end of the IMF to unprecedented levels. Here we will present SONYC results for three different regions: NGC 1333 (Scholz et al., 2009, ApJ, 702, 805), rho Ophiuchus (Geers et al., 2011, ApJ, 726, 23) and Chamaeleon-I (Muzic et al., 2011, ApJ, submitted). In NGC 1333, we find evidence for a possible cutoff in the mass function at 10 - 20 $M_{\rm Jup}$. We investigate the benefits and biases of the currently used observing strategies, discuss the completeness of the current brown dwarf census in young clusters, and the implications of our findings for star formation.

72 VLT-MAD observations of the young massive cluster Trumpler 14

Boyke Rochau[1]
[1] Max Planck Institute for Astronomy

Abstract

The Multi-conjugate Adaptive optics Demonstrator is the first multi-conjugate adaptive optics system at the VLT. We present deep observations of the young massive cluster Trumpler 14 revealing the power of MCAO systems by providing significant improvement of the spatial PSF stability compared to single conjugated AO systems. Photometry of our observations of the core of Trumpler 14 reveals a cluster of 1 Myr in age. Hints of still ongoing and continuous star formation over the last 3 Myr are present, suggesting that low intensity star formation might have been going on in the HII region for the past 3 Myr, whereas the massive cluster originated in a more recent starburst-like event. We derived the luminosity function and mass function which appears shallow above 0.55 $M_{\odot}$ with a power law slope of -0.45 $\pm$ 0.19. Towards lower masses it decreases depicting a deficiency in low-mass and very-low-mass stars in the core of Trumpler 14.
We identify the change of the mass function slope at 0.55 $M_{\odot}$, similar to the characteristic mass in the Kroupa-IMF and as observed in other clusters.

73 A deep all-sky census of the Hyades

Siegfried Roeser[1]
[1] ZAH-ARI University of Heidelberg

Abstract

Applying the convergent point method to the data of the PPMXL catalogue, we performed an all-sky census of the Hyades down to masses of about 0.2 $M_\odot$ in a region up to 30 pc from the cluster centre.
We found 724 stellar systems co-moving with the bulk Hyades space velocity, which represent a total mass of 435 $M_\odot$. We discuss the present-day luminosity and mass functions in different areas of the cluster, its 3D spatial structure and the velocity dispersion.

74 Probing the evolution of Milky Way disk using Guo Shou Jing telescope of China (LAMOST)

Jinliang Hou[1]
[1] Shanghai Astronomical Observatory, Chinese Academy of Sciences

Abstract

The Chinese Guo Shou Jing telescope (LAMOST) project is expected to start survey observations in 2012. One of the key programs is the survey of stellar objects for the study of the Galaxy with resolution around R = 2000. We expect to have 5 years Milky Way structure survey, including two parts of the Galactic region: 2.5 million spectra of high Galactic latitude stars to g0 < 20, 5 million low latitude spectra observed during bright moon time reaching J < 16.
The low Galactic latitude sources will be observed at both R = 2000 and R = 5000. And it is divided into two parts: a Galactic anticenter survey with Galactic latitude |b|< 30, and longitude 150 < l < 210; and an extended disk survey that covers as much of the low latitude sky (|b|< 20) as is available from Xinglong Station, north of Beijing.
Here I will mainly report the recent progress in preparing the low latitude extended disk survey, with the first step to survey the disk region of |b| < 5, based on the recent IPHAS catalogue.

75 Speckle photometry of close stellar systems in galactic open star clusters

Carlos Alberto Guerrero Peña[1]
[1] Instituto de Astronomía, UNAM

Abstract

The study of the binary and multiple star population in open clusters represents an important field of research of stellar astrophysics, however, the HR diagram is affected if these stars are not taken into account, since the color dispersion among the stars in the CMD along the Main Sequence, is due in part from a large population of unresolved binary stars. But this problem

cannot be solved by classical photometry because photometry does not have enough space resolution. This problem can be solved with space telescopes like the Hubble Space Telescope or the Gaia ESA space mission, but it is difficult to get time on the HST for this purpose. Another solution to this problem can be based on speckle photometry. In this presentation I will discuss how we can resolve this issue and confirm whether suspected to be binary stars actually are, with the telescopes of the OAN Mexico.

76 Dynamical evolution of Eta Chamealeontis

Christophe Becker[1]
[1] IPAG, Grenoble

Abstract

Eta Chamaeleontis is a remarkable young ($\sim$ 9 Myr) association. It is sparse and compact (18 systems are concentrated in a 1 pc radius), and presents a mass function that is comparable to other rich open clusters in the mass range 0.15 - 4 $M_{\odot}$. However it presents some non standard mass distribution features (deficit of low mass stars and brown dwarfs, lack of wide binaries, mass segregation).
Moraux et al. (2007) performed N-body simulations and found that these properties can result from dynamical evolution, when starting with a "universal" log-normal IMF but a very compact configuration.
In this talk, we report last results of N-body numerical simulations of the early dynamical evolution of Eta-Cha. More realistic initial conditions taking into account the presence of primordial binaries, using different mass-ratio distributions, as well as cluster substructures and/or subvirial conditions have been tested.

Part III

Poster Contributions (in author's alphabetical order)

III.1 List of poster contributions (in author's alphabetical order)

- **Angela Adamo**
  Young star clusters as powerful tool to constraint the host environment
- **Richard Allison**
  The dynamical evolution of structure in young star forming groups
- **Fco. Javier Alonso-Floriano**
  An Aladin-based search for proper-motion companions to young stars in the Local Association, Tucana-Horologium, and beta Pictori
- **Lola Balaguer Núñez**
  Studies on the Corona of the open cluster M 67
- **Katia Biazzo**
  Elemental abundances of low-mass stars in star-forming regions
- **Ronny Blomme**
  Finding early-type stars in the Gaia catalogue
- **Jerome Bouvier**
  The rotational evolution of solar-type stars in young open clusters
- **Annalisa Calamida**
  Multiple stellar populations in omega Centauri
- **Annalisa Calamida**
  Star forming regions in the Milky Way and the LMC observed with the E-ELT
- **Clara Cortijo Ferrero**
  Stellar clusters in LIRGs: IC 1623 and NGC 2623
- **Jos de Bruijne**
  Gaia's view of open clusters
- **Carlos González Fernández**
  The Red Super Giant complex in the inner Milky Way: a recent bar-driven starbust?
- **Marco Grossi**
  Young stellar clusters and associations in M 33
- **Patrick Guillout**
  Mining the sky for TW Hya analogs
- **Maryam Habibi**
  The extinction map of the Arches starburst cluster in the Galactic center
- **Narae Hwang**
  The Nature of Extended Star Clusters in the Dwarf Galaxy NGC 6822
- **David James**
  Lithium Depletion and Mass Segregation in the Disk Crossing Cluster Blanco 1
- **Evrim Kiran**
  The First Multi - Color Photometry of Three ASCC Clusters
- **Nadejda Kaltcheva**
  Galactic Structure Toward the Carina Tangent

- **Alexis Klutsch**
  A sparse populations of juvenile stars towards the CO Cepheus void
- **Amparo Marco**
  Evidence for triggered star formation in the open cluster Stock 8
- **Maria Monguió**
  Connecting the Perseus arm stellar overdensity and the stellar clusters in the anticenter direction
- **Valeri Orlov**
  Speckle Photometry at Telescopes of Observatorio Astronómico Nacional
- **Celeste Parisi**
  New Old Clusters in the SMC
- **Richard Parker**
  The Effect of Dynamical Evolution on Planets in Clusters
- **Dawn Peterson**
  The Role of Environment in Star Formation: Young Clusters Forming in Isolation
- **Roberto Raddi**
  Distant clusters from Be star identifications
- **Maddalena Reggiani**
  An HST study of the age distribution of the Orion Nebula Cluster
- **Carlos Román Zúñiga**
  A distributed population in the outskirts of W3 OH
- **Jacob Simones**
  Stellar Clusters in M31 from the Panchromatic Hubble Andromeda Treasury (PHAT): Comparing Young Cluster Properties using Halpha, UV, and Resolved Stars
- **Rodolfo Smiljanic**
  Using open clusters to study mixing in low- and intermediate-mass stars
- **Alfredo Sota Ballano**
  The Galactic O-Star Spectroscopic Survey (GOSSS). First results: A new O-Type classification atlas.
- **Hugo Tabernero**
  Chemical Tagging of Stellar Kinematic Groups
- **Belén Vicente**
  Kinematical determination of the luminosity function in the solar neighborhood
- **José Manuel Vílchez**
  A detailled 2D spectroscopic study of the central region of NGC 5253
- **Clare Worley**
  The AMBRE Project: Looking for stellar clusters in FEROS Archived Spectra
- **Miaomiao Zhang**
  The proper motions of molecular hydrogen outflows in rho Ophiuchi molecular cloud
- **María Rosa Zapatero Osorio**
  Near-infrared linear polarization of cool dwarfs

III.2 Posters Abstracts

1 Young star clusters as powerful tool to constraint the host environment

Angela Adamo[1]
[1] Stockholm University

Abstract

Because massive star clusters seem to be a rather common product of the star-forming galaxies, their properties can be used to study the formation history of their host systems. It has been observed that galaxy mergers produce more numerous and more massive clusters than quiescent spirals (Larsen 2009). Observed empirical relations between the properties of massive young star clusters (luminosity or cluster formation efficiency) and the star formation rate (SFR) in the host support such a scenario. I applied these cluster-host relations to the cluster populations of blue compact galaxies (BCGs). These galaxies are metal-poor actively star-forming systems, characterised by bright ultraviolet and blue luminosities. They show recently increased SFRs and a high fraction of massive clusters, probably as a result of minor/major merger events. I looked for analogies/differences between their environment and more massive star-forming spirals or merging systems like LIRGs and the Antennae. BCGs still follow the trend of the cluster-host relations, even though they have much higher SFR surface densities. The trend suggests that a higher SFR in BCGs enables the formation of more massive (luminous) clusters than in quiescent spiral galaxies. The cluster formation efficiency (i.e., the fraction of star formation happening in star clusters) in BCGs is higher than the reported 8 - 10 % found from quiescent spirals and dwarf starburst galaxies by Bastian (2008). BCGs have cluster formation efficiency comparable to luminous IR galaxies and spiral starburst nuclei (the averaged value is $\sim$ 30 %), suggesting an important role of the merger event in the cluster formation.

2 The dynamical evolution of structure in young star forming groups

Richard Allison[1]
[1] University of Sheffield / ITA Heidelberg

Abstract

I present dynamical simulations of the evolution of initially substructured star forming groups, and investigate the effect of the initial viral ratio on the evolution of the cluster.

3 An Aladin-based search for proper-motion companions to young stars in the Local Association, Tucana-Horologium, and beta Pictori

Francisco Javier Alonso-Floriano[1]
[1] Universidad Complutense de Madrid (UCM)

Abstract

We have used Virtual Aladin tools, such as Aladin, to look for new common proper-motion pairs, in three stellar kinematic groups: Local Association (LA), Tucana-Horologium (Tuc-Hor) and beta Pictoris (β Pic). The LA is a group formed by stars that originated from the same cloud complex only 10 - 120 Myr ago. Tuc-Hor and β Pic are subgroups of the LA formed by stars of 30 and 10 Myr respectively. We have found 11 known common proper-motion pairs and 9 new common proper-motion companions to the 210 investigated stars. With the CAFOS instrument at the 2.2 m Calar Alto telescope, we have investigated in detail the HD 143809 AB system, wich is formed by a G0V primary star and a previously unknown young M1.0 - 1.5 dwarf.

4 Studies on the Corona of the open cluster M 67

Lola Balaguer Núñez[1]
[1] Universitat de Barcelona. ICC-UB. IEEC.

Abstract

The systematic study of selected open clusters by our team lead to the production of the best set of Strömgren photometry ever obtained of the old open cluster M 67.
The previous astrometric study of the area has now been extended with the Meridian Circle of San Fernando CMASF at El Leoncito (Argentina) to derive properties of stars fainter than our previous survey and covering a wider area in the cluster region. The new data has yield proper motions and a new membership study of the cluster lead us to a complete study of its structure. We derive structural parameters and discuss the spatial dependance of the luminosity and mass functions. We analyzed the spatial distribution of mass functions and the cluster mass segregation.
In addition, we have 81 medium dispersion spectra of the corona area taken using the PMAS/PPAK spectrograph at 3.5 m telescope in Calar Alto and we have performed further wide-field photometry of the area (2007, 2008 and 2009 runs) to perform a detailed analysis of variability.
All these data give some more information about the overdensity of more than 60 stars detected in the HR diagram, located below the cluster main sequence.

5 Elemental abundances of low-mass stars in star-forming regions

Katia Biazzo[1]
[1] Capodimonte Astronomical Observatory

Abstract

Abundance measurements in nearby star-forming regions and young associations are powerful tools to investigate several topics. In particular, they help us to study the star-forming history in the solar vicinity, to investigate the formation scenarios, and to unveil possible chemical enrichment due to supernovae explosions. Moreover, considering the metallicity-giant planet connection, the detection of nearby metal-rich SFRs could provide preferential targets for future planet searches around young stars.
In the last ten years, a large observational effort for measuring elemental abundances in star-forming regions was done, but the available measurements often yield contradictory results. Thanks to new accurate and homogeneous abundance measurements of low-mass stars some issues have been disentangled, but more observations are needed.
In this talk, I will introduce the work done so far in abundance measurements of young stars in star-forming regions, the open questions, and future perspectives.

6 Finding early-type stars in the Gaia catalogue

Ronny Blomme[1]
[1] Royal Observatory of Belgium

Abstract

Photometric data, such as will be provided by the Gaia satellite, have a degeneracy between effective temperature and interstellar extinction (Bailer-Jones, 2011). This degeneracy becomes worse at higher temperatures. It will therefore be difficult to distinguish the early-type stars in the future Gaia catalogue. We explore how the use of complementary data can help break this degeneracy.

7 The rotational evolution of solar-type stars in young open clusters

Jerome Bouvier[1]
[1] IPAG

Abstract

I will present the latest observations of rotational period distributions derived for solar-type and lower-mass stars in young open clusters. I will compare these observational results to the predictions of angular momentum evolution models and discuss the implications on the major physical processes that drive the rotational evolution of low mass stars from their birth to the end of the main sequence.

8 Multiple stellar populations in omega Centauri

Annalisa Calamida[1]
[1] OAR - INAF

Abstract

We present near-infrared (NIR) JK-band deep data collected with the new camera NEWFIRM at the CTIO telescope for the Galactic Globular Cluster omega Centauri. These data cover a field of view of $\sim$ 30x30 arcmin centered on the cluster and we cross-correlated them with our UBVI-band photometry collected with the Wide Field camera at the 2.2 m ESO telescope. The huge temperature sensitivity of the optical-NIR color planes, and the comparison with theory, allows us to disentangle in age and metallicity the different stellar populations present in the cluster. Moreover, the match with ACS/HST photometry covering the center of omega Centauri, enables us to verify the presence of population gradients.

9 Star forming regions in the Milky Way and the LMC observed with the E-ELT

Annalisa Calamida[1]
[1] OAR - INAF

Abstract

We present the results of near-infrared (NIR) imaging and spectroscopic simulations of young star forming regions of the Milky Way and the LMC observed with E-ELT. The simulated JHK-band images of a star forming region in the LMC show that we will be able to obtain nearly complete sample of young brown dwarfs above the deuterium burning limit (M > 13 $M_{\rm Jup}$) and to detect giant-planet-mass objects under favourable conditions.
The optical-NIR simulated spectra show that in spite of the assumed non-optimal atmosphere conditions and the limited exposure time (< 2 h) given to the object rotation, we will be able to distinguish between giant-planet mass objects with the same effective temperature but different surface gravity down to Teff $\sim$ 1000 K in close Galactic star forming regions (d < 150 pc).

10 Stellar clusters in LIRGs: IC 1623 and NGC 2623

Clara Cortijo Ferrero[1]
[1] Instituto de Astrofísica de Andalucía - CSIC

Abstract

We present the analysis of multiwavelenght imaging data from Hubble Space Telescope (STIS, ACS and NICMOS) for the z = 0.02 merging system IC 1623. IC 1623 is a very Luminous Infrared system, log(L_IR/Lsum) = 11.65, being the west component very bright at ultraviolet wavelength too.
The images show that the merging system is composed of two galaxies. The western component is very bright in the UV and optical, while the eastern one is very bright in the infrared. The

west galaxy shows properties very similar to the cosmological Lyman Break galaxies, and it can be considered as the nearest Lyman Break Analog. We have identified the stellar clusters in the HST images, and the colours indicate that there are two different types of clusters: those located in the UV bright galaxy which have ages between 1 - 10 Myr and are little affected by extinction 0 Ã 1 mag, and those located in the IR bright galaxy with ages up to 1 Gyr and 2 - 3 magnitudes of extinction. The masses of the clusters span a range between 10^6 and 10^8 $M_\odot$. Additionally, we have started the photometric stellar clusters analysis for other LIRGs, as NGC 2623, using their HST images.

11 Gaia's view of open clusters

Jos de Bruijne[1]
[1] ESA-ESTEC

Abstract

We investigate the potential of Gaia to observe open clusters based on the performance of the on-board object detection algorithm. We simulate dense stellar environments including realistic, patchy backgrounds representative of star-forming regions and investigate, for various cluster distances, which stars will be detected and observed by Gaia.

12 The Red Super Giant complex in the inner Milky Way: a recent bar-driven starbust?

Carlos González Fernández[1]
[1] Universidad de Alicante

Abstract

Over the past few years, several clusters rich in red supergiants and stellar formation complexes, totaling near 10^6 $M_\odot$, have been found in the in-plane region spanning from l = 24 to l = 31, an area of the Galaxy associated with the end of the long bar.
Whether the driver of their formation is the influence of this structure in the inner disk or is just a projection effect (as at these latitudes the line of sight is tangent to the molecular ring/Scutum-Crux arm), the characterization of these clusters will improve -if not change- our knowledge of the overall structure of the Milky Way.
In this poster we offer a review of the discoveries of these clusters, the problems associated with their characterization and the research efforts that our group is developing in order to tackle them.

13 Young stellar clusters and associations in M 33

Marco Grossi[1]
[1] CAAUL

Abstract

We analyze multi-wavelength observations of 32 young star clusters and associations in M 33 with known oxygen abundance ($8 < 12 + \log(O/H) < 8.7$). The data set includes ultraviolet (UV), optical, mid-infrared (MIR), CO (1-0) and 21-cm line (Hi) observations. We derive the spectral energy distribution (SED) of these systems and the properties of their gaseous environment to investigate the process of star formation and the interplay with the interstellar medium (ISM). We determine age, bolometric luminosities, masses, and the extinction by comparing the multi-band integrated photometry to single-age stellar population models.

14 Mining the sky for TW Hya analogs

Patrick Guillout[1]
[1] Observatoire Astronomique de Strasbourg

Abstract

Accreting young stars whose origin cannot be unmistakably linked to standard stellar birth places are extremely rare and also challenging candidates for the commonly accepted theory of stellar formation. They may help to shed new lights on atypical formation processes of stars and planets in low-mass clouds. We present preliminary results of high-resolution spectroscopic observations conducted on 13 "isolated" active stars showing strong near- and far-infrared excess that could be due to circumstellar discs.

15 The extinction map of the Arches starburst cluster in the Galactic center

Maryam Habibi[1]
[1] University of Bonn

Abstract

The Galactic center is the most active site of star formation in the Milky Way Galaxy, where particularly high-mass stars have formed very recently and are still forming today. The Arches cluster is a young, massive starburst cluster, near the Galactic center.
>From wide field JHK imaging we derive the extinction map of the region.
We are analyzing 2 epochs of K band images of the Arches cluster obtained by NACO's adaptive optics system in order to obtain proper motion membership and derive the density map of the cluster.
In the poster, we will present a first analysis of the distribution of cluster members in the wider area around the cluster core. These data will ultimately allow us to derive the large scale

properties of the Arches cluster, such as the total cluster mass, the true extent and the initial mass function.

16 The Nature of Extended Star Clusters in the Dwarf Galaxy NGC 6822

Narae Hwang[1]
[1] National Astronomical Observatory of Japan

Abstract

Recently new types of objects linking globular clusters (GCs) and dwarf galaxies are being discovered: GCs with multiple stellar populations, extended star clusters (ESCs) much larger than typical GCs, faint fuzzy clusters, wandering GCs, ultra-faint dSphs (UFDs), and ultra-compact dwarf galaxies (UCDs). The origin and nature of these objects must be closely related with the evolution of their host galaxies. However, we are still far from understanding what they are and how they formed.
>From CFHT/Megacam imaging we discovered four old ESCs in the remote halo of NGC 6822. They are much larger than known GCs in NGC 6822, an isolated dwarf irregular galaxy with an intriguing complex structure in the Local Group. These clusters are the nearest among the known ESCs, enabling us to obtain the most detailed photometry of individual stars in ESCs. We present the photometric properties of these ESCs and discuss their possible origin in the context of complex stellar structure of a small dwarf galaxy NGC 6822. We also discuss the current status of observational and theoretical understandings regarding the origin of ESCs and their possible connection to other objects such as GCs and UCDs.

17 Lithium Depletion and Mass Segregation in the Disk Crossing Cluster Blanco 1

David James[1]
[1] CTIO

Abstract

We present the results of an extensive multi-field, multi-epoch photometric and spectroscopic survey of the Pleiades-age open cluster Blanco 1. In concert with our recent lithium depletion boundary work, we present lithium abundances for the higher mass G and K stars, investigating both its absolute mass-dependent lithium depletion as well as the spread in abundance among its solar-type stars.
Given the completeness of our sample for all proper motion selected objects (down to $V < 16$), we investigate the effects of mass segregation in this young cluster, which are especially interesting as its kinematics suggest a Galactic disk-crossing past.

18 The First Multi - Color Photometry of Three ASCC Clusters

Evrim Kiran[1]
[1] Ege University

Abstract

In this work, we present the first comprehensive photometry of the three open cluster (ASCC 31, 111 and 112) listed in the open clusters catalogue published by Kharchenko et al. (2005b). Plotting the data in color-magnitude and color-color diagrams, and using the main sequence fitting method we estimated the distance modules of 9.3, 10.62 and 9.7 and the distances 724, 1330 and 871 pc for ASCC 31, ASCC 111 and ASCC 112 clusters, respectively. Using theoretical isochrones taken from related literature (e.g. Charbonnel et al. 1999 and references therein) we computed the ages as follows; in the order mentioned above log (t) = 9.14, 6.09 and 8.00 of these open clusters.

19 Galactic Structure Toward the Carina Tangent

Nadejda Kaltcheva[1]
[1] University of Wisconsin Oshkosh USA & V. Golev, University of Sofia, Bulgaria

Abstract

This investigation presents a photometric study of the structure toward the Carina tangent of the Milky Way. The field is located between 280° and 286° galactic longitude and -4° to 4° galactic latitude. All currently available uvbyβ data is used to obtain homogeneous color excesses and distances for more than 260 stars of spectral types O to G. We present revised distances and average extinction for the open clusters and cluster candidates NGC 3293, NGC 3114, Loden 46 and Loden 112. We found OB stars at the same distance as Loden 112 and, based on their proper motions, suggest a group of early B-type stars that could represent a new OB association. Based on BV photometry and spectral classification of 15 O-type stars in the very young open cluster Wd2, we provide a new distance estimate of 14.13 ± 0.16 (s.e.) (6700 pc), in excellent agreement with recent distance determination to the giant molecular structures in this direction.

20 A sparse populations of juvenile stars towards the CO Cepheus void

Alexis Klutsch[1]
[1] Universidad Complutense de Madrid (UCM)

Abstract

Once mixed in the ambient galactic plane stellar population, young stars are virtually indiscernible because neither their global photometric properties nor the presence of nearby gas can help to disentangle them from older ones. Nevertheless, the study of the RasTyc sample revealed 4 lithium-rich field stars displaying the same space motion, which are located within a few degrees from each other on the celestial sphere near the Cepheus-Cassiopeia complex and

at a similar distance from the Sun. Both physical and kinematical indicators show that all these stars are young, with ages in the range 10 - 30 Myr. Using multivariate analysis methods, we selected optical counterparts of ROSAT All-Sky Survey / XMM-Newton X-ray sources cross-identified with late-type stars around these young stars. Recent spectroscopic observations of this sample allowed us to discover additional lithium-rich sources. Our preliminary results showed that some of them share the same space motion as the 4 young comoving stars. They have properties rather similar to the members of the TW Hydrae association, although they seem to be slightly older and are located in the northern hemisphere. Nearby young stars in the field are of great importance to understand the recent local history of star formation.

21 Evidence for triggered star formation in the open cluster Stock 8

Amparo Marco[1]
[1] Universidad de Alicante

Abstract

We present a deep study of the area surrounding the open cluster Stock 8, consisting of infrared photometry of the cluster area, wide area Strömgren photometry of its surroundings and spectroscopy of OB stars. Stock 8 seems to be emerging from its parental cloud, with a significant fraction of the stars still embedded. The most massive stars have spectral types B0 - 1. The geometry of the region suggests triggering by nearby O type stars. We study the connection of other small clusters in the neighbourhood with this main star-forming group.

22 Connecting the Perseus arm stellar overdensity and the stellar clusters in the anticenter direction

Maria Monguió[1]
[1] Universitat de Barcelona

Abstract

The cartography and dynamics of the outer spiral structure of the Milky Way is still highly controversial. A deep Strömgren photometric survey in the anticenter direction (INT-WFC) is being carried out to determine the overdensity associated to the Perseus arm. Good photometric distances are now available for thousands of B5 - A3 stars to quantify the radial distribution of this massive stellar component. Furthermore, accurate interstellar extinction distribution allows us to investigate the presence of the dust layer associated to the arm. All this new data will be combined with the cartography of the young clusters distribution on the second and third galactic quadrants to discuss the response of each stellar component to the density way perturbation.

23 Speckle Photometry at Telescopes of Observatorio Astronómico Nacional

Valeri Orlov[1]

[1] Instituto de Astronomía, Universidad Nacional Autónoma de México (IA-UNAM)

Abstract

The OAN is a facility of the Instituto de Astronomía of the Universidad Nacional Autónoma de México (IA-UNAM). There are two astronomical sites where the four telescopes are mounted: one site is located at San Pedro Mártir (OAN-SPM), Baja California, and the second one at Tonantzintla (OAN-T), near Puebla, Mexico. These telescopes can be effectively used for speckle photometric measurements of multiple star systems to the Rayleigh resolution limit R = 1.22 λ/D. Regular speckle interferometric measurements of binary stars have been made with telescopes of the OAN since 2008. In 2011 we start speckle photometric measurements in three colors (VRI).

24 New Old Clusters in the SMC

M. Celeste Parisi[1], **D. Geisler**[2], **A. J. Grocholski**[3], **J. J. Clariá**[1], **G. Carraro**[4], **E. Costa**[5], **A. E. Piatti**[6], **A. Sarajedini**[7] **& R. Leiton**[8]

[1] Observatorio Astronómico de Córdoba - Argentina

[2] Universidad de Concepción - Chile

[3] Yale University - USA

[4] European Southern Observatory - Chile

[5] Universidad de Chile - Chile

[6] Instituto de Astronomía y Física del Espacio - Argentina

[7] University of Florida - USA

[8] Universidad de Concepción - Chile, Université Paris - France

Abstract

Using Ca triplet spectroscopy and *PSF* photometry performed on data taken with the "Very Large Telescope" (Chile), we derived metallicities and ages of fifteen SMC star clusters. We found three of the sample to have ages and metallicities comparable to that of NGC 121, the only currently known "old" (Galactic globular cluster -aged) cluster in the SMC. These clusters add greatly to our knowledge of the chemical evolution of this galaxy during the earliest epochs. We discuss the age-metallicity relation and metallicity gradient based on our data.

25 The Effect of Dynamical Evolution on Planets in Clusters

Richard Parker[1]
[1] ETH Zurich, Switzerland

Abstract

The birth place for the majority of stars is in stellar clusters. Presumably, planet formation must therefore be occurring in clusters and associations. In dense environments, dynamical interactions may disrupt young planetary systems; either via direct liberation of planets from their host stars, or via secondary processes such as the Kozai mechanism. I will present the results of N-body simulations of open clusters in which I investigate both processes and discuss their implications.

26 The Role of Environment in Star Formation: Young Clusters Forming in Isolation

Dawn Peterson[1]
[1] Harvard-Smithsonian Center for Astrophysics

Abstract

We present preliminary results from a study of a large sample of Bok globules that have been observed with the NASA Spitzer Space Telescope. We identify and classify young stellar objects using Spitzer and near-infrared 2MASS photometry, and will present the ratio of Class I to Class II YSOs in each of the regions. In addition, near-infrared extinction maps will be presented. The stellar populations will be used, along with the known gas masses of these clouds to estimate the fraction of the gas from a molecular cloud that typically ends up as stars. The initial conditions for the formation of a single star, binary or cluster of stars can be constrained, and with an estimate of the age from theoretical models, the time it takes a star (or a cluster of stars) to form can also be constrained, as well as the timescales for the various evolutionary states. Bok globules are unique because they are simple environments, free from the confusing effects of winds and external turbulence that are often seen in young clusters embedded within larger, star-forming complexes. As part of our study, we will compare these simple structures, which span a wide range of evolutionary states, with more complex bright-rimmed clouds, which are strongly influenced by nearby O and B stars, ultimately studying the role of environment in star formation.

27 Distant clusters from Be star identifications

Roberto Raddi[1]
[1] CAR/STRI, University of Hertfordshire

Abstract

Follow up spectroscopy of candidate emission line stars from the Witham et al (2008, MNRAS, 384, 1277) catalogue is confirming a large sample of fainter ($13 < r < 17$) classical Be stars

across the Galactic disk in the northern hemisphere. We are examining the environments of a sample of ~ 70 of these stars in the direction of the Perseus Arm in the 2^{nd} Galactic quadrant for evidence of the clusters they might be located within. The distances of these objects place them within the Perseus Arm for the nearest examples, but they range out to Galacto-centric radii as large as ~ 13 kpc. This search has the potential to probe the outer disk, looking for evidence of recent start formation, out to ~ 20 kpc.

28 An HST study of the age distribution of the Orion Nebula Cluster

Maddalena Reggiani[1]
[1] Swiss Federal Institute of Technology (ETH)

Abstract

We present a study of the distribution of stellar ages in the Orion Nebula Cluster (ONC) based on accurate HST photometry taken from the HST Treasury Program observations of the ONC utilizing the most recent estimate of the cluster's distance (Menten et al. 2007). The distribution of sources in the HR-diagram is compared with different theoretical isochrones to estimate the mean cluster age and age dispersion. According to Siess et al. (2000) evolutionary models the mean age of the Cluster is 2.2 Myr with a scatter of few Myr. We perform Monte Carlo simulations to disentangle the cluster evolutionary history from observational uncertainties. The observed age spread appears to be inconsistent with a coeval stellar population, but is consistent with star formation activity between 2 and 3.5 Myr.

29 A distributed population in the outskirts of W3 OH

Carlos Román Zúñiga[1]
[1] Instituto de Astronomía, Sede Ensenada, Universidad Nacional Autónoma de México

Abstract

The W3 molecular cloud is a region of massive star formation with 3 distinct cluster populations. Deep near-infrared observations of the region southeast of W3 OH may indicate the presence of of a low surface density component which could not be coeval with the W3 OH clusters. We discuss the plausibility of a distributed population in W3.

30 Stellar Clusters in M 31 from the Panchromatic Hubble Andromeda Treasury (PHAT): Comparing Young Cluster Properties using Halpha, UV, and Resolved Stars

Jacob Simones[1]
[1] University of Minnesota

Abstract

The Panchromatic Hubble Andromeda Treasury (PHAT) offers a rich set of multi-wavelength HST imaging (UV through near-IR) with which to study the resolved populations of stellar clusters in M 31. We compare various properties (e.g. age) of young clusters as derived from PHAT data to those from ancillary data sets, including integrated ultraviolet and Halpha fluxes from GALEX and the Local Group Survey, respectively. We use a color-magnitude diagram fitting technique to determine the ages and masses for a sample of young clusters. In conjunction with spectral synthesis models, the ages and masses derived from CMD analysis lead to estimates of the total integrated light for each cluster, which we compare directly to the ancillary observations.

31 Using open clusters to study mixing in low- and intermediate-mass stars

Rodolfo Smiljanic[1]
[1] ESO - Germany

Abstract

It is well established that standard evolutionary models (where mixing is driven only by convection) fail to reproduce most of the observed variations of the abundances of light elements in the atmospheres of low- and intermediate-mass stars. Work is still ongoing on both the observational and the modeling sides to properly constrain and explain the mixing properties and the physical processes taking place in these stars. In this sense, open clusters are ideal as they are composed of stars with the same age and chemical composition and, moreover, the stellar masses can be well determined. Abundances of many light elements (Li, Be, C, N, O and Na) can be used to probe mixing events. In this work, I discuss the mixing along the evolutionary sequence of open clusters from an observational point of view. Results are presented for young stars that just arrived on the zero age main sequence, for turn-off stars showing the Li(Be)-dip, and for red- and clump-giants. Abundances of the light elements listed above in these stars show how, and in which phases, there are indications of the existence of extra- or less efficient mixing processes.

32 The Galactic O-Star Spectroscopic Survey (GOSSS). First results: A new O-Type classification atlas.

Sota Ballano, Alfredo[1], Maíz Apellániz, Jesús[1], Barbá, Rodolfo H.[2], Walborn, Nolan R.[3], Alfaro Navarro, Emilio J.[1], Gamen, Roberto C.[4], Morrell, Nidia I.[5], Arias, Julia I.[2] & Penadés Ordaz, Miguel[1]

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[5] Las Campanas Observatory, Observatories of the Carnegie Institution of Washington, La Serena, Chile

Abstract

The Galactic O-Star Spectroscopic Survey (GOSSS) is a project that is observing all known Galactic O stars with B < 13 (~ 2000 objects) in the blue-violet part of the spectrum with R ~ 2500. It is based on v2.0 of the Galactic O star catalog (v1, Maíz Apellániz et al. 2004; v2, Sota et al. 2008). We have completed the first part of the main project. Here we present a new O-type classification atlas, which supersedes previous versions.

33 Chemical Tagging of Stellar Kinematic Groups

Hugo Tabernero[1]

[1] Universidad Complutense de Madrid (UCM)

Abstract

Stellar Kinematic Groups are kinematical coherent groups of stars which may share a common origin. These groups spread through the Galaxy over time due to tidal effects caused by galactic rotation and disk heating, however some chemical information remains unchanged.
The aim of chemical tagging is to show that abundances of every element in the analysis must be homogeneous between members. We have studied the case of the Hyades Supercluster in order to compile a reliable list of members (FGK stars) based on chemical tagging information. This information has been derived from high-resolution echelle spectra obtained during our surveys of late-type stars. For selected northern stars of the Hyades Supercluster, stellar atmospheric parameters (Teff, log(g), ξ and [Fe/H]) have been determined using an automatic code which takes into account the sensibility of iron EWs measured in the spectra.
We have derived absolute abundances consistent with galactic abundance trends reported in previous studies. The chemical tagging method has been applied with a carefully differential abundance analysis of each candidate star, using a well-known member of the Hyades cluster as reference.

34 Kinematical determination of the luminosity function in the solar neighbourhood

Belén Vicente[1]
[1] Instituto de Astrofísica de Andalucía - CSIC

Abstract

The luminosity function is not only crucial to know stellar density distribution in space, and thus to know the structure of the Galaxy, but it allows the determination of the stellar mass function using the mass-luminosity relationship.
The luminosity function and mass function are fundamental to the understanding star formation and evolution of the Milky Way. It is customary to assume that the luminosity function in the solar neighbourhood, which can be obtained directly from precise star counts, well represents that of the Galactic disk, if not over the whole Galaxy and external galaxies of similar morphological type.
Under this assumption, we simply need to calculate in the solar vicinity and then move it to the disk area of interest. In this regard, the larger the sample used for determining more reliable is the extrapolation to galactic studies.
We have determined the luminosity function in the solar neighbourhood up to 200 pc considering the proper motions as distance estimators. We used the parameter "reduced proper motion" (Luyten 1938) for calibration of the apparent magnitudes to absolute ones.
This calibration must be done with kinematically similar populations, i.e., they share the same velocity distribution. So, prior to calculating the luminosity determination we used the SKY model (Wainscoat et al. 1992) to separate stars with different kinematic evolution in our catalogue.
As our kinematical database, we used the CdC-SF Catalogue (Vicente et al. 2010), which has proper motion precision similar to that of Hipparcos but to much fainter magnitudes (V=15). Such a rich data allow getting the luminosity function for distances greater than those identified so far by extending existing results. Have greater distances involved have information of the luminosity function for stars more luminous, since the number of bright stars near the sun is quite low. Also, a larger sample with smaller proper motions produce a luminosity function more adapted to the real Galaxy model due to decrease the correction factor of completeness.

35 A detailled 2D spectroscopic study of the central region of NGC 5253

José Manuel Vílchez[1]
[1] Instituto de Astrofísica de Andalucía - CSIC

Abstract

Starbursts are considered one of the main contributors to the chemical enrichment of the Interstellar Medium. However, the mechanisms governing the interaction between the recent/ongoing star formation and the surrounding gas are not yet fully understood. Because of their 'a priori' simplicity, the subgroup of HII galaxies constitute the ideal environment to study these mechanisms.
Here, we present a detailed study of the central region of a nearby HII galaxy, NGC 5253, using optical Integral Field Spectroscopy with FLAMES at the VLT, where two Super Stellar Clusters

are ionizing and polluting the ambient gas. In particular, the extinction and electron density structure will be shown. Also, we will explore the mechanisms responsible of the ionization in this area. Finally, we will localize the zones showing nitrogen pollution as well as Wolf-Rayet and nebular HeI features.

36 The AMBRE Project: Looking for stellar clusters in FEROS Archived Spectra

Clare Worley[1]
[1] Observatoire de la Cote d'Azur

Abstract

The goal of AMBRE, a joint project between ESO and the Observatoire de la Cote d'Azur, is to provide a homogeneous determination of the stellar parameters (including mean metallicity and some chemical abundances) for the archived spectra of the FEROS, HARPS, UVES and Flames/GIRAFFE spectrographs. These parameters will be made available to the astronomical community via the Virtual Observatory. The analysis of the FEROS spectra is now complete and the analysis of the UVES and HARPS spectra is underway.
We present here the analysis of the homogeneously determined stellar parameters for the FEROS archive sample. We have extracted samples that correspond kinematically to key stellar cluster populations within the Galaxy and then compared the MATISSSE chemical properties of these samples to the typical literature values for these stellar populations.

37 The proper motions of molecular hydrogen outflows in rho Ophiuchi molecular cloud

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[1] Max Planck Institute for Astrometry

Abstract

We performed a deep search for molecular hydrogen outflows (MHOs) toward the rho Ophiuchi cloud, covering about 0.1 square degrees sky area. In total, seven new MHOs are discovered and 27 known MHOs are detected, too. Using previously-published H2 images, we also measured proper motions for H2 features in 29 outflows. Based on the morphologies and the proper motions of MHOs, we associated most of them with 17 young stellar objects (YSOs) that are identified by Spitzer Space Telescope. Among 17 YSOs, there are eight sources, about 50%, being classified as Class I source, including the famous Class 0 source, VLA 1623-243. The distribution of MHOs has a inclination to concentrate on the L 1688 dense core. However, there is no obvious correlation between the distribution of MHOs and the distribution of 1.1 mm cores (correlation coefficient is less than 0.5).

38 Near-infrared linear polarization of cool dwarfs

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[2] Instituto de Astrofísica de Canarias (IAC)

[3] Max Planck Institute for Astronomy (MPIA)

Abstract

We report on near-infrared J- and H-band linear polarimetric photometry of eight ultracool dwarfs (two late-M, five L0 - L7.5, and one T2.5) with known evidence for photometric variability due to dust clouds, or anomalous red infrared colors, or low-gravity atmospheres. The polarimetric data were acquired with the LIRIS instrument on the William Herschel Telescope. We also provide mid-infrared photometry in the interval 3.4 - 24 μm for some targets obtained with Spitzer and WISE, which has allowed us to confirm the peculiar red colors of five sources in the sample. We can impose rather modest upper limits of 0.9% and 1.8% on the linear polarization degree for seven targets with a confidence of 99%. Only one source, 2MASS J02411151-0326587 (L0), appears to be strongly polarized (P $\sim$ 3%) in the J-band with a significance level of P/σ_P $\sim$ 10. The likely origin of its linearly polarized light and rather red infrared colors may reside in a surrounding disk with an asymmetric distribution of grains. Given its proximity, this object becomes an excellent target for the direct detection of the disk.

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