$\mathcal{SCYON}$

The Star Clusters Young & Old Newsletter

edited by Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

SCYON can be found at URL:
`http://astro.u-strasbg.fr/scyon`

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EDITORIAL

Dear Colleagues,

after some unexpected delays we are now happy to send you the 42nd issue of the SCYON newsletter. In total we have 25 abstracts from refereed publications and a summary of the thesis work of Bernhard Baumann from Vienna University.

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

Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

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@astro.u-strasbg.fr.

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

The Clustering Behavior of Pre-Main Sequence Stars in NGC 346 in the Small Magellanic Cloud

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We present evidence that the star-forming region NGC 346/N66 in the Small Magellanic Cloud is the product of hierarchical star formation, probably from more than one star formation event. We investigate the spatial distribution and clustering behavior of the pre-main sequence (PMS) stellar population in the region, using data obtained with Hubble Space Telescope's Advanced Camera for Surveys. By applying the nearest neighbor and minimum spanning tree methods on the rich sample of PMS stars previously discovered in the region we identify ten individual PMS clusters in the area and quantify their structures. The clusters show a wide range of morphologies from hierarchical multi-peak configurations to centrally condensed clusters. However, only about 40 per cent of the PMS stars belong to the identified clusters. The central association NGC 346 is identified as the largest stellar concentration, which cannot be resolved into subclusters. Several PMS clusters are aligned along filaments of higher stellar density pointing away from the central part of the region. The PMS density peaks in the association coincide with the peaks of [OIII] and 8 μm emission. While more massive stars seem to be concentrated in the central association when considering the entire area, we find no evidence for mass segregation within the system itself.

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Also available from the URL `http://arxiv.org/abs/0812.3080`

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2. Galactic Open Clusters

Universality of young cluster sequences

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I. Physikalisches Institut University of Cologne

Most stars do not form in isolation but as part of a cluster comprising anywhere between a few dozen to several million stars with stellar densities ranging from 0.01 to several $10^5 M_\odot$ pc^{-3}. The majority of these clusters dissolve within 20 Myr. The general assumption is that clusters are born more or less over this entire density range. A new analysis of cluster observations is presented. It demonstrates that, in fact, clustered star formation works under surprisingly tight constraints with respect to cluster size and density. The observed multitude of cluster densities simply results from snapshots of two sequences evolving in time along pre-defined tracks in the density-radius plane. This implies that the cluster size can actually be used to determine its age.

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SPITZER/IRAC-MIPS Survey of NGC2451A and B: Debris Disks at 50-80 million years

Z. Balog, L. L. Kiss, J. Vinko, G. H. Rieke, J. Muzerolle, A. Gaspar, E. T. Young, N. Gorlova

Univ. of Arizona, Univ. of Sudney, Univ. of Szeged, Univ. of Arizona, Univ. of Arizona, Univ. of Arizona, Univ. of Florida

We present a Spitzer IRAC and MIPS survey of NGC 2451 A and B, two open clusters in the 50-80 Myr age range. We complement these data with extensive ground-base d photometry and spectroscopy to identify the cluster members in the Spitzer survey field. We find only two members with 8 micron excesses. The incidence of exc esses at 24 microns is much higher, 11 of 31 solar-like stars and 1 of 7 early-type (A) stars. This work nearly completes the debris disk surveys with Spitzer of clusters in the 30-130 Myr range. This range is of interest because it is when large planetesimal collisions may have still been relatively common (as indicated by the one that led to the formation of the Moon during this period of the evolution of the Solar System). We review the full set of surveys and find that there are only three possible cases out of about 250 roughly solar-mass stars where very large excesses suggest that such collisions have occurred recently.

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Open Cluster ASCC21 as a Probable Birthplace of the Neutron Star Geminga

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We analyze the encounters of the neutron star Geminga with open star clusters in the OB association OriOB1a through the integration of epicyclic orbits into the past by taking into account the errors in the data. The open cluster ASCC21 is shown to be the most probable birthplace of either a single progenitor star for the Geminga pulsar or a binary progenitor system that subsequently broke up. Monte Carlo simulations of Geminga–ASCC21 encounters with the pulsar radial velocity $V_r = -100 \pm 50$ km s^{-1} have shown that close encounters could occur between them within ≤ 10 pc at about $t = -0.52$ Myr. In addition, the trajectory of the neutron star Geminga passes at a distance of $\approx$25 pc from the center of the compact OB association λ Ori at about $t = -0.39$ Myr, which is close to the age of the pulsar estimated from its timing.

To appear in : Astronomy Letters, 2009, Vol. 35, No. 6
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O and Na abundance patterns in open clusters of the Galactic disk

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Aims. A global O-Na abundance anti-correlation is observed in globular clusters, which is not present in the Galactic field population. Open clusters are thought to be chemically homogeneous internally. We aim to explore the O and Na abundance pattern among the open cluster population of the Galactic disk. Methods. We combine open cluster abundance ratios of O and Na from high resolution spectroscopic studies in the literature and normalize them to a common solar scale. We compare the open cluster abundances against the globular clusters and disk field. Results. We find that the different environments show different abundance patterns. The open clusters do not show the O-Na anti-correlation at the extreme O-depletion / Na-enhancement as observed in globular clusters. Furthermore, the high Na abundances in open clusters do not match the disk field stars. If real, it may be suggesting that the dissolution of present day open clusters are not a significant contribution to building the Galactic disk. Large-scale homogeneous studies of clusters and field will further confirm the reality of the Na enhancement.

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UKIRT follow-up observations of the old open cluster FSR0358 (Kirkpatrick 1)

D. Froebrich ([1]), H. Meusinger ([2]), C.J. Davis ([3]), S. Schmeja ([4])
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We aim to characterise the properties of the stellar clusters in the Milky Way. Utilising an expectation-maximisation method we determined that the cluster FSR0358, originally discovered by J.D. Kirkpatrick, is the most likely real cluster amongst the cluster candidates from Froebrich et al.. Here we present new deep high resolution near infrared imaging of this object obtained with UKIRT. The analysis of the data reveals that FSR0358 (Kirkpatrick 1) is a 5 ± 2 Gyr old open cluster in the outer Milky Way. Its age, metallicity of Z=0.008 and distance from the Galactic Centre of 11.2kpc are typical for the known old open galactic clusters. So far six of the FSR cluster candidates have been identified as having an age above 5Gyr. This shows the significance of this catalogue in enhancing our knowledge of the oldest open clusters in the Galaxy.

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The Cassiopeia-Perseus Open Cluster Family

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The observed distribution of young open clusters is far from uniform. Statistics shows that, when age, spatial distribution and kinematics are considered simultaneously, they tend to appear in clumps. These young cluster groups or families constitute unambiguously coeval, genetically related complexes associated to the underlying spiral structure. In this paper, we derive detailed physical properties for one of them: the Cassiopeia-Perseus family. With a diameter of about 600 pc, it is located 2 kpc from the Sun, embedded in the Perseus arm, and probably includes 10 to 20 members. It began to form 20 to 40 Myr ago although we find distinctive evidence for at least three generations of star formation organized in two distinct fronts, with the oldest clusters located at lower Galactic longitude than the youngest. The plane roughly defined by the structure is inclined to the Galactic disk with most candidate members located below the disk and moving away from it. Our results for this cluster of clusters suggest that, within a coherent cloud complex, the first generation of star formation is triggered by the shock wave induced by a spiral arm. The second and subsequent generations are sustained by ionization fronts and supernova shocks created by the evolution of the first generation of massive stars. In this particular case, the front moves with average velocity of about 70 km/s in the direction of increasing Galactic longitude. The Cassiopeia-Perseus family and related objects appear to be a close relative of the cluster complexes found in the spiral galaxy M51 or perhaps a younger analog of the Gould Belt.

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Does Collinder 236 host a Cepheid calibrator?

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Photoelectric UBV photometry and star counts are presented for the previously unstudied open cluster Collinder 236, supplemented by observations for stars near the Cepheid WZ Car. Collinder 236 is typical of groups associated with Cepheids, with an evolutionary age of $(3.4 \pm 1.1) \times 10^7$ years, but it is 1944+-71 pc distant, only half the predicted distance to WZ Car. The cluster is reddened by E(B-V) 0.26, and has nuclear and coronal radii of rn 2 arcmin (1.1 pc) and Rc 8 arcmin (4.5 pc), respectively. The Cepheid is not a member of Collinder 236 on the basis of location beyond the cluster tidal radius and implied distance, but its space reddening can be established as E(B-V)=0.268+-0.006 s.e. from 5 adjacent stars. Period changes in WZ Car studied with the aid of archival data are revised. The period of WZ Car is increasing, its rate of $+8.27 \pm 0.19$ s yr^{-1} being consistent with a third crossing of the instability strip.

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Also available from the URL `http://lanl.arxiv.org/abs/0905.0834`
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3. Galactic Globular Clusters

The velocity dispersion and mass-to-light ratio of the remote halo globular cluster NGC 2419

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Precise radial velocity measurements from HIRES on the Keck I telescope are presented for 40 stars in the outer halo globular cluster NGC 2419. These data are used to probe the cluster's stellar mass function and search for the presence of dark matter in this cluster. NGC 2419 is one of the best Galactic globular clusters for such a study due to its long relaxation time ($T_{r0} \approx 10^{10}$ yr) and large Galactocentric distance ($R_{GC} \approx 90$ kpc) — properties that make significant evolutionary changes in the low-mass end of the cluster mass function unlikely. We find a mean cluster velocity of $<v_r> = -20.3 \pm 0.7$ km/sec and an internal velocity dispersion of $\sigma = 4.14 \pm 0.48$ km/sec, leading to a total mass of $(9.0 \pm 2.2) \cdot 10^5$ $M_\odot$ and a global mass-to-light ratio of $M/L_V = 2.05 \pm 0.50$ in solar units. This mass-to-light ratio is in good agreement with what one would expect for a pure stellar system following a standard mass function at the metallicity of NGC 2419. In addition, the mass-to-light ratio does not appear to rise towards the outer parts of the cluster. Our measurements therefore rule out the presence of a dark matter halo with mass larger than $\sim 10^7$ $M_\odot$ inside the central 500 pc, which is lower than what is found for the central dark matter densities of dSph galaxies. We also discuss the relevance of our measurements for alternative gravitational theories such as MOND, and for possible formation scenarios of ultra-compact dwarf galaxies.

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Testing Fundamental Physics with Distant Star Clusters: Analysis of Observational Data on Palomar 14

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We use the distant outer halo globular cluster Palomar 14 as a test case for classical vs. modified Newtonian dynamics (MOND). Previous theoretical calculations have shown that the line-of-sight velocity dispersion predicted by these theories can differ by up to a factor of three for such sparse, remote clusters like Pal 14. We determine the line-of-sight velocity dispersion of Palomar 14 by measuring radial velocities of 17 red giant cluster members obtained using the Very Large Telescope (VLT) and Keck telescope. The systemic velocity of Palomar 14 is 72.28 ± 0.12 km/s. The derived velocity dispersion of 0.38 ± 0.12 km/s of the 16 definite member stars is in agreement with the theoretical prediction for the classical Newtonian case according to Baumgardt et al. (2005). In order to exclude the possibility that a peculiar mass function might have influenced our measurements, we derived the cluster's main sequence mass function down to 0.53 $M_\odot$ using archival images obtained with the Hubble Space Telescope. We found a mass function slope of 1.27 ± 0.44, which is, compared to the canonical mass function, a significantly shallower slope. The derived lower limit on the cluster's mass is higher than the theoretically predicted mass in case of MOND. Our data are consistent with a central density of 0.1 $M_\odot$ pc^{-3}. We need no dark matter in Palomar 14. If the cluster is on a circular orbit, our spectroscopic and photometric results argue against MOND, unless this cluster experienced significant mass loss.

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Mass Segregation in NGC 2298: limits on the presence of an Intermediate Mass Black Hole

Pasquato, Mario; Trenti, Michele; De Marchi, Guido; Gill, Michael; Hamilton, Douglas P.; Miller, M. Coleman; Stiavelli, Massimo; van der Marel, Roeland P.

Theoretical investigations have suggested the presence of Intermediate Mass Black Holes (IMBHs, with masses in the 100-10000 Msun range) in the cores of some Globular Clusters (GCs). In this paper we present the first application of a new technique to determine the presence or absence of a central IMBH in globular clusters that have reached energy equipartition via two-body relaxation. The method is based on the measurement of the radial profile for the average mass of stars in the system, using the fact that a quenching of mass segregation is expected when an IMBH is present. Here we measure the radial profile of mass segregation using main-sequence stars for the globular cluster NGC 2298 from resolved source photometry based on HST-ACS data. The observations are compared to expectations from direct N-body simulations of the dynamics of star clusters with and without an IMBH. The mass segregation profile for NGC 2298 is quantitatively matched to that inferred from simulations without a central massive object over all the radial range probed by the observations, that is from the center to about two half-mass radii. Profiles from simulations containing an IMBH more massive than ∼300-500 Msun (depending on the assumed total mass of NGC 2298) are instead inconsistent with the data at about 3 sigma confidence, irrespective of the IMF and binary fraction chosen for these runs. While providing a null result in the quest of detecting a central black hole in globular clusters, the data-model comparison carried out here demonstrates the feasibility of the method which can also be applied to other globular clusters with resolved photometry in their cores.

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A peculiar H I cloud near the distant globular cluster Pal 4

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We present 21-cm observations of four Galactic globular clusters, as part of the on-going GALFA-H I Survey at Arecibo. We discovered a peculiar H I cloud in the vicinity of the distant (109 kpc) cluster Pal 4, and discuss its properties and likelihood of association with the cluster. We conclude that an association of the H I cloud and Pal 4 is possible, but that a chance coincidence between Pal 4 and a nearby compact high-velocity cloud cannot be ruled out altogether. New, more stringent upper limits were derived for the other three clusters: M 3, NGC 5466, and Pal 13. We briefly discuss the fate of globular cluster gas and the interaction of compact clouds with the Galactic Halo gas.

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An Ultracompact X-ray Binary in the Globular Cluster NGC 1851

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We present far-ultraviolet photometry obtained with the *Hubble Space Telescope* of the low-mass X-ray binary 4U 0513-40 in the globular cluster NGC 1851. Our observations reveal a clear, roughly sinusoidal periodic signal with $P \simeq 17$ min and amplitude 3%-10%. The signal appears fully coherent and can be modeled as a simple reprocessing effect associated with the changing projected area presented by the irradiated face of a white dwarf donor star in the system. All of these properties suggest that the signal we have detected is orbital in nature, thus confirming 4U 0513-40 as an ultracompact X-ray binary (UCXB). All four confirmed UCXBs in globular clusters have orbital periods below 30 minutes, whereas almost all UCXBs in the Galactic field have orbital periods longer than this. This suggests that the dynamical formation processes dominate UCXB production in clusters, producing a different orbital period distribution than observed among field UCXBs. Based on th! e likely system parameters, we show that 4U 0513-40 should be a strong gravitational wave source and may be detectable by LISA over the course of a multi-year mission.

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4. Galactic Center Clusters

Globular cluster systems in nearby dwarf galaxies - II. Nuclear star clusters and their relation to massive Galactic globular clusters

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Using luminosities and structural parameters of globular clusters (GCs) in the nuclear regions (nGCs) of low-mass dwarf galaxies from HST/ACS imaging we derive the present-day escape velocities (v_{esc}) of stellar ejecta to reach the cluster tidal radius and compare them with those of Galactic GCs with extended (hot) horizontal branches (EHBs-GCs). For EHB-GCs, we find a correlation between the present-day v_{esc} and their metallicity as well as $(V\text{-}I)_0$ colour. The similar v_{esc}, $(V\text{-}I)_0$ distribution of nGCs and EHB-GCs implies that nGCs could also have complex stellar populations. The v_{esc}-[Fe/H] relation could reflect the known relation of increasing stellar wind velocity with metallicity, which in turn could explain why more metal-poor clusters typically show more peculiarities in their stellar population than more metal-rich clusters of the same mass do. Thus the cluster v_{esc} can be used as parameter to describe the degree of self-enrichment. The nGCs populate the same Mv vs. rh region as EHB-GCs, although they do not reach the sizes of the largest EHB-GCs like Omega Cen and NGC 2419. We argue that during accretion the rh of an nGC could increase due to significant mass loss in the cluster vicinity and the resulting drop in the external potential in the core once the dwarf galaxy dissolves. Our results support the scenario in which Galactic EHB-GCs have originated in the centres of pre-Galactic building blocks or dwarf galaxies that were later accreted by the Milky Way.

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On the number of young stellar discs in the Galactic Centre

Ulf Löckmann and Holger Baumgardt
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Observations of the Galactic Centre show evidence of disc-like structures of very young stars orbiting the central super-massive black hole within a distance of a few 0.1 pc. While it is widely accepted that about half of the stars form a relatively flat disc rotating clockwise on the sky, there is a substantial ongoing debate on whether there is a second, counter-clockwise disc of stars.

By means of N-body simulations using our BHINT code, we show that two highly inclined stellar discs with the observed properties cannot be recognised as two flat circular discs after 5 Myr of mutual interaction. Instead, our calculations predict a significant warping of the two discs, which we show to be apparent among the structures observed in the Galactic Centre. While the high eccentricities of the observed counter-clockwise orbits suggest an eccentric origin of this system, we show the eccentricity distribution in the inner part of the more massive clockwise disc to be perfectly consistent with an initially circular disc in which stellar eccentricities increase due to both non-resonant and resonant relaxation.

We conclude that the relevant question to ask is therefore not whether there are two discs of young stars, but whether there were two such discs to begin with.

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A New Secular Instability of Eccentric Stellar Disks Around Supermassive Black Holes, with Application to the Galactic center

Ann-Marie Madigan, Yuri Levin and Clovis Hopman
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We identify a new secular instability of eccentric stellar disks around supermassive black holes. We show that retrograde precession of the stellar orbits, due to the presence of a stellar cusp, induces coherent torques that amplify deviations of individual orbital eccentricities from the average, and thus drive all eccentricities away from their initial value. We investigate the instability using N-body simulations, and show that it can drive individual orbital eccentricities to significantly higher or lower values on the order of a precession time-scale.

This physics is relevant for the Galactic center, where massive stars are likely to form in eccentric disks around the SgrA* black hole. We show that the dynamical evolution of such a disk results in several of its stars acquiring high $(1 - e \ll 0.1)$ orbital eccentricity. Binary stars on such highly eccentric orbits would get tidally disrupted by the SgrA* black hole, possibly producing both S-stars near the black hole and high-velocity stars in the Galactic halo.

Submitted to : Astrophysical Journal
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Also available from the URL `http://arxiv.org/abs/0812.3395`
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Explaining the Orbits of the Galactic Center S-Stars

David Merritt, Alessia Gualandris, Seppo Mikkola
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The young stars near the supermassive black hole at the galactic center follow orbits that are nearly random in orientation and that have an approximately thermal distribution of eccentricities, N(e) e. We show that both of these properties are a natural consequence of a few million years' interaction with an intermediate-mass black hole (IBH), if the latter's orbit is mildly eccentric and if its mass exceeds approximately 1500 solar masses. Producing the most tightly-bound S-stars requires an IBH orbit with periastron distance less than about 10 mpc. Our results provide support for a model in which the young stars are carried to the galactic center while bound to an IBH, and are consistent with the hypothesis that an IBH may still be orbiting within the nuclear star cluster.

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5. Dynamical evolution - Simulations

How well do STARLAB and NBODY4 compare? I: Simple models

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N-body simulations are widely used to simulate the dynamical evolution of a variety of systems, among them star clusters. Much of our understanding of their evolution rests on the results of such direct N-body simulations. They provide insight in the structural evolution of star clusters, as well as into the occurrence of stellar exotica. Although the major pure N-body codes STARLAB/KIRA and NBODY4 are widely used for a range of applications, there is no thorough comparison study yet. Here we thoroughly compare basic quantities as derived from simulations performed either with STARLAB/KIRA or NBODY4. We construct a large number of star cluster models for various stellar mass function settings (but without stellar/binary evolution, primordial binaries, external tidal fields etc), evolve them in parallel with STARLAB/KIRA and NBODY4, analyse them in a consistent way and compare the averaged results quantitatively. For this quantitative comparison we develop a bootstrap algorithm for functional dependencies. We find an overall excellent agreement between the codes, both for the clusters' structural and energy parameters as well as for the properties of the dynamically created binaries. However, we identify small differences, like in the energy conservation before core collapse and the energies of escaping stars, which deserve further studies. Our results reassure the comparability and the possibility to combine results from these two major N-body codes, at least for the purely dynamical models (i.e. without stellar/binary evolution) we performed.

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The early evolution of the star cluster mass function

Mark Gieles
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Several recent studies have shown that the star cluster initial mass function (CIMF) can be well approximated by a power law, with indications for a steepening or truncation at high masses. This contribution considers the evolution of such a mass function due to cluster disruption, with emphasis on the part of the mass function that is observable in the first ∼Gyr. A Schechter type function is used for the CIMF, with a power law index of -2 at low masses and an exponential truncation at M*. Cluster disruption due to the tidal field of the host galaxy and encounters with giant molecular clouds flattens the low-mass end of the mass function, but there is always a part of the 'evolved Schechter function' that can be approximated by a power law with index -2. The mass range for which this holds depends on age, t, and shifts to higher masses roughly as $t^{0.6}$. Mean cluster masses derived from luminosity limited samples increase with age very similarly due to the evolutionary fading of clusters. Empirical mass functions are, therefore, approximately power laws with index -2, or slightly steeper, at all ages. The results are illustrated by an application to the star cluster population of the interacting galaxy M51, which can be well described by a model with M*=$(1.9 \pm 0.5) \times 10^5 M_\odot$ and a short (mass-dependent) disruption time destroying M* clusters in roughly a Gyr.

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SimClust - A Program to Simulate Star Clusters

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We present a program tool, SimClust, designed for Monte-Carlo modeling of star clusters. It populates the available stellar isochrones with stars according to the initial mass function and distributes stars randomly following the analytical surface number density profile. The tool is aimed at simulating realistic images of extragalactic star clusters and can be used to: (i) optimize object detection algorithms, (ii) perform artificial cluster tests for the analysis of star cluster surveys, and (iii) assess the stochastic effects introduced into photometric and structural parameters of clusters due to random distribution of luminous stars and non-uniform interstellar extinction. By applying SimClust, we have demonstrated a significant influence of stochastic effects on the determined photometric and structural parameters of low-mass star clusters in the M31 galaxy disk. The source code and examples are available at the SimClust website: `http://www.astro.ff.vu.lt/software/simclust/`.

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Testing fundamental physics with distant star clusters: theoretical models for pressure-supported stellar systems

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We investigate the mean velocity dispersion and the velocity dispersion profile of stellar systems in MOND, using the N-body code N-MODY, which is a particle-mesh based code with a numerical MOND potential solver developed by Ciotti, Londrillo and Nipoti (2006). We have calculated mean velocity dispersions for stellar systems following Plummer density distributions with masses in the range of 104 M(sun) to 109 M(sun) and which are either isolated or immersed in an external field. Our integrations reproduce previous analytic estimates for stellar velocities in systems in the deep MOND regime ($a_i, a_e \ll a_0$), where the motion of stars is either dominated by internal accelerations ($a_i \gg a_e$) or constant external accelerations ($a_e \gg a_i$). In addition, we derive for the first time analytic formulae for the line-of-sight velocity dispersion in the intermediate regime ($a_i \sim a_e \sim a_0$). This allows for a much improved comparison of MOND with observed velocity dispersions of stellar systems. We finally derive the velocity dispersion of the globular cluster Pal 14 as one of the outer Milky Way halo globular clusters that have recently been proposed as a differentiator between Newtonian and MONDian dynamics.

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Tidal disruption of globular clusters in dwarf galaxies with triaxial dark matter haloes

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We use N-body simulations to study the tidal evolution of globular clusters (GCs) in dwarf spheroidal (dSph) galaxies. Our models adopt a cosmologically motivated scenario in which the dSph is approximated by a static NFW halo with a triaxial shape. We apply our models to five GCs spanning three orders of magnitude in stellar density and two in mass, chosen to represent the properties exhibited by the five GCs of the Fornax dSph. We show that only the object representing Fornax's least dense GC (F1) can be fully disrupted by Fornax's internal tidal field—the four denser clusters survive even if their orbits decay to the centre of Fornax. For a large set of orbits and projection angles we examine the spatial and velocity distribution of stellar debris deposited during the complete disruption of an F1-like GC. Our simulations show that such debris appears as shells, isolated clumps and elongated over-densities at low surface brightness (≥ 26 mag/arcsec^2), reminiscent of substructure observed in several MW dSphs. Such features arise from the triaxiality of the galaxy potential and do *not* dissolve in time. The kinematics of the debris depends strongly on the progenitor's orbit. Debris associated with box and resonant orbits does not display stream motions and may appear "colder"/"hotter" than the dSph's field population if the viewing angle is perpendicular/parallel to progenitor's orbital plane. In contrast, debris associated with loop orbits shows a rotational velocity that may be detectable out to few kpc from the galaxy centre. Chemical tagging that can distinguish GC debris from field stars may reveal whether the merger of GCs contributed to the formation of multiple stellar components observed in dSphs.

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6. Miscellaneous

Accuracy of Star Cluster Parameters from Integrated UBVRIJHK Photometry

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We investigate the capability of the UBVRIJHK photometric system to quantify star clusters in terms of age, metallicity and color excess by their integrated photometry in the framework of PEGASE single stellar population (SSP) models. The age-metallicity-extinction degeneracy was analyzed for various parameter combinations, assuming different levels of photometric accuracy. We conclude, that most of the parameter degeneracies, typical to the UBVRI photometric system, are broken in the case when the photometry data are supplemented with at least one infrared magnitude of the JHK passbands, with an accuracy better than 0.05 mag. The presented analysis with no preassumptions on the distribution of photometric errors of star cluster models, provides estimate of the intrinsic capability of any photometric system to determine star cluster parameters from integrated photometry.

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What does a universal IMF imply about star formation?

Simon P. Goodwin and M.B.N. Kouwenhoven
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We show that the same initial mass function (IMF) can result from very different modes of star formation from very similar underlying core and/or system mass functions. In particular, we show that the canonical IMF can be recovered from very similar system mass functions, but with very different mass ratio distributions within those systems. This is a consequence of the basically log-normal shapes of all of the distributions. We also show that the relationships between the shapes of the core, system, and stellar mass functions may not be trivial. Therefore, different star formation in different regions could still result in the same IMF.

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Recurrent gas accretion by massive star clusters, multiple stellar populations and mass thresholds for spheroidal stellar systems

Jan Pflamm-Altenburg, Pavel Kroupa
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We explore the gravitational influence of pressure supported stellar systems on the internal density distribution of a gaseous environment. We conclude that compact massive star clusters with masses $\geq 10^6 M_\odot$ act as cloud condensation nuclei and are able to accrete gas recurrently from a warm interstellar medium which may cause further star formation events and account for multiple stellar populations in the most massive globular and nuclear star clusters. The same analytical arguments can be used to decide whether an arbitrary spherical stellar system is able to keep warm or hot interstellar material or not. These mass thresholds coincide with transition masses between pressure supported galaxies of different morphological types.

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Statistische Auswertung der homogenen Koordinatensätze offener Sternhaufen in WEBDA
(Statistical analysis of homogeneous data sets within open clusters in WEBDA)

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High accurate positional data of stars within the boundaries of open clusters are needed to determine membership probabilities and thus more precise cluster parameters (age, reddening, and distance). Unfortunately, such data sets are very much missing in the literature.
On the basis of WEBDA, the database for open clusters, a statistical analysis of the currently available positional and kinematic data was started. Currently, there are about 140 000 (B1950), 650 000 (J2000) and 1 200 000 [X,Y] coordinates included.
The availability of B1950 coordinates does not imply that there are also J2000 coordinates for the same object and vice versa. So I developed several Perl programs which perform the transformation and the calculation of the mean values of stars with available multiple coordinates. With the help of these programs, the already available J2000 coordinates can be compared with the calculated ones and are programmed in a way that they can be easily applied to newly published data sets. The transformation algorithm is mainly based on the method described in Jean Meeus (1998, Astronomical algorithms (2nd ed.), Richmond, Willmann-Bell Verlag) and Peter Duffett-Smith (1979, Practical Astronomy with your calculator, 1979, Cambridge Univ. Press).
The analysis is naturally connected with a quality check of the database content and the identification of erroneous entries.
About 140 000 measurements were transformed from B1950 into J2000 coordinates. For 93404 data in 446 open clusters, we were able to check the differences of the calculated versus the published J2000 coordinates. In addition the calculated proper motions of 334 open star clusters could be compared with the published ones and so checked and verified.

Bakkalaureatsarbeit (in german), University Vienna
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Star Clusters - Witnesses of Cosmic History
September 8-12, 2008, Vienna, Austria

Dear Colleagues,

we would like to draw your attention to the talks and posters presented at the Symposium "Star Clusters - Witnesses of Cosmic History" within the JENAM 2008 Meeting in Vienna which have now been made available online. You can find the topics and presentations at the following URL:

`http://www.univie.ac.at/webda/minisymposium.html.`

With best regards,

Ernst Paunzen (on behalf of the SOC)