SCYON

The Star Clusters Young & Old Newsletter

edited by Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

SCYON can be found at URL:
`http://www.univie.ac.at/scyon/`

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EDITORIAL

This is the 49th issue of the SCYON newsletter. Since we had some problems with the Strasbourg site recently, we decided to move the newsletter to Vienna to have it closer to the WEBDA abstract submission site. Todays issue is the first that is being sent from Vienna, please let us know if you experience any problems.

From now onward, the SCYON email address is going to be

scyon@univie.ac.at

and the new webpage is

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

Please update your links to SCYON since the old website and email address will stop working at some point.

Today we have 27 abstracts from refereed publications and an announcement for a new version of the open cluster catalogue by Wilton Dias. We also have four job announcements, two in observational research (at Kavli Institute and Macquarie University) and two in computational astrophysics (Bremen and Potsdam).

Since this is the last newsletter for this year, we wish everybody a merry holiday season and a happy new year 2011 and thank all who sent us their contributions.

Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

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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.

Concerning possible infringements to copyright laws, we understand that the authors themselves are taking responsibility for the material they send us. We make no claim whatsoever to owning the material that is posted at our url or circulated by email. The newsletter SCYON is a free service. It does not substitute for our personal opinions, nor does it reflect in any way the views of our respective institutes of affiliations.

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/)

1. Star Forming Regions

Star formation: statistical measure of the correlation between the prestellar core mass function and the stellar initial mass function

G. Chabrier[1] and P. Hennebelle[2]
[1]CRAL, ENS-Lyon, [2]LERMA, ENS Paris

We present a simple statistical analysis of recent numerical simulations exploring the correlation between the core mass function obtained from the fragmentation of a molecular cloud and the stellar mass function which forms from these collapsing cores. Our analysis shows that the distributions of bound cores and sink particles obtained in the simulations are consistent with the sinks being formed predominantly from their parent core mass reservoir, with a statistical dispersion of the order of one third of the core mass. Such a characteristic dispersion suggests that the stellar initial mass function is relatively tightly correlated to the parent core mass function, leading to two similar distributions, as observed. This in turn argues in favor of the IMF being essentially determined at the early stages of core formation and being only weakly affected by the various environmental factors beyond the initial core mass reservoir, at least in the mass range explored in the present study. Accordingly, the final IMF of a star forming region should be determined reasonably accurately, statistically speaking, from the initial core mass function, provided some uniform efficiency factor. The calculations also show that these statistical fluctuations, due e.g. to variations among the core properties, broaden the low-mass tail of the IMF compared with the parent CMF, providing an explanation for the fact that this latter appears to underestimate the number of "pre brown dwarf" cores compared with the observationally-derived brown dwarf IMF.

Accepted by: ApJ Letters
Also available from the URL `http://arxiv.org/pdf/1011.1185`

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The distinction between star clusters and associations

Mark Gieles ([1]) and Simon F. Portegies Zwart ([2])
([1]) Cambridge ([2]) Leiden

In Galactic studies a distinction is made between (open) star clusters and associations. For barely resolved objects at a distance of several Mpc, this distinction is not trivial to make. Here we provide an objective definition by comparing the age of the stars to the crossing time of nearby stellar agglomerates. We find that a satisfactory separation can be made where this ratio equals unity. Stellar agglomerates for which the age of the stars exceeds the crossing time are bound, and are referred to as star clusters. Alternatively, those for which the crossing time exceeds the stellar age are unbound and are referred to as associations. This definition is useful whenever reliable measurements for the mass, radius and age are available.

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Also available from the URL http://arxiv.org/abs/1010.1720
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The puzzle of the cluster-forming core mass-radius relation and why it matters

Geneviève Parmentier[1] **and Pavel Kroupa**[1]

[1]Argelander-Institut für Astronomie, Bonn Universität, Auf dem Hügel 71, D-53121 Bonn, Germany

We highlight how the mass-radius relation of cluster-forming cores combined with an external tidal field can influence infant weight-loss and disruption likelihood of clusters at the end of their violent relaxation, namely, when their dynamical response to the expulsion of their residual star-forming gas is over. Specifically, building on the cluster N-body model grid of Baumgardt & Kroupa (2007), we study how the relation between the bound fraction of stars staying in clusters at the end of violent relaxation and the cluster-forming core mass is affected by the slope and normalization of the core mass-radius relation. Assuming mass-independent star formation efficiency and gas-expulsion time-scale τ_{GExp}/τ_{cross} and a given external tidal field, it is found that constant surface density cores and constant radius cores have the potential to lead to the preferential removal of high- and low-mass clusters, respectively. In contrast, constant volume density cores result in mass-independent cluster infant weight-loss, as suggested by some observations. These trends result from how core volume density and core mass scale with each other. Infant weight-loss is quantified for cluster-forming cores with either number density $n_{H2,core} \simeq 6 \times 10^4\,cm^{-3}$, or surface density $\Sigma_{core} \simeq 0.5\,g.cm^{-2}$, or radius $r_{core} = 0.3\,\text{pc}$. Our modelling includes predictions about the evolution of high-mass cluster-forming cores (say $m_{core} > 10^5\,M_\odot$), a regime not yet covered by the observations. We show how, for a given external tidal field, the core mass-radius diagram constitutes a straightforward diagnostic tool to assess whether the tidal field influences the fate of clusters after gas expulsion.

An overview of various issues directly affected by the nature of the core mass-radius relation is presented. In relation with the tidal field impact, these are the evolution of the cluster mass function at young ages (i.e. over the first $\simeq 30\,\text{Myr}$), and our ability to reconstruct the star formation history of galaxies from their cluster age distribution. Independently of the tidal field impact, the slope and/or normalization of the cluster-forming core mass-radius relation also influences the mass-metallicity relation of old globular clusters predicted by self-enrichment models, and the duration of cluster violent relaxation.

Finally, we emphasize that observational mass-radius data-sets of dense gas regions must be handled with caution as they may be the imprint of the molecular tracer used to map them, rather than reflecting cluster formation conditions.

To appear in: Monthly Notices of the Royal Astronomical Society

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Also available from the URL `http://arxiv.org/abs/1009.5381`

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Top-heavy integrated galactic stellar initial mass functions (IGIMFs) in starbursts

Carsten Weidner[1], Pavel Kroupa[2] and Jan Pflamm-Altenburg[2]
[1]Scottish Universities Physics Alliance (SUPA), School of Physics and Astronomy, University of St Andrews, North Haugh, St Andrews, Fife KY16 9SS, UK,
[2]Argelander-Institut für Astronomie, Bonn Universität, Auf dem Hügel 71, D-53121 Bonn, Germany

Star formation rates (SFR) larger than 1000 $M_{\odot}$/yr are observed in extreme star bursts. This leads to the formation of star clusters with masses $> 10^6$ $M_{\odot}$ in which crowding of the pre-stellar cores may lead to a change of the stellar initial mass function (IMF). Indeed, the large mass-to-light ratios of ultra-compact dwarf galaxies and recent results on globular clusters suggest the IMF to become top-heavy with increasing star-forming density. We explore the implications of top-heavy IMFs in these very massive and compact systems for the integrated galactic initial mass function (IGIMF), which is the galaxy-wide IMF, in dependence of the star-formation rate of galaxies. The resulting IGIMFs can have slopes, α_3, for stars more massive than about 1 $M_{\odot}$ between 1.5 and the Salpeter slope of 2.3 for an embedded cluster mass function (ECMF) slope (β) of 2.0, but only if the ECMF has no low-mass clusters in galaxies with major starbursts. Alternatively, β would have to decrease with increasing SFR > 10 $M_{\odot}$/yr such that galaxies with major starbursts have a top-heavy ECMF. The resulting IGIMFs are within the range of observationally deduced IMF variations with redshift.

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2. Galactic Open Clusters

Old open clusters and the Galactic metallicity gradient: Berkeley 20, Berkeley 66, and Tombaugh 2

Gloria Andreuzzi (1), Angela Bragaglia (2), Monica Tosi (2), Gianni Marconi (3)
1: INAF-OA Roma and Fundacion Galileo Galilei, 2: INAF-OA Bologna, 3: ESO

To study the crucial range of Galactocentric distances between 12 and 16 kpc, where little information is available, we have obtained VI CCD imaging of Berkeley 20 and BVI CCD imaging of Berkeley 66 and Tombaugh 2, three distant, old open clusters. Using the synthetic colour magnitude diagram (CMD) technique with three types of evolutionary tracks of different metallicities, we have determined age, distance, reddening and indicative metallicity of these systems. The CMD of Be 20 is best reproduced by stellar models with a metallicity about half of solar (Z=0.008 or 0.01), in perfect agreement with high resolution spectroscopic estimates. Its age is between 5 and 6 Gyr from stellar models with overshooting and between 4.3 and 4.5 Gyr from models without it. The distance modulus from the best fitting models is always (m-M)0=14.7 (corresponding to a Galactocentric radius of about 16 kpc), and the reddening E(B-V) ranges between 0.13 and 0.16. A slightly lower metallicity ($Z \sim 0.006$) appears to be more appropriate for Be 66. This cluster is younger, (age of 3 Gyr), and closer, (m-M)0=13.3 (i.e., at 12 kpc from the Galactic centre), than Be 20, and suffers from high extinction, $1.2 <$ E(B-V) < 1.3, variable at the 2-3 per cent level. Finally, the results for To 2 indicate that it is an intermediate age cluster, with an age of about 1.4 Gyr or 1.6-1.8 Gyr for models without and with overshooting, respectively. The metallicity is about half of solar (Z=0.006 to 0.01), in agreement with spectroscopic determinations. The distance modulus is (m-M)0=14.5, implying a distance of about 14 kpc from the Galactic centre; the reddening E(B-V) is 0.31-0.4, depending on the model and metallicity, with a preferred value around 0.34.

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Evidence for Extended Star Formation in the Old, Metal-Rich Open Cluster, NGC 6791?

B. A. Twarog ([1]) G. Carraro ([2]) B. J. Anthony-Twarog ([1])
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NGC 6791 is an old, metal-rich star cluster normally considered to be a disk open cluster. Its red giant branch is broad in color yet, to date, there is no evidence for a metallicity spread among its stars. The turnoff region of the main sequence is also wider than expected from broad-band photometric errors. Analysis of the color-magnitude diagram reveals a color gradient between the core of the cluster and its periphery; we evaluate the potential explanations for this trend. While binarity and photometric errors appear unlikely, reddening variations across the face of the cluster cannot be excluded. We argue that a viable alternative explanation for this color trend is an age spread resulting from a protracted formation time for the cluster; the stars of the inner region of NGC 6791 appear to be older by $\sim$1 Gyr on average than those of the outer region.

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The evolution of luminosity, colour and the mass-to-luminosity ratio of Galactic open clusters: comparison of discrete vs. continuous IMF models

A.E. Piskunov[1,2,3] and N.V. Kharchenko[1,3,4] and E. Schilbach[3] and S. Röser[3] and R.-D. Scholz[1] and H. Zinnecker[1]

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We found in previous studies that standard Simple Stellar Population (SSP) models are unable to describe or explain the colours of Galactic open clusters both in the visible and in the NIR spectral range. The reason for this disagreement is the continuous nature of the stellar IMF in clusters which is the underlying assumption in the SSP models. In reality, the Galactic open clusters are scarcely populated with the brightest stars responsible for integrated fluxes. In this study, we aim at constructing discrete SSP-models which are able to adequately describe the observed magnitude-, colour-, and mass-to-luminosity-ratio-age relations of open clusters by including a number of rarely considered effects. We construct a numerical SSP-model, with an underlying Salpeter IMF, valid within an upper m_u and lower m_l stellar mass range, and with total masses $M_c = 10^2 \ldots 10^4\, m_\odot$ typical of open clusters. We assume that the mass loss from a cluster is provided by mass loss from evolved stars and by the dynamical evaporation of low-mass members due to two-body relaxation. The data for the latter process were scaled to the models from high-resolution N-body calculations. We also investigate how a change of the m_l-limit influences **magnitudes** and colours of clusters of a given mass and derive a necessary condition for a luminosity and colour flash. The discreteness of the IMF leads to bursts in magnitude and colour of model clusters at moments when red supergiants or giants appear and then die. The amplitude of the burst depends on the cluster mass and on the spectral range; it is strongly increased in the NIR compared to optical passbands. In the discrete case variations of the parameter m_l are able to substantially change the magnitude-age and M/L-age relations. For the colours, the lowering of m_l considerably amplifies the discreteness effect. The influence of dynamical mass loss on colour and magnitude is weak, although it provides a change of the slopes of the considered relations, improving their agreement with observations. For the Galactic open clusters we determined luminosity and tidal mass independent of each other. The derived mass-to-luminosity ratio **shows, on average, an increase with cluster age in the optical**, but gradually declines with age in the NIR. The observed flash statistics ca! n be used to constrain m_l in open clusters.

Accepted by : Astronomy & Astrophysics

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Star formation in the outer Galaxy: membership and fundamental parameters of the young open cluster NGC 1893

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(1) INAF - Osservatorio Astronomico di Palermo, (2) Centro de Astrobiologia CSIC-INTA, Madrid, Spain, (3) ESO, Garching-bei-München, Germany

Different environmental conditions can play a crucial role in determining final products of the star formation process and in this context, less favorable activities of star formation are expected in the external regions of our Galaxy. We studied the properties of the young open cluster NGC 1893 located about 12 Kpc from the galactic center, to investigate how different physical conditions can affect the process of star formation. By adopting a multiwavelength approach, we compiled a catalog extending from X-rays to NIR data to derive the cluster membership. In addition, optical and NIR photometric properties are used to evaluate the cluster parameters. We find 415 diskless candidate members plus 1061 young stellar objects with a circumstellar disk or class II candidate members, 125 of which are also Halpha emitters. Considering the diskless candidate members, we find that the cluster distance is 3.6±0.2 kpc and the mean interstellar reddening is E(B-V)=0.6±0.1 with evidence of differential reddening in the whole surveyed region. NGC 1893 contains a conspicuous population of pre-main sequence stars together with the well studied main sequence cluster population; we found a disk fraction of about 70% similar to that found in clusters of similar age in the solar neighbour and then, despite expected unfavorable conditions for star formation, we conclude that very rich young clusters can form also in the outer regions of our Galaxy.

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3. Galactic Globular Clusters

X-shooter Observations of Main-sequence Stars in the Globular Cluster NGC 2808: First Chemical Tagging of a He-normal and a He-rich Dwarf

Bragaglia, A.; Carretta, E.; Gratton, R. G.; Lucatello, S.; Milone, A.; Piotto, G.; D'Orazi, V.; Cassisi, S.; Sneden, C.; Bedin, L. R.

We present the first chemical composition study of two unevolved stars in the globular cluster NGC 2808, obtained with the X-shooter spectrograph at VLT. NGC 2808 shows three discrete, well-separated main sequences. The most accepted explanation for this phenomenon is that their stars have different helium contents. We observed one star on the bluest main sequence (bMS, claimed to have a high helium content, Y 0.4) and the other on the reddest main sequence (rMS, consistent with a canonical helium content, Y = 0.245). We analyzed features of NH, CH, Na, Mg, Al, and Fe. While Fe, Ca, and other elements have the same abundances in the two stars, the bMS star shows a huge enhancement of N, a depletion of C, an enhancement of Na and Al, and a small depletion of Mg with respect to the rMS star. This is exactly what is expected if stars on the bMS formed from the ejecta produced by an earlier stellar generation in the complete CNO and MgAl cycles whose main product is helium. The elemental abundance pattern differences in these two stars are consistent with the differences in the helium content suggested by the color-magnitude diagram positions of the stars.

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Helium in first and second-generation stars in globular clusters from spectroscopy of red giants

Bragaglia, A.; Carretta, E.; Gratton, R.; D'Orazi, V.; Cassisi, S.; Lucatello, S.

The stars in a globular cluster (GC) have always been considered coeval and of the same metallicity. Recently, this assumption has been challenged on the basis of spectroscopic and photometric observations, which show various generations of stars in GCs, differing in the abundances of products of H-burning at high temperatures. The main final product of this burning is He. It is then important to study the connections between stars properties and He content. We consider here the nearly 1400 stars on the red giant branch (RGB) observed with FLAMES@VLT in 19 Galactic Globular Clusters (GCs) in the course of our project on the Na-O anticorrelation. Stars with different He are expected to have different temperatures (i.e., different colours), slightly different metallicities [Fe/H], and different luminosity levels of the RGB bump. All these differences are small, but our study has the necessary precision, good statistics, and homogeneity to detect them. Besides considering the observed colours and the temperatures and metallicities determined in our survey, we computed suitable sets of stellar models - fully consistent with those present in the BaSTI archive - for various assumptions about the initial He content. We find that differences in observable quantities that can be attributed to variations in He content are generally detectable between stars of the primordial (P, first-generation) and extreme (E, second-generation) populations, but not between the primordial and intermediate ones (I). The only exception, where differences are also significant between P and I populations, is the cluster NGC 2808, where three populations are clearly separated also on the main sequence and possibly on the horizontal branch. The average enhancement in the He mass fraction Y between P and E stars is about 0.05-0.11, depending on the assumptions. The differences in Y, for NGC 2808 alone, are about 0.11-0.14 between P and I stars, and about 0.15-0.19 between P and E stars, again depending on the assumptions. When we consider the RGB bump luminosity of first and second-generation stars we find different levels; the implied Y difference is more difficult to quantify, but agrees with the other determinations.

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An analysis of the blue straggler population in the Sgr dSph globular cluster Arp 2

G. Carraro ([1]) **A. F. Seleznev** ([2])
([1]) ESO Chile ([2]) Ural State University

We present and discuss new BVI CCD photometry in the field of the globular cluster Arp 2, which is considered a member of the Sagittarius Dwarf Spheroidal Galaxy. The main goal of this investigation is to study of the statistics and spatial distribution of blue straggler stars in the cluster. Blue stragglers are stars observed to be hotter and bluer than other stars with the same luminosity in their environment. As such, they appear to be much younger than the rest of the stellar population. Two main channels have been suggested to produce such stars: (1) collisions between stars in clusters or (2) mass transfer between, or merger of, the components of primordial short-period binaries. The spatial distribution of these stars inside a star cluster, compared with the distribution of stars in different evolutionary stages, can cast light on the most efficient production mechanism at work. In the case of Arp 2, we found that blue straggler stars are significantly more concentrated than main sequence stars, while they show the same degree of concentration as evolved stars (either red giants or horizontal branch stars). Since Arp 2 is not a very concentrated cluster, we suggest that this high central concentration is an indication that blue stragglers are mostly primordial binary stars.

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Abundances for a Large Sample of Red Giants in NGC 1851: Hints for a Merger of Two Clusters?

Carretta, E.; Gratton, R. G.; Lucatello, S.; Bragaglia, A.; Catanzaro, G.; Leone, F.; Momany, Y.; D'Orazi, V.; Cassisi, S.; D'Antona, F.; Ortolani, S.

We present the abundance analysis of a sample of more than 120 red giants in the globular cluster (GC) NGC 1851, based on FLAMES spectra. We find a small but detectable metallicity spread. This spread is compatible with the presence of two different groups of stars with a metallicity difference of 0.06-0.08 dex, in agreement with earlier photometric studies. If stars are divided into these two groups according to their metallicity, both components show Na-O anticorrelation (signature of a genuine GC nature) of moderate extension. The metal-poor stars are more concentrated than the metal-rich ones. We tentatively propose the hypothesis that NGC 1851 formed from a merger of two individual GCs with a slightly different Fe and alpha-element content and possibly an age difference up to 1 Gyr. This is also supported by number ratios of stars on the split subgiant and on the bimodal horizontal branches. The distribution of n-capture process elements in the two components also supports the idea that the enrichment must have occurred in each of the structures separately and not as a continuum of events in a single GC. The most probable explanation is that the proto-clusters formed into a (now dissolved) dwarf galaxy and later merged to produce the present GC.

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Detailed abundances of a large sample of giant stars in M 54 and in the Sagittarius nucleus

Carretta, E.; Bragaglia, A.; Gratton, R. G.; Lucatello, S.; Bellazzini, M.; Catanzaro, G.; Leone, F.; Momany, Y.; Piotto, G.; D'Orazi, V.

Homogeneous abundances of light elements, alpha-elements, and Fe-group elements from high-resolution FLAMES spectra are presented for 76 red giant stars in NGC 6715 (M 54), a massive globular cluster (GC) lying in the nucleus of the Sagittarius dwarf galaxy. We also derived detailed abundances for 27 red giants belonging to the Sgr nucleus. Our abundances measure the intrinsic metallicity dispersion (∼0.19 dex, rms scatter) of M 54, with the bulk of stars peaking at [Fe/H] ∼ -1.6 and a long tail extending to higher metallicities, similar to Omega Cen. The spread in these probable nuclear star clusters exceeds those of most GCs: these massive clusters are located in a region intermediate between normal GCs and dwarf galaxies. The GC M 54 exibits a Na-O anticorrelation, a typical signature of GCs, which is instead absent for the Sgr nucleus. The light elements (Mg, Al, Si) participating in the high temperature Mg-Al cycle show that the entire pattern of (anti)correlations produced by proton-capture reactions in H-burning is clearly different between the most metal-rich and most metal-poor components in the two most massive GCs in the Galaxy, confirming early results based on the Na-O anticorrelation. As in Omega Cen, stars affected by most extreme processing, i.e. showing the signature of more massive polluters, are those of the metal-rich component. These observations can be understood if the burst of star formation giving birth to the metal-rich component was delayed by as much as 10-30 Myr with respect to the metal-poor one. The evolution of these massive GCs can be easily reconciled in the general scenario for the formation of GCs sketched previously by ourselves, taking into account that Omega Cen may have already incorporated the surrounding nucleus of its progenitor and lost the remainder of the hosting galaxy while the two are still observable as distinct components in M 54 and the surrounding field.

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Properties of stellar generations in globular clusters and relations with global parameters

Carretta, E.; Bragaglia, A.; Gratton, R. G.; Recio-Blanco, A.; Lucatello, S.; D'Orazi, V.; Cassisi, S.

We revise the scenario of the formation of Galactic globular clusters (GCs) by adding the observed detailed chemical composition of their different stellar generations to the set of their global parameters. We exploit the unprecedented set of homogeneous abundances of more than 1200 red giants in 19 clusters, as well as additional data from literature, to give a new definition of bona fide GCs, as the stellar aggregates showing the Na-O anticorrelation. We propose a classification of GCs according to their kinematics and location in the Galaxy in three populations: disk/bulge, inner halo, and outer halo. We find that the luminosity function of GCs is fairly independent of their population, suggesting that it is imprinted by the formation mechanism only marginally affected by the ensuing evolution. We show that a large fraction of the primordial population should have been lost by the proto-GCs. The extremely low Al abundances found for the primordial population of massive GCs indicate a very fast enrichment process before the formation of the primordial population. We suggest a scenario for the formation of GCs that includes at least three main phases: i) the formation of a precursor population (likely due to the interaction of cosmological structures similar to those that led to the formation of dwarf spheroidals, but residing at smaller Galactocentric distances, with the early Galaxy or with other structures); ii) the triggering of a long episode of star formation (the primordial population) from the precursor population; and iii) the formation of the current GC, mainly within a cooling flow formed by the slow winds of a fraction of the primordial population. The precursor population is very effective in raising the metal content in massive and/or metal-poor (mainly halo) clusters, while its rle is minor in small and/or metal-rich (mainly disk) ones. Finally, we use principal component analysis and multivariate relations to study the phase of metal enrichment from first to second generation. We conclude that most of the chemical signatures of GCs may be ascribed to a few parameters, the most important being metallicity, mass, and cluster age. Location within the Galaxy (as described by the kinematics) also plays some rle, while additional parameters are required to describe their dynamical status.

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M54 + Sagittarius = Omega Centauri

Carretta, E.; Bragaglia, A.; Gratton, R. G.; Lucatello, S.; Bellazzini, M.; Catanzaro, G.; Leone, F.; Momany, Y.; Piotto, G.; D'Orazi, V.

We derive homogeneous abundances of Fe, O, Na, and alpha-elements from high-resolution FLAMES spectra for 76 red giant stars in NGC 6715 (M54) and for 25 red giants in the surrounding nucleus of the Sagittarius (Sgr) dwarf galaxy. Our main findings are the following. (1) We confirm that M54 shows intrinsic metallicity dispersion, $\sim$0.19 dex rms. (2) When the stars of the Sgr nucleus are included, the metallicity distribution strongly resembles that in Omega Cen; the relative contribution of the most metal-rich stars is, however, different in these two objects. (3) In both globular clusters (GCs) there is a very extended Na-O anticorrelation, which is a signature of different stellar generations born within the cluster. (4) The metal-poor and metal-rich components in M54 (and Omega Cen) show clearly distinct extension of the Na-O anticorrelation, the most heavily polluted stars being those of the metal-rich component. We propose a tentative scenario for cluster formation that could explain these features. Finally, similarities and differences found in the two most massive GCs in our Galaxy can be easily explained if they are similar objects (nuclear clusters in dwarf galaxies) observed at different stages of their dynamical evolution.

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Time-Series Photometry of Globular Clusters: M62 (NGC 6266), the Most RR Lyrae-Rich Globular Cluster in the Galaxy?

Contreras, R. ([1,2]); Catelan, M. ([1]); Smith, H. A. ([3]); Pritzl, B. J. ([4]); Borissova, J. ([5]); Kuehn, C. A. ([3])

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We present new time-series CCD photometry, in the B and V bands, for the moderately metal-rich ([Fe/H]   -1.3) Galactic globular cluster (GC) M62 (NGC 6266). The present dataset is the largest obtained so far for this cluster, and consists of 168 images per filter, obtained with the Warsaw 1.3m telescope at the Las Campanas Observatory (LCO) and the 1.3m telescope of the Cerro Tololo Inter-American Observatory (CTIO), in two separate runs over the time span of three months. The procedure adopted to detect the variable stars was the optimal image subtraction method (ISIS v2.2), as implemented by Alard. The photometry was performed using both ISIS and DAOPHOT/ALLFRAME. We have identified 245 variable stars in the cluster fields that have been analyzed so far, of which 179 are new discoveries. Of these variables, 133 are fundamental mode RR Lyrae stars (RRab), 76 are first overtone (RRc) pulsators, 4 are type II Cepheids, 25 are long-period variables (LPV), 1 is an eclipsing binary, and 6 are not yet well classified. Such a large number of RR Lyrae stars places M62 among the top two most RR Lyrae-rich (in the sense of total number of RR Lyrae stars present) GCs known in the Galaxy, second only to M3 (NGC 5272) with a total of 230 known RR Lyrae stars. Since this study covers most but not all of the cluster area, it is not unlikely that M62 is in fact the most RR Lyrae-rich GC in the Galaxy. In like vein, we were also able to detect the largest sample of LPV's known in a Galactic GC. We analyze a variety of Oosterhoff type indicators for the cluster, and conclude that M62 is an Oosterhoff type I system. This is in good agreement with the moderately high metallicity of the cluster, in spite of its predominantly blue horizontal branch morphology – which is more typical of Oosterhoff type II systems. We thus conclude that metallicity plays a key role in defining Oosterhoff type. [abridged]

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The connection between missing AGB stars and extended horizontal branches

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Recent surveys confirm early results about a deficiency or even absence of CN-strong stars on the asymptotic giant branch (AGB) of globular clusters (GCs), although with quite large cluster-to-cluster variations. In general, this is at odds with the distribution of CN band strengths among first ascent red giant branch (RGB) stars. Norris et al. proposed that the lack of CN-strong stars in some clusters is a consequence of a smaller mass of these stars that cannot evolve through the full AGB phase. In this short paper we found that the relative frequency of AGB stars can change by a factor of two between different clusters. We also find a very good correlation between the minimum mass of stars along the horizontal branch (Gratton et al. 2010) and the relative frequency of AGB stars, with a further dependence on metallicity. We conclude that indeed the stars with the smallest mass on the HB cannot evolve through the full AGB phase, being AGB-manque'. These stars likely had large He and N content, and large O-depletion. We then argue that there should not be AGB stars with extreme O depletion, and few of them with a moderate one.

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The second and third parameters of the horizontal branch in globular clusters

Gratton, R. G.; Carretta, E.; Bragaglia, A.; Lucatello, S.; D'Orazi, V.

Context. The second parameter (the first being metallicity) defining the distribution of stars on the horizontal branch (HB) of globular clusters (GCs) has long been one of the major open issues in our understanding of the evolution of normal stars. Large photometric and spectroscopic databases are now available: they include large and homogeneous sets of colour-magnitude diagrams, cluster ages, and homogeneous data about chemical compositions from our FLAMES survey. Aims: We use these databases to re-examine this issue. Methods: We use the photometric data to derive median and extreme (i.e., the values including 90Results: We find that a simple linear dependence on metallicity of this total mass lost describes quite well the median colours of HB stars. Assuming this mass loss law to be universal, we find that age is the main second parameter, determining many of the most relevant features related to HBs. In particular, it allows us to explain the Oosterhoff dichotomy as a consequence of the peculiar age-metallicity distribution of GCs in our Galaxy, although both Oosterhoff groups have GCs spanning a rather wide range of ages. However, at least an additional - third - parameter is clearly required. The most likely candidate is the He abundance, which might be different in GC stars belonging to the different stellar generations whose presence was previously derived from the Na-O and Mg-Al anticorrelations. Variations in the median He abundance allow us to explain the extremely blue HB of GCs like NGC 6254 (=M 10) and NGC 1904 (=M 79); such variations are found to be (weakly) correlated! with the values of the R-parameter (that is the ratio of the number of stars on the HB and on the RGB). We also show that suitable He abundances allow deriving ages from the HB which are consistent with those obtained from the Main Sequence. Small corrections to these latter ages are then proposed. We find that a very tight age-metallicity relation (with a scatter below 4(including NGC 104=47 Tuc and in less measure NGC 5272=M 3); however, they can be perhaps accommodated in a scenario for the formation of GCs that relates their origin to cooling flows generated after very large episodes of star formation, as proposed by Carretta et al. (2009d).

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Testing Newtonian gravity with distant globular clusters: NGC1851 and NGC1904

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Globular clusters are useful to test the validity of Newtonian dynamics in the low acceleration regime typical of galaxies, without the complications of non-baryonic dark matter. Specifically, in absence of disturbing effects, e.g. tidal heating, their velocity dispersion is expected to vanish at large radii. If such behaviour is not observed, and in particular if, as observed in elliptical galaxies, the dispersion is found constant at large radii below a certain threshold acceleration, this might indicate a break down of Newtonian dynamics. To minimise the effects of tidal heating in this paper we study the velocity dispersion profile of two distant globular clusters, NGC 1851 and NGC 1904. The velocity dispersion profile is derived from accurate radial velocities measurements, obtained at the ESO 8m VLT telescope. Reliable data for 184 and 146 bona fide cluster star members, respectively for NGC 1851 and NGC 1904, were obtained. These data allow to trace the velocity dispersion profile up to $\sim 2r_0$, where r_0 is the radius at which the cluster internal acceleration of gravity is $a_0 = 10^{-8}$ cm/s^2. It is found that in both clusters the velocity dispersion becomes constant beyond $simr_0$. These new results are fully in agreement with those found for other five globular clusters previously investigated as part of this project. Taken all together, these 7 clusters support the claim that the velocity dispersion is constant beyond r_0, irrespectively of the specific physical properties of the clusters: mass, size, dynamical history, and distance from the Milky Way. The strong similarly with the constant velocity dispersion observed in elliptical galaxies beyond r0 is suggestive of a common origin for this phenomenon in the two class of objects, and might indicate a breakdown of Newtonian dynamics below a_0.

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Abundance analysis of a sample of evolved stars in the outskirts of Omega Centauri

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The globular cluster ω Centauri (NGC 5139) is a puzzling stellar system harboring several distinct stellar populations whose origin still represents a unique astrophysical challenge. Current scenarios range from primordial chemical inhomogeneities in the mother cloud to merging of different sub-units and/or subsequent generations of enriched stars - with a variety of different pollution sources- within the same potential well. In this paper we study the chemical abundance pattern in the outskirts of Omega Centauri, half-way to the tidal radius (covering the range of 20-30 arcmin from the cluster center), and compare it with chemical trends in the inner cluster regions, in an attempt to explore whether the same population mix and chemical compositions trends routinely found in the more central regions is also present in the cluster periphery.We extract abundances of many elements from FLAMES/UVES spectra of 48 RGB stars using the equivalent width method and then analyze the metallicity distribution function and abundance ratios of the observed stars. We find, within the uncertainties of small number statistics and slightly different evolutionary phases, that the population mix in the outer regions cannot be distinguished from the more central regions, although it is clear that more data are necessary to obtain a firmer description of the situation. From the abundance analysis, we did not find obvious radial gradients in any of the measured elements.

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4. Galactic Center Clusters

Tidal breakup of binary stars at the Galactic Center. II. Hydrodynamic simulations

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In Paper I, we followed the evolution of binary stars as they orbited near the supermassive black hole (SMBH) at the Galactic center, noting the cases in which the two stars would come close enough together to collide. In this paper we replace the point-mass stars by fluid realizations, and use a smoothed-particle hydrodynamics (SPH) code to follow the close interactions. We model the binary components as main-sequence stars with initial masses of 1, 3 and 6 Solar masses, and with chemical composition profiles taken from stellar evolution codes. Outcomes of the close interactions include mergers, collisions that leave both stars intact, and ejection of one star at high velocity accompanied by capture of the other star into a tight orbit around the SMBH. For the first time, we follow the evolution of the collision products for many (> 100) orbits around the SMBH. Stars that are initially too small to be tidally disrupted by the SMBH can be puffed up by close encounters or collisions, with the result that tidal stripping occurs in subsequent periapse passages. In these cases, mass loss occurs episodically, sometimes for hundreds of orbits before the star is completely disrupted. Repeated tidal flares, of either increasing or decreasing intensity, are a predicted consequence. In collisions involving a low-mass and a high-mass star, the merger product acquires a high core hydrogen abundance from the smaller star, effectively resetting the nuclear evolution "clock" to a younger age. Elements like Li, Be and B that can exist only in the outermost envelope of a star are severely depleted due to envelope ejection during collisions and due to tidal forces from the SMBH. Tidal spin-up due to either a collision or tidal torque by the SMBH at periapsis can explain the observed high rotational velocity of HVS 8. However, in the absence of collisions, tidal spin-up of stars is only important in a narrow range of periapse distances, $r_t/2 < r_{per} < r_t$ with r_t the tidal disruption radius. We discuss the implications of these results for the formation of the S-stars and the hypervelocity stars.

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5. Extragalactic Clusters

Two formation channels of UCDs in Hickson compact groups

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The formation of ultra-compact dwarf galaxies (UCDs) is believed to be driven by interaction, and UCDs are abundant in the cores of galaxy clusters, environments that mark the end-point of galaxy evolution. Nothing is known about the properties of UCDs in compact groups of galaxies, environments where most of galaxy evolution and interaction is believed to occur and where UCDs in an intermediate stage in their evolution may be expected.

The main goal of this study is to detect and characterize, for the first time, the UCD population of compact groups of galaxies. For that, two nearby groups in different evolutionary stages, HCG 22 and HCG 90, were targeted.

We selected about 40 UCD candidates from pre-existing photometry of both groups, and obtained spectra of these candidates using the VLT FORS2 instrument in MXU mode. Archival HST/ACS imaging was used to measure their structural parameters.

We detect 16 and 5 objects belonging to HCG 22 and HCG 90, respectively, covering the magnitude range $-10.0 > M_R > -11.5$ mag. Their integrated colours are consistent with old ages covering a broad range in metallicities (metallicities confirmed by the spectroscopic measurements). Photometric mass estimates put 4 objects in HCG 90 and 9 in HCG 22 in the mass range of UCDs ($> 2 \times 10^6 M_\odot$) for an assumed age of 12 Gyr. These UCDs are on average 2-3 times larger than the typical size of Galactic GCs, covering a range of $2 < r_h < 21$ pc. The UCDs in HCG 22 are more concentrated around the central galaxy than in HCG 90, at the 99% confidence level. They cover a broad range in [α/Fe] abundances from sub- to super-solar. The spectra of 3 UCDs (2 in HCG 22, 1 in HCG 90) show tentative evidence of intermediate age stellar populations. The clearest example is the largest and most massive UCD ($\sim 10^7 M_\odot$) in our sample, which is detected in HCG 22. Its properties are most consistent with a stripped dwarf galaxy nucleus. We calculate the specific frequency (S_N) of UCDs for both groups, finding that HCG 22 has about three times higher S_N than HCG 90.

The ensemble properties of the detected UCDs supports two co-existing formation channels: a star cluster origin (low-luminosity, compact sizes, old ages, super-solar α/Fe), and an origin as tidally stripped dwarf nuclei (more extended and younger stellar populations). Our results imply that the UCDs detected in both groups do not, in their majority, originate from relatively recent galaxy interactions. Most of the detected UCDs have likely been brought into the group along with their host galaxies.

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6. Dynamical evolution - Simulations

Direct N-body simulations of globular clusters: (I) Palomar 14

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We present the first ever direct N-body computations of an old Milky Way globular cluster over its entire life time on a star-by-star basis. Using recent GPU hardware at Bonn University, we have performed a comprehensive set of N-body calculations to model the distant outer halo globular cluster Palomar 14 (Pal 14). Pal 14 is unusual in that its density is about ten times smaller than that in the solar neighborhood. By varying the initial conditions we aim at finding an initial N-body model which reproduces the observational data best in terms of its basic parameters, i.e. half-light radius, mass and velocity dispersion. We furthermore focus on reproducing the mass function slope of Pal 14 which was found to be significantly shallower than in most globular clusters.

While some of our models can reproduce Pal 14's basic parameters reasonably well, we find that dynamical mass segregation alone cannot explain the mass function slope of Pal 14 when starting from the canonical Kroupa IMF. In order to seek for an explanation for this discrepancy, we compute additional initial models with varying degrees of primordial mass segregation as well as with a flattened IMF. The necessary degree of primordial mass segregation turns out to be very high, though, such that we prefer the latter hypothesis which we discuss in detail. This modelling has shown that the initial conditions of Pal 14 to reach its current state must have been a half-mass radius of about 20 pc, a mass of about 50000 $M_\odot$, and some mass segregation but in particularly with an already established non-canonical IMF depleted in low-mass stars. Such conditions might be obtained by a violent early gas-expulsion phase from an embedded cluster born with mass segregation. Only at large Galactocentric radii are cluster likely to survive as bound entities the destructive gas-expulsion process we seem to have uncovered for Pal 14.

In addition we compute a model with a 5% primordial binary fraction to test if such a population has an effect on the cluster's evolution. We see no significant effect, though, and moreover find that the binary fraction of Pal 14 stays almost the same and gives the final fraction over its entire life time due to the cluster's extremely low density. Low-density, halo globular clusters might therefore be good targets to test primordial binary fractions of globular clusters.

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Star Clusters Under Stress: Why Small Clusters Cannot Dynamically Relax

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Utilizing a series of N-body simulations, we argue that gravitationally bound stellar clusters of modest population evolve very differently from the picture presented by classical dynamical relaxation theory. The system's most massive stars rapidly sink toward the center and form binary systems. These binaries efficiently heat the cluster, reversing any incipient core contraction and driving a subsequent phase of global expansion. Most previous theoretical studies demonstrating deep and persistent dynamical relaxation have either conflated the process with mass segregation, ignored three-body interactions, or else adopted the artificial assumption that all cluster members are single stars of identical mass. In such a uniform-mass cluster, binary formation is greatly delayed, as we confirm here both numerically and analytically. The relative duration of core contraction and global expansion is affected by stellar evolution, which causes the most massive stars to die out before they form binaries. In clusters of higher N, the epoch of dynamical relaxation lasts for progressively longer periods. By extrapolating our results to much larger populations, we can understand, at least qualitatively, why some globular clusters reach the point of true core collapse.

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7. Miscellaneous

Anchoring the Universal Distance Scale via a Wesenheit Template

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A VI Wesenheit diagram featuring SX Phoenicis, delta Scuti, RR Lyrae, type II and classical Cepheid variables is calibrated by means of geometric-based distances inferred from HST, Hipparcos, and VLBA observations (n=30). The distance to a target population follows from the offset between the observed Wesenheit magnitudes and the calibrated template. The method is evaluated by ascertaining the distance moduli for the LMC ($\mu_0 = 18.43 \pm 0.03$ se) and the globular clusters omega Cen, M54, M13, M3, and M15. The results agree with estimates cited in the literature, although a nearer distance to M13 is favoured (pending confirmation of the data's photometric zero-point) and observations of variables near the core of M15 suffer from photometric contamination. The calibrated LMC data is subsequently added to the Wesenheit template since that galaxy exhibits precise OGLE photometry for innumerable variables of differing classes, that includes recent observations for delta Scuti variabl! es indicating the stars follow a steeper VI Wesenheit function than classical Cepheids pulsating in the fundamental mode. VI photometry for the calibrators is tabulated to facilitate further research, and includes new observations acquired via the AAVSO's robotic telescope network (e.g., VY Pyx: V=7.25 and V-I=0.67). The approach outlined here supersedes the lead author's prior first-order effort to unify variables of the instability strip in order to establish reliable distances.

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Identifying star clusters in a field: A comparison of different algorithms

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Star clusters are often hard to find, as they may lie in a dense field of background objects or, because in the case of embedded clusters, they are surrounded by a more dispersed population of young stars. This paper discusses four algorithms that have been developed to identify clusters as stellar density enhancements in a field, namely stellar density maps from star counts, the neareast neighbour method and the Voronoi tessellation, and the separation of minimum spanning trees. These methods are tested and compared to each other by applying them to artificial clusters of different sizes and morphologies. While distinct centrally concentrated clusters are detected by all methods, clusters with low overdensity or highly hierarchical structure are only reliably detected by methods with inherent smoothing (star counts and nearest neighbour method). Furthermore, the algorithms differ strongly in computation time and additional parameters they provide. Therefore, the method to choose primarily depends on the size and character of the investigated area and the purpose of the study.

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Star Clusters, Galaxies, and the Fundamental Manifold

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(1) Univ. of Arizona, (2) Univ. of Florida

We explore whether global observed properties, specifically half-light radii, mean surface brightness, and integrated stellar kinematics, suffice to unambiguously differentiate galaxies from star clusters, which presumably formed differently and lack dark matter halos. We find that star clusters lie on the galaxy scaling relationship referred to as the Fundamental Manifold (FM), on the extension of a sequence of compact galaxies, and so conclude that there is no simple way to differentiate star clusters from ultra-compact galaxies. By extending the validity of the FM over a larger range of parameter space and a wider set of objects, we demonstrate that the physics that constrains the resulting baryon and dark matter distributions in stellar systems is more general than previously appreciated. The generality of the FM implies 1) that the stellar spatial distribution and kinematics of one type of stellar system do not arise solely from a process particular to that set of systems, such as violent relaxation for elliptical galaxies, but are instead the result of an interplay of all processes responsible for the generic settling of baryons in gravitational potential wells, 2) that the physics of how baryons settle is independent of whether the system is embedded within a dark matter halo, and 3) that peculiar initial conditions at formation or stochastic events during evolution do not ultimately disturb the overall regularity of baryonic settling. We also utilize the relatively simple nature of star clusters to relate deviations from the FM to the age of the stellar population and find that stellar population models systematically and significantly over predict the mass-to-light ratios of old, metal-rich clusters. We present an empirical calibration of stellar population mass-to-light ratios with age and color. Finally, we use the FM to estimate velocity dispersions for the low-surface brightness, outer halo clusters that lack such measurements.

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New catalogue of optically visible open clusters and candidates - version 3.1 (2010)

W. S. Dias[1], B. S. Alessi, A. Moitinho[2] and J. R. D. Lépine[1]

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We are pleased to announce that the most recent version (3.1) of the DAML02 Catalogue is available online. In this new edition (version 3.1), we included 50 new open cluster candidates in the database. Virtually all papers published after the version 3.0 of the catalogue were investigated resulting in the inclusion of new fundamental parameters, mean radial velocities and metallicities for various clusters. Corrections of coordinates, apparent diameters and names for the open clusters were performed.

The complete statistical information is:

Number of clusters: 2140
Clusters with Diameters: 2136 (99.8%)
Clusters with Distances: 1310 (61.2%)
Clusters with Reddening: 1290 (60.3%)
Clusters with Ages: 1270 (59.3%)
Clusters with Dist,Redd. and Ages: 1259 (58.8%)
Clusters with Proper motions: 890 (42.5%)
Clusters with Radial velocities: 505 (23.5%)
Clusters with P.Motions + RVs: 484 (22.6%)
Clusters with Dist,Ages,PMS and RVs 467 (21.8%)
Clusters with Abundances: 187 (8.7%)

This catalogue is being constantly updated and maintained in electronic form for the widest possible accessibility. The latest version (3.1) can be accessed on line at http://www.astro.iag.usp.br/˜wilton All efforts are being made to examine critically the data included in the catalogue, specially when data from different authors are available. Part of the data are results of our own measurements, and a number of private communications are included. The data sources are always stated. This catalogue has been used and cited in more than 200 papers. Like in the past more than one catalogue were available in the literature, the present one does not intend to be the unique one, but it is certainly a major one. Please, send your comments, suggestions and published results.

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Postdoctoral position in star cluster evolution and resolved stellar populations

Kavli Institute for Astronomy & Astrophysics, Peking University, China

Applications are invited for a postdoctoral position based at the Kavli Institute for Astronomy and Astrophysics (KIAA) at Peking University. The successful applicant will work with Prof. Richard de Grijs on a programme of forefront research into the formation and evolution of star clusters and their galactic-field environments. Depending on the successful applicant's background and expertise, the project will involve either (i) analysis of high-resolution spectroscopy combined with aspects of numerical modelling or (ii) resolved stellar population studies of the Magellanic Clouds or the Galactic Centre region based on new near-infrared VISTA observations. Applicants are encouraged to propose programmes of their own interest within these constraints.

The Institute is designed to be a forum for global scientific exchange and a training centre for international postdocs and students. KIAA organises a variety of academic activities and programmes to stimulate research and promote interdisciplinary interactions. The working language is English and there is a broad mix of international faculty and postdocs. The successful applicant will be given the opportunity to supervise some of the highly talented Peking University graduate students.

The appointment is grant supported and will be made for two years from 1 March 2011 or as soon as possible thereafter. Informal enquiries are welcomed by Prof. Richard de Grijs (grijs@pku.edu.cn). To apply, send a cover letter, CV, and research plan (maximum 3 pages in 12pt font) to grijs@pku.edu.cn. Assessment of complete applications will begin on **1 January 2011** until a suitable candidate has been identified. Recommendation letters will be taken up for short-listed applicants only.

Postdoc Position in Theoretical/Computational Astrophysics

Jacobs University, Bremen, Germany

A postdoc position in the field of theoretical/computational astrophysics is at Jacobs University, Bremen is available immediately, without any restriction on citizenship.

The successful candidate will have a PhD in Physics or Astrophysics, in exceptional cases also in Mathematics or Computer Science.

The main topic of the project will be related to the tidal disruption of stars by massive black holes, but other topics related to compact objects may also be studied. The current research interests of the group comprise space-plasma physics, galaxy clusters, compact objects, binary systems, supernova explosions, Gamma-ray bursts, nucleosynthesis, sources of gravitational waves and computational methods.

Jacobs University Bremen is an English-speaking private research University in the North of Germany. Jacobs University has excellent local computing facilities and access to national supercomputing centres.

The selection process will begin **15 December 2010,** but applications will be considered for as long as the position is available.

Potential applicants are encouraged to make informal enquiries to

Prof. Dr. Stephan Rosswog
Jacobs University Bremen
Campus Ring 1
28759 Bremen, Germany
Email: s.rosswog@jacobs-university.de
http://www.faculty.iu-bremen.de/srosswog

Candidates should send HARDCOPIES (no emails, please) of their application material (curriculum vitae, publication list, summary of current research interests; max. 2 pages) to the above address. They should also arrange for two letters of reference to arrive by the same date.

Three HERMES Super Science Fellowships at Macquarie University

The Department of Physics and Astronomy at Macquarie University seeks to appoint THREE (3) highly-motivated Super Science Fellows to carry out research related to the HERMES project. HERMES is an innovative new multi-object high-resolution spectrograph being built for the Anglo-Australian Telescope, specifically designed for conducting large stellar surveys, which will observe more than 1 million stars in the Galactic disk and Magellanic Clouds in order to test current theories of galaxy formation and stellar astrophysics (see http://www.aao.gov.au/HERMES). The Super Science Fellows will work with Dr. Daniel Zucker and the other members of the HERMES Super Science team (Freeman, Bland-Hawthorn, Lattanzio, De Silva), as well as with collaborators at the Australian Astronomical Observatory, Australian National University, the University of Sydney, Monash University and other universities and institutes around the world. The Fellows will lay the groundwork for, and exploit the data flowing from, the massive Galactic Archaeology and Magellanic Cloud surveys planned for HERMES. These surveys will obtain detailed elemental abundances and precision radial velocities for over a million stars, yielding a dataset uniquely suited to a wide range of astrophysical research, and directly complementary to major projects such as ESA's Gaia mission. Macquarie University, a dynamic research and teaching institution, is located on a park-like campus in suburban Sydney, Australia, in close proximity to the headquarters of the Australian Astronomical Observatory (AAO) and the Australia Telescope National Facility (ATNF). The Astronomy and Astrophysics group at Macquarie has undergone a rapid expansion in the past 5 years, now comprising over 35 faculty, postdoctoral researchers and students, making it one of the largest and most active astronomy groups within Australia. In order to enhance collaboration between the participating institutions, the Fellows will have the opportunity to visit the AAO, ANU, Monash, and the University of Sydney for up to a year.

The Fellowships are full-time, fixed-term 3 year positions, available from 1 July 2011, with research funds of AUD$25,000 per year per fellow attached to the project. There are also two PhD scholarships associated with the project, and Fellows will have the opportunity to co-supervise these students. Applicants should have a PhD in a relevant field (e.g., astronomy or physics), usually awarded not more than 3 years before the nominal start date for the Fellowships (1 July 2011); a demonstrated track record of ongoing research and publication, with an emphasis on observational or theoretical astronomy; the ability to carry out independent research and the ability or capacity to develop research collaborations; the ability or capacity to attract and supervise research students, and to obtain competitive funding; the ability to work independently and as a member of a team; and excellent written, verbal and interpersonal communication skills.

Applications must be submitted through the Macquarie University jobs website:
http://www.mq.edu.au/jobs , Reference No. 00V8B.

Candidates should include a CV, list of publications, contact details for three referees, and a one to two page statement about their research interests and how these would contribute to the HERMES project. Applications must be received by **15 December 2010**.

The positions have an annual salary package from AUD$91,916 per annum, including (Level B) base salary from AUD$77,670 to AUD$92,103, plus 17% employer's superannuation contribution and annual leave loading. Relocation assistance will be provided in accordance with the Macquarie University Relocation Guidelines.

Postdoctoral Research Associate in the Astrophysical Relativity division of the Max-Planck Institut fuer Gravitationsphysik (Albert Einstein-Institut)

The Astrophysical Relativity division of the AEI in Golm, close to Potsdam and Berlin, (URL: http://www.aei.mpg.de) is seeking applications for a postdoctoral position in the area of theoretical and numerical astrophysics.

The successful candidate is expected to work with Pau Amaro-Seoane and Luciano Rezzolla on the modeling and identification of electromagnetic counterparts to the gravitational radiation emitted by binaries of (super)massive black holes. This includes modeling of gravitational-wave sources, numerical relativity, and related astrophysical topics.

Research of the AEI group focuses on studies of gravitational waves from the point of view of theoretical and numerical astrophysics, numerical relativity and data analysis.

The positions are for one year and renewable up to three depending on satisfactory progress. The appointments are expected to begin around Sept. 1, 2011, but an earlier date is also possible.

Please note that:

The deadline for applications is Dec. 15, 2010

Applicants should upload a CV, a publication list, a research summary and should arrange for 3 letters of reference.

URL for submission:
https://lotus1.aei.mpg.de/job-form.nsf/registrationNR.xsp

URL for more information:
http://numrel.aei.mpg.de

Please contact Pau Amaro-Seoane (Pau.Amaro-Seoane[at]aei.mpg.de) and Luciano Rezzolla (Luciano.Rezzolla[at]aei.mpg.de) if you have any questions. Submissions only via the web interface.