$\mathcal{SCYON}$

The Star Clusters Young & Old Newsletter

edited by Holger Baumgardt and Ernst Paunzen

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EDITORIAL

This is the 55th issue of the SCYON newsletter. Todays edition contains 16 abstracts from refereed publications and conference proceedings. We also have a summary of the PhD thesis of Michael Marks completed at the University of Bonn, and an announcement by Paolo Miocchi for a new King and Wilson model generator.

As usual we would like to thank all who sent us their contributions.

Holger Baumgardt and Ernst Paunzen

CONTENTS

SCYON POLICY

The SCYON Newsletter publishes abstracts from any area in astronomy which are relevant to research on star clusters. We welcome all contributions. Topics to be covered include

1. Abstracts from refereed articles
2. Abstracts from conference proceedings
3. PhD summaries
4. General announcements : Conferences, new databases, and the likes.

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SCYON will be published initially once every two months. If the number of contributions justifies monthly installments, we will move toward more frequent issues in order to keep the newsletter relatively short, manageable for us, and up-to-date.

Conference and journal abstracts can be submitted at any time either by web download, or failing this, we also accept abstracts typeset using the latest latex abstract template (available from the SCYON webpage). We much prefer contributors to use the direct download form, since it is mostly automated. Abstracts will normally appear on the website as soon as they are submitted to us. Other contributions, such as PhD summaries, should be sent to us using the LaTeX template. *Please do not submit postscript files, nor encoded abstracts as e-mail attachments.*

All abstracts/contributions will be processed, but we reserve the right to not post abstracts submitted in the wrong format or which do not compile. If you experience any sort of problems accessing the web site, or with the LaTeX template, please write to us at scyon@univie.ac.at.

A "Call for abstracts" is sent out approximately one week before the next issue of the newsletter is finalised. This call contains the deadline for abstract submissions for that coming issue and the LaTeX abstract template.

Depending on circumstances, the editors might actively solicit contributions, usually those spotted on a preprint server, but they do not publish abstracts without the author's consent.

We implicitly encourage further dissemination of the letter to institutes and astronomers who may benefit from it.

The editors

SCYON Mirrors

The official Scyon mirror site in Australia is hosted at the Centre for Astrophysics & Supercomputing of the University of Swinburne by Duncan Forbes and his team :

HTTP://ASTRONOMY.SWIN.EDU.AU/SCYON/)

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1. Star Forming Regions

Multiwavelength Study of NGC 281 Region

Saurabh Sharma[1,2,3], A. K. Pandey[1], J. C. Pandey[1], N. Chauhan[1,8], K. Ogura[4], D. K. Ojha[5], J. Borrissova[2], H. Mito[6], T. Verdugo[2,9] and B. C. Bhatt[7]

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We present a multiwavelength study of the NGC 281 complex which contains the young cluster IC 1590 at the center, using deep wide-field optical $UBVI_c$ photometry, slitless spectroscopy along with archival data sets in the near-infrared (NIR) and X-ray. The extent of IC 1590 is estimated to be ∼6.5 pc. The cluster region shows a relatively small amount of differential reddening. The majority of the identified young stellar objects (YSOs) are low mass PMS stars having age $< 1 - 2$ Myr and mass 0.5-3.5 $M_\odot$. The slope (Γ) of the mass function for IC 1590, in the mass range $2 < M/M_\odot \leq 54$, is found to be -1.11 ± 0.15. The slope of the K-band luminosity function (0.37 ± 0.07) is similar to the average value (∼0.4) reported for young clusters. The distribution of gas and dust obtained from the IRAS, CO and radio maps indicates clumpy structures around the central cluster. The radial distribution of the young stellar objects, their ages, $\Delta(H-K)$ NIR-excess, and the fraction of classical T Tauri stars suggest triggered star formation at the periphery of the cluster region. However, deeper optical, NIR and MIR observations are needed to have a conclusive view of star formation scenario in the region. The properties of the Class 0/I and Class II sources detected by using the *Spitzer* mid-infrared observations indicate that a majority of the Class II sources are X-ray emitting stars, whereas X-ray emission is absent from the Class 0/I sources. The spatial distribution of Class 0/I and Class II sources reveals the presence of three sub-clusters in the NGC 281 West region.

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Mining the UKIDSS GPS: star formation and embedded clusters

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Context. Data mining techniques must be developed and applied to analyse the large public data bases containing hundreds to thousands of millions entries.

Aims. To develop methods for locating previously unknown stellar clusters from the UKIDSS Galactic Plane Survey catalogue data.

Methods. The cluster candidates are computationally searched from pre-filtered catalogue data using a method that fits a mixture model of Gaussian densities and background noise using the Expectation Maximization algorithm. The catalogue data contains a significant number of false sources clustered around bright stars. A large fraction of these artefacts were automatically filtered out before or during the cluster search. The UKIDSS data reduction pipeline tends to classify marginally resolved stellar pairs and objects seen against variable surface brightness as extended objects (or "galaxies" in the archive parlance). 10% or 66×10^6 of the sources in the UKIDSS GPS catalogue brighter than 17^{m} in the K band are classified as "galaxies". Young embedded clusters create variable NIR surface brightness because the gas/dust clouds in which they were formed scatters the light from the cluster members. Such clusters appear therefore as clusters of "galaxies" in the catalogue and can be found using only a subset of the catalogue data. The detected "galaxy clusters" were finally screened visually to eliminate the remaining false detections due to data artefacts. Besides the embedded clusters the search also located locations of non clustered embedded star formation.

Results. The search covered an area of 1302 deg^2 and 137 previously unknown cluster candidates and 30 previously unknown sites of star formation were found.

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2. Galactic Open Clusters

The anticentre old open clusters Berkeley 27, Berkeley 34, and Berkeley 36: new additions to the BOCCE project.

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In this paper we present the investigation of the evolutionary status of three open clusters: Berkeley 27, Berkeley 34, and Berkeley 36, all located in the Galactic anti-centre direction. All of them were observed with SUSI2@NTT using the Bessel B, V, and I filters. The cluster parameters have been obtained using the synthetic colour-magnitude diagram (CMD) method *i.e.* the direct comparison of the observational CMDs with a library of synthetic CMDs generated with different evolutionary sets (Padova, FRANEC, and FST). This analysis shows that Berkeley 27 has an age between 1.5 and 1.7 Gyr, a reddening $E(B-V)$ in the range 0.40 and 0.50, and a distance modulus $(m-M)_0$ between 13.1 and 13.3; Berkeley 34 is older with an age in the range 2.1 and 2.5 Gyr, $E(B-V)$ between 0.57 and 0.64, and $(m-M)_0$ between 14.1 and 14.3; Berkeley 36, with an age between 7.0 and 7.5 Gyr, has a reddening $E(B-V) \sim 0.50$ and a distance modulus $(m-M)_0$ between 13.1 and 13.2. For all the clusters our analysis suggests a sub-solar metallicity in accord with their position in the outer Galactic disc.

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Anchoring the Distance Scale via X-ray/IR Data for Cepheid Clusters: SU Cas

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New X-ray (XMM-Newton) and JHKs (OMM) observations for members of the star cluster Alessi 95, which Turner et al.(2012) discovered hosts the classical Cepheid SU Cas, were used in tandem with UCAC3 (proper motion) and 2MASS observations to determine precise cluster parameters: E(J-H)=0.08+-0.02 and d=405+-15 pc. The ensuing consensus among cluster, pulsation, IUE, and trigonometric distances (d=414+-5(se)+-10(sd) pc) places SU Cas in a select group of nearby fundamental Cepheid calibrators (Delta Cep, Zeta Gem). High-resolution X-ray observations may be employed to expand that sample as the data proved pertinent for identifying numerous stars associated with SU Cas. Acquiring X-ray observations of additional fields may foster efforts to refine Cepheid calibrations used to constrain H_0.

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BVRI photometry of NGC 3231, NGC 7055, and NGC 7127

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Open clusters are often used as tracers for the formation and evolution of the Milky Way. But they can also be used to study distinct "local stellar populations" and all kind of stellar groups. All these studies crucially depend on their unambiguous detection and classification separating them from the fore- and background field population. Still more than one third of the catalogued galactic open clusters are unstudied to date. We have chosen three northern open cluster fields, namely NGC 3231, NGC 7055, and NGC 7127 which have been never studied before to shed more light on their true nature. We present Johnson-Cousins BVRI photometry down to V$\sim$ 19mag. After the transformation to the standard systems, colour-magnitude diagrams were generated. These diagrams were used to fit solar abundant isochrones to determine the distance modulus, reddening and apparent age of the main sequences. As reported before, a significant plate-dependent distortion of the UCAC3 compared to the PPMXL within all three star fields was found. No correlation of this distortion with the apparent magnitude of the objects was detected. From the analysis of the colour-magnitude diagrams and the available proper motions we conclude that NGC 7055 and NGC 7127 are young, real, open clusters with ages of about 10 and 100 Myr, respectively. They are located in a distance of about 3300 as well as 5700 pc from the Sun. NGC 3231, on the other hand, is probably a high galactic latitude open cluster remnant.

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3. Galactic Globular Clusters

Comparing Mid-Infrared Globular Cluster Colors With Population Synthesis Models

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Several population synthesis models now predict integrated colors of simple stellar populations in the mid-infrared bands. To date, the models have not been extensively tested in this wavelength range. In a comparison of the predictions of several recent population synthesis models, the integrated colors are found to cover approximately the same range but to disagree in detail, for example on the effects of metallicity. To test against observational data, globular clusters are used as the closest objects to idealized groups of stars with a single age and single metallicity. Using recent mass estimates, we have compiled a sample of massive, old globular clusters in M31 which contain enough stars to guard against the stochastic effects of small-number statistics, and measured their integrated colors in the Spitzer/IRAC bands. Comparison of the cluster photometry in the IRAC bands with the model predictions shows that the models reproduce the cluster colors reasonably well, except for a small (not statistically significant) offset in [4.5]-[5.8]. In this color, models without circumstellar dust emission predict bluer values than are observed. Model predictions of colors formed from the V band and the IRAC 3.6 and 4.5 micron bands are redder than the observed data at high metallicities and we discuss several possible explanations. In agreement with model predictions, V-[3.6] and V-[4.5] colors are found to have metallicity sensitivity similar to or slightly better than V-Ks.

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The velocity dispersion and mass function of the outer halo globular cluster Palomar 4

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We obtained precise line-of-sight radial velocities of 23 member stars of the remote halo globular cluster Palomar 4 (Pal 4) using the High Resolution Echelle Spectrograph (HIRES) at the Keck I telescope. We also measured the mass function of the cluster down to a limiting magnitude of $V \sim 28$ mag using archival *HST*/WFPC2 imaging. We derived the cluster's surface brightness profile based on the WFPC2 data and on broad-band imaging with the Low-Resolution Imaging Spectrometer (LRIS) at the Keck II telescope. We find a mean cluster velocity of $72.55 \pm 0.22\,\mathrm{km\,s^{-1}}$ and a velocity dispersion of $0.87 \pm 0.18\,\mathrm{km\,s^{-1}}$. The global mass function of the cluster, in the mass range $0.55 \leq \mathrm{M} \leq 0.85\,\mathrm{M_\odot}$, is shallower than a Kroupa mass function and the cluster is significantly depleted in low-mass stars in its center compared to its outskirts. Since the relaxation time of Pal 4 is of the order of a Hubble time, this points to primordial mass segregation in this cluster. Extrapolating the measured mass function towards lower-mass stars and including the contribution of compact remnants, we derive a total cluster mass of $29{,}800\,\mathrm{M_\odot}$. For this mass, the measured velocity dispersion is consistent with the expectations of Newtonian dynamics and below the prediction of MOND. Pal 4 adds to the growing body of evidence that the dynamics of star clusters in the outer Galactic halo can hardly be explained by MOND.

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Central kinematics of the globular cluster NGC 2808: Upper limit on the mass of an intermediate-mass black hole

Nora Lützgendorf ([1]), Markus Kissler-Patig ([1]), Karl Gebhardt ([2]), Holger Baumgardt ([3]), Eva Noyola ([4]), Behrang Jalali ([5]), P. Tim de Zeeuw ([1]), Nadine Neumayer ([1])
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Globular clusters are an excellent laboratory for stellar population and dynamical research. Recent studies have shown that these stellar systems are not as simple as previously assumed. With multiple stellar populations as well as outer rotation and mass segregation they turn out to exhibit high complexity. This includes intermediate-mass black holes which are proposed to sit at the centers of some massive globular clusters. Today's high angular resolution ground based spectrographs allow velocity-dispersion measurements at a spatial resolution comparable to the radius of influence for plausible IMBH masses, and to detect changes in the inner velocity-dispersion profile. Together with high quality photometric data from HST, it is possible to constrain black-hole masses by their kinematic signatures. We determine the central velocity-dispersion profile of the globular cluster NGC 2808 using VLT/FLAMES spectroscopy. In combination with HST/ACS data our goal is to probe whether this massive cluster hosts an intermediate-mass black hole at its center and constrain the cluster mass to light ratio as well as its total mass. We derive a velocity-dispersion profile from integral field spectroscopy in the center and Fabry Perot data for larger radii. High resolution HST data are used to obtain the surface brightness profile. Together, these data sets are compared to dynamical models with varying parameters such as mass to light ratio profiles and black-hole masses. Using analytical Jeans models in combination with variable M/L profiles from N-body simulations we find that the best fit model is a no black hole solution. After applying various Monte Carlo simulations to estimate the uncertainties, we derive an upper limit of the back hole mass of $M_{BH} < 1 \cdot 10^4$ $M_\odot$ (with 95 % confidence limits) and a global mass-to-light ratio of $M/L_V = (2.1 \pm 0.2)$ $M_\odot/L_\odot$.

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High-velocity stars in the cores of globular clusters: The illustrative case of NGC 2808

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We report the detection of five high-velocity stars in the core of the globular cluster NGC 2808. The stars lie on the the red giant branch and show total velocities between 40 and 45 km/s. For a core velocity dispersion $\sigma_c = 13.4$ km/s, this corresponds to up to 3.4 σ_c. These velocities are close to the estimated escape velocity (~ 50 km/s) and suggest an ejection from the core. Two of these stars have been confirmed in our recent integral field spectroscopy data and we will discuss them in more detail here. These two red giants are located at a projected distance of ~ 0.3 pc from the center. According to their positions on the color magnitude diagram, both stars are cluster members. We investigate several possible origins for the high velocities of the stars and conceivable ejection mechanisms. Since the velocities are close to the escape velocity, it is not obvious whether the stars are bound or unbound to the cluster. We therefore consider both cases in our analysis. We perform numerical simulations of three-body dynamical encounters between binaries and single stars and compare the resulting velocity distributions of escapers with the velocities of our stars. We compare the predictions for a single dynamical encounter with a compact object with those of a sequence of two-body encounters due to relaxation. If the stars are unbound, the encounter must have taken place recently, when the stars were already in the giant phase. After including binary fractions and black-hole retention fractions, projection effects, and detection probabilities from Monte-Carlo simulations, we estimate the expected numbers of detections for all the different scenarios. Based on these numbers, we conclude that the most likely scenario is that the stars are bound and were accelerated by a single encounter between a binary of main-sequence stars and a ~ 10 $M_\odot$ black hole.

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4. Extragalactic Clusters

PHAT Stellar Cluster Survey I. Year 1 Catalog and Integrated Photometry

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The Panchromatic Hubble Andromeda Treasury (PHAT) survey is an on-going Hubble Space Telescope (HST) multi-cycle program to obtain high spatial resolution imaging of one-third of the M31 disk at ultraviolet through near-infrared wavelengths. In this paper, we present the first installment of the PHAT stellar cluster catalog. When completed, the PHAT cluster catalog will be among the largest and most comprehensive surveys of resolved star clusters in any galaxy. The exquisite spatial resolution achieved with HST has allowed us to identify hundreds of new clusters that were previously inaccessible with existing ground-based surveys. We identify 601 clusters in the Year 1 sample, representing more than a factor of four increase over previous catalogs within the current survey area (390 arcmin^2). This work presents results derived from the first $\sim$ 25 % of the survey data; we estimate that the final sample will include $\sim$2500 clusters. For the Year 1 objects, we present a catalog with positions, radii, and six-band integrated photometry. Along with a general characterization of the cluster luminosities and colors, we discuss the cluster luminosity function, the cluster size distributions, and highlight a number of individually interesting clusters found in the Year 1 search.

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Low-mass pre–main-sequence stars in the Magellanic Clouds

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The stellar Initial Mass Function (IMF) suggests that stars with sub-solar mass form in very large numbers. Most attractive places for catching low-mass star formation in the act are young stellar clusters and associations, still (half-)embedded in star-forming regions. The low-mass stars in such regions are still in their pre–main-sequence (PMS) evolutionary phase, i.e., they have not started their lives on the main-sequence yet. The peculiar nature of these objects and the contamination of their samples by the fore- and background evolved populations of the Galactic disk impose demanding observational techniques, such as X-ray surveying and optical spectroscopy of large samples for the detection of complete numbers of PMS stars in the Milky Way. The Magellanic Clouds, the metal-poor companion galaxies to our own, demonstrate an exceptional star formation activity. The low extinction and stellar field contamination in star-forming regions of these galaxies imply a more efficient detection of low-mass PMS stars than in the Milky Way, but their distance from us make the application of the above techniques unfeasible. Nonetheless, imaging with the Hubble Space Telescope within the last five years yield the discovery of solar and sub-solar PMS stars in the Magellanic Clouds from photometry alone. Unprecedented numbers of such objects are identified as the low-mass stellar content of star-forming regions in these galaxies, changing completely our picture of young stellar systems outside the Milky Way, and extending the extragalactic stellar IMF below the persisting threshold of a few solar masses. This review presents the recent developments in the investigation of the PMS stellar content of the Magellanic Clouds, with special focus on the limitations by single-epoch photometry that can only be circumvented by the detailed study of the observable behavior of these stars in the color-magnitude diagram. The achieved characterization of the low-mass PMS stars in the Magellanic Clouds allowed thus a more comprehensive understanding of the star formation process in our neighboring galaxies.

To appear in : Space Science Reviews
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Evidence for inhomogeneous reionization in the local Universe from metal-poor globular cluster systems

Spitler, Lee R.; Romanowsky, Aaron J.; Diemand, Jürg; Strader, Jay; Forbes, Duncan A.; Moore, Ben; Brodie, Jean P.

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Exploiting a fundamental characteristic of galaxy assembly in the ΛCDM paradigm, the observed spatial biasing and kinematics of metal-poor globular star clusters are used to constrain the local reionization epoch around individual galaxies. Selecting three galaxies located in different environments, the first attempt at constraining the environmental propagation of reionization in the local Universe is carried out. The joint constraint from the three galaxies (z_{reion} = 10.5+/-1.0) agrees remarkably well with the latest WMAP constraint on z_{reion} for a simple instantaneous reionization model. More importantly, the range of z_{reion} values found here are consistent with the global range of z_{reion} estimates from other observations. We furthermore find a 1.7σ indication that reionization completed in low-density environments before the intergalactic medium in high-density environments was reionized. This is consistent with certain theoretical models that predict that reionization was globally prolonged in duration, with neutral hydrogen pockets surviving in high-density environments, even after the surrounding regions were reionized. More generally, this work provides a useful constraint on the formation history of galaxy stellar halos.

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5. Dynamical evolution - Simulations

A prescription and fast code for the long-term evolution of star clusters

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We introduce the star cluster evolution code Evolve Me A Cluster of StarS (EMACSS), a simple yet physically motivated computational model that describes the evolution of some fundamental properties of star clusters in static tidal fields. We base our prescription upon the flow of energy within the cluster, which is a constant fraction of the total energy per half-mass relaxation time. According to Hénon's predictions, this flow is independent of the precise mechanisms for energy production within the core, and therefore does not require a complete description of the many-body interactions therein. For a cluster of equal-mass stars, we thence use dynamical theory and analytic descriptions of escape mechanisms to construct a series of coupled differential equations expressing the time-evolution of cluster mass and radius. These equations are numerically solved using a 4th order Runge-Kutta integration kernel, and the results bench-marked against a database of direct N-body simulations. We use simulations containing a modest initial number of stars ($1024 \leq N \leq 65536$), and point-mass tidal fields of various strengths. Our prescription is publicly available, and reproduces the N-body results to within $\sim 10\%$ accuracy for the entire post-collapse evolution of star clusters.

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On the origin of planets at very wide orbits from the re-capture of free floating planets

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In recent years several planets have been discovered at wide orbits (> 100 AU) around their host stars. Theoretical studies encounter difficulties in explaining their formation and origin. Here we propose a novel scenario for the production of planetary systems at such orbits, through the dynamical recapture of free floating planets (FFPs) in dispersing stellar clusters and stellar associations. This process is a natural extension of the recently suggested scenario for the formation of wide stellar binaries. We use N-body simulations of dispersing clusters with $10 - 1000$ stars and comparable numbers of FFPs to study this process. We find that planets are captured into wide orbits in the typical range $\sim$ few $\times 100 - 10^6$ AU, and have a wide range of eccentricities (thermal distribution). Typically, $3 - 6 \times (f_{\rm FFP}/1)$ % of all stars capture a planetary companion with such properties (where $f_{\rm FFP}$ is the number of FFP per star in the birth clusters). The planetary capture efficiency is comparable to that of capture-formed stellar-binaries, and shows a similar dependence on the cluster size and structure. It is almost independent of the specific planetary mass; planets as well as sub-stellar companions of any mass can be captured. The capture efficiency decreases with increasing cluster size, and for a given cluster size the it increases with the host/primary mass. We also find that more than one planet can be captured around the same host through independent consecutive captures; similarly planets can be captured into binary systems, both in circumstellar and circumbinary orbits. We also expect planets to be captured into pre-existing planetary (and protoplanetary systems) as well as into orbits around black holes and massive white dwarfs, if these formed early enough before the cluster dispersal. In particular, stellar black holes have a high capture efficiency ($> 50\%$ and $5 - 10 \times (f_{\rm FFP}/1)$ % for capture of stars and planetary companions, respectively) due to their large mass. Finally, although rare, two FFPs or brown dwarfs can become bound and form a FFP-binary system with no stellar host.

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6. Miscellaneous

Chemically tagging the Hyades Supercluster: A homogeneous sample of F6-K4 kinematically-selected northern stars

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Stellar kinematic groups are kinematical coherent groups of stars that might have a common origin. These groups are dispersed throughout the Galaxy over time by the tidal effects of both Galactic rotation and disc heating, although their chemical content remains unchanged. The aim of chemical tagging is to establish that the abundances of every element in the analysis are homogeneus among the members. We study the case of the Hyades Supercluster to compile a reliable list of members (FGK stars) based on our chemical tagging analyisis. For a total of 61 stars from the Hyades Supercluster, stellar atmospheric parameters ($T_{\rm eff}$, $\log g$, ξ, and [Fe/H]) are determined using our code called StePar, which is based on the sensitivity to the stellar atmospherics parameters of the iron EWs measured in the spectra. We derive the chemical abundances of 20 elements and find that their [X/Fe] ratios are consistent with Galactic abundance trends reported in previous studies. The chemical tagging method is applied with a carefully developed differential abundance analysis of each candidate member of the Hyades Supercluster, using a well-known member of the Hyades cluster as a reference (vB 153). We find that only 28 stars (26 dwarfs and 2 giants) are members, i.e. that 46 % of our candidates are members based on the differential abundance analysis. This result confirms that the Hyades Supercluster cannot originate solely from the Hyades cluster.

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Southern near-infrared photometric monitoring of Galactic young star clusters (*NIP of Stars*)

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We have performed a near-infrared photometric monitoring of 39 galactic young star clusters and star-forming regions, known as *NIP of Stars*, between the years 2009–2011, using the Swope telescope at Las Campanas Observatory (Chile) and the RetroCam camera. The primary objective of the campaign is to perform a census of photometric variability of such clusters and to discover massive eclipsing binary stars. In this work, we describe the general idea, the implementation of the survey, and the first preliminary results of some of the observed clusters. This monitoring program is complementary to the *Vista Variables in the Via Lactea* (*VVV*), as the brightest sources observed in *NIP of Stars* are saturated in *VVV*.

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Dynamical fingerprints of star cluster formation

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I demonstrated previously in my diploma thesis (the results published in Marks & Kroupa 2008) that the violent phase of residual-gas expulsion, i.e. the removal of the gas that is left-over from star formation, depletes the low-mass stellar initial mass function in a way that is consistent with observations of the present-day mass function. In the first part of this thesis, these data are used to constrain for the first time parameters determining the residual-gas expulsion process which allows to infer initial masses, sizes and densities for a sample of twenty Galactic globular clusters. The constrained quantities lead to novel insights into the formation process of star clusters, in particular uncovering cluster metallicity as the potential driving physical quantity of residual-gas expulsion and star cluster formation (Marks & Kroupa 2010). If the residual-gas is assumed to be removed over some given time-scale, it is shown that the derived initial conditions require globular clusters to have formed with a non-standard stellar initial mass function at the high-mass end depending on cluster metallicity and birth density for stars more massive than the Sun. The deduced variation of the IMF is consistent qualitatively with the theoretically predicted variation of the IMF with physical conditions of star formation (Marks, Kroupa, Dabringhausen & Pawlowski 2012).

The second part of this thesis deals with the evolution of initially binary star dominated star clusters. It is shown that a population of binaries with initially invariant properties changes its characteristics on a dynamical crossing time-scale. This finding allows to devise an analytical method to describe the dynamically induced evolution of the distributions of binary orbital parameters in NBODY computations depending on the initial cluster density (Marks, Kroupa & Oh 2011). This novel method is subsequently used to compare observed binary orbital-parameter distributions in young star clusters with those expected from the model. All of the investigated regions can be explained within the framework of the dynamical modification of the initially invariant binary star distribution into the observed ones. The model delivers initial cluster densities for the sample of young clusters and predicts present-day overall binary-fractions in them as well as the shape of their distribution functions. The derived initial densities compare excellently with observed pre-cluster cloud core densities (Marks & Kroupa 2012). The same analytical method is employed to calculate the single and binary star populations in galactic fields by summing up the individual stellar populations in star clusters. The model results in binary star distributions consistent with those observed in the Milky Way if clusters formed compact. Having adjusted the parameters determining a galaxy-wide population for other galaxies allows for the first time the prediction of the single and binary star content for elliptical, spiral and dwarf galaxies (Marks & Kroupa 2011).

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New King and Wilson Model Generator

As a part of the Cosmic-Lab project (`http://www.cosmic-lab.eu/`), a wide range of single-mass and isotropic King/Wilson models is made available on-line to the scientific community at

`http://www.cosmic-lab.eu/bhking/index.php`

The BHKing tool builds single-mass and isotropic King (1966) and Wilson (1976) models, which are commonly considered to properly represent globular clusters. Once a value of the W_0 shape parameter is selected, various structural and morphological parameters, and a preview of the projected surface density profile of the corresponding model are immediately visualized. Scale-free radial profiles of the volume density, surface density, and line-of-sight velocity dispersion can be downloaded. The user can also include a central intermediate-mass black hole, according to the self-consistent model generalization of Miocchi (2007, MNRAS 381, 103); in this case the ratio between the black hole and the cluster mass has to be selected by the user.

For questions and further information, please contact Dr. Paolo Miocchi (`paolo.miocchi@gmail.com`).