SCYON

The Star Clusters Young & Old Newsletter

edited by Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

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EDITORIAL

This is the 48st issue of the SCYON newsletter. We have 14 abstracts from refereed publications and conference proceedings and the summary of Sourav Chatterjee's PhD thesis. We would also like to bring to your attention two announcements for job offers from Grenoble and ESA and an announcement for a conference at ESO-Santiago in April 2011.

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

Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

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SCYON POLICY

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

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

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

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

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

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1. Star Forming Regions

Variations in integrated galactic initial mass functions due to sampling method and cluster mass function

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Context Stars are thought to be formed predominantly in clusters. The star clusters are formed according to a cluster initial mass function (CMF) similar to the stellar initial mass function (IMF). Both the IMF and the CMF can be approximated by (broken) power-laws, which favour low-mass objects. The numerous low-mass clusters will lack high mass stars compared to the underlying IMF, since the most massive star cannot be more massive than its host cluster. If the integrated galactic initial mass function (IGIMF, i.e. the total stellar mass function of all stars in a galaxy) originates from stars formed in star clusters, the IGIMF could be steeper than the IMF in clusters.

Aims We investigate how well constrained this steepening is and how it depends on the choice of sampling method and CMF. We investigate the observability of the IGIMF effect in terms of galaxy photometry and metallicities.

Method We study various ways to sample the stellar IMF within star clusters and build up the IGIMF from these clusters. We compare analytic sampling to several implementations of random sampling of the IMF and different CMFs. We implement different IGIMFs into the GALEV evolutionary synthesis package to obtain colours and metallicities for galaxies.

Results Choosing different ways of sampling the IMF results in different IGIMFs. Depending on the lower cluster mass limit and the slope of the cluster mass function, the steepening varies between very strong and negligible. We find the size of the effect is continuous as a function of the power-law slope of the CMF if the CMF extends to masses smaller than the maximum stellar mass. The number of O-stars detected by GAIA will, if some uncertain factors are better understood, help to judge the importance of the IGIMF effect. The impact of different IGIMFs on integrated galaxy photometry is small, within the intrinsic scatter of observed galaxies. Observations of gas fractions and metallicities could rule out at least the most extreme sampling methods, if other sources of error are sufficiently understood.

Conclusions As we still do not understand the details of star formation and the sampling of the stellar IMF in clusters, one sampling method cannot be favoured over another. Also, the CMF at very low cluster masses is not well constrained observationally. These uncertainties therefore need to be taken into account when using an IGIMF, with severe implications for galaxy evolution models and interpretations of galaxy observations.

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Escaping stars from young low-N clusters

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With the use of N-body calculations the amount and properties of escaping stars from low-N (N = 100 and 1000) young embedded star clusters prior to gas expulsion are studied over the first 5 Myr of their existence. Besides the number of stars also different initial radii and binary populations are examined as well as virialised and collapsing clusters. It is found that these clusters can loose substantial amounts (up to 20%) of stars within 5 Myr with considerable velocities up to more than 100 km/s. Even with their mean velocities between 2 and 8 km/s these stars will still be travelling between 2 and 30 pc during the 5 Myr. Therefore can large amounts of distributed stars in star-forming regions not necessarily be counted as evidence for the isolated formation of stars.

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2. Galactic Open Clusters

Chemical composition of A and F dwarfs members of the Hyades open cluster

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Abundances of 15 chemical elements have been derived for 28 F and 16 A stars members of the Hyades open cluster in order to set constraints on self-consistent evolutionary models including radiative and turbulent diffusion.
A spectral synthesis iterative procedure was applied to derive the abundances from selected high quality lines in high resolution high signal-to-noise spectra obtained with SOPHIE and AURELIE at the Observatoire de Haute Provence.
The abundance patterns found for A and F stars in the Hyades resemble those observed in Coma Berenices and Pleiades clusters. In graphs representing the abundances versus the effective temperature, A stars often display abundances much more scattered around their mean values than the coolest F stars do. Large star-to-star variations are detected in the Hyades A dwarfs in their abundances of C, Na, Sc, Fe, Ni, Sr, Y and Zr, which we interpret as evidence of transport processes competing with radiative diffusion.
In A and Am stars, the abundances of Cr, Ni, Sr, Y and Zr are found to be correlated with that of iron as in the Pleiades and in Coma Berenices. The ratios [C/Fe] and [O/Fe] are found to be anticorrelated with [Fe/H] as in Coma Berenices. All Am stars in the Hyades are deficient in C and O and overabundant in elements heavier than Fe but not all are deficient in calcium and/or scandium. The F stars have solar abundances for almost all elements except for Si.
The overall shape of the abundance pattern of the slow rotator HD30210 cannot be entirely reproduced by models including radiative diffusion and different amounts of turbulent diffusion.
While part of the discrepancies between derived and predicted abundances could be due to non-LTE effects, the inclusion of competing processes such as rotational mixing and/or mass loss seems necessary in order to improve the agreement between the observed and predicted abundance patterns.

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Photometric characterization of the Galactic star cluster Trumpler 20

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We present deep *UBVI* photometry for Trumpler 20, a rich, intermediate-age open cluster located at $l = 301.47°$, $b = +2.22°$ ($\alpha = 12^h\ 39^m\ 34^s$, $\delta = -60°\ 37'\ 00''$, J2000.0) in the fourth Galactic quadrant. In spite of its interesting properties, this cluster has received little attention, probably because the line of sight to it crosses twice the Carina spiral arm (and possibly also the Scutum-Crux arm), which causes a significant contamination of its color-magnitude diagram (CMD) by field stars, therefore complicating seriously its interpretation. In this paper we provide more robust estimates of the fundamental parameters of Trumpler 20, and investigate the most prominent features of its CMD: a rich He-burning star clump, and a vertical sequence of stars above the turnoff, which can be either blue stragglers or field stars. Our precise photometry, in combination with previous investigations, has allowed us to derive updated values of the age and heliocentric distance of Trumpler 20, which we estimate to be 1.4 ± 0.2 Gyr and 3.0 ± 0.3 kpc, respectively. As predicted by models, at this age the clump has a tail towards fainter magnitudes and bluer colors, thus providing further confirmation of the evolutionary status of stars in this particular phase. The derived heliocentric distance places the cluster in the inter-arm region between the Carina and Scutum arms, which naturally explains the presence of the vertical sequence of stars (which was originally interpreted as the cluster itself) observed in the upper part of the CMD. Most of these stars would therefore belong to the general galactic field, while only a few of them would be *bona fide* cluster blue stragglers. Our data suggest that the cluster metallicity is solar, and that its reddening is $E(B\text{-}V) = 0.35 \pm 0.04$. Finally, we believe we have solved a previously reported inconsistency between the spectroscopic temperatures and colors of giant stars in the cluster.

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Old Star Clusters in the FSR catalogue

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We investigate the old star clusters in the sample of cluster candidates from Froebrich, Scholz & Raftery 2007 – the FSR list. Based on photometry from the 2-Micron All Sky Survey we generated decontaminated colour-magnitude and colour-colour diagrams to select a sample of 269 old stellar clusters. This sample contains 63 known globular clusters, 174 known open clusters and 32 so far unclassified objects. Isochrone fitting has been used to homogeneously calculate the age, distance and reddening to all clusters. The mean age of the open clusters in our sample is 1Gyr. The positions of these clusters in the Galactic Plane show that 80% of open clusters older than 1Gyr have a Galactocentric distance of more than 7kpc. The scale height for the old open clusters above the Plane is 375pc, more than three times as large as the 115pc which we obtain for the younger open clusters in our sample. We find that the mean optical extinction towards the open clusters in the disk of the Galaxy is 0.70mag/kpc. The FSR sample has a strong selection bias towards objects with an apparent core radius of 30" to 50" and there is an unexplained paucity of old open clusters in the Galactic Longitude range of 120deg $< l <$ 180deg.

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3. Galactic Globular Clusters

Is the distant globular cluster Pal 14 in a deep-freeze?

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We investigate the velocity dispersion of Pal 14, an outer Milky-Way globular cluster at Galactocentric distance of 71 kpc with a very low stellar density (central density 0.1-0.2 $M_\odot/pc^3$). Due to this low stellar density the binary population of Pal 14 is likely to be close to the primordial binary population.

Artificial clusters are generated with the observed properties of Pal 14 and the velocity dispersion within these clusters is measured as Jordi et al. (2009) have done with 17 observed stars of Pal 14. We discuss the effect of the binary population on these measurements and find that the small velocity dispersion of 0.38 km/s which has been found by Jordi et al. (2009) would imply a binary fraction of less than 0.1, even though from the stellar density of Pal 14 we would expect a binary fraction of more than 0.5. We also discuss the effect of mass segregation on the velocity dispersion as possible explanation for this discrepancy, but find that it would increase the velocity dispersion further.

Thus, either Pal 14 has a very unusual stellar population and its birth process was significantly different than we see in today's star forming regions, or the binary population is regular and we would have to correct the observed 0.38 km/s for binarity. In this case the true velocity dispersion of Pal 14 would be much smaller than this value and the cluster would have to be considered as "kinematically frigid", thereby possibly posing a challenge for Newtonian dynamics but in the opposite sense to MOND.

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Also available from the URL http://esoads.eso.org/abs/2010arXiv1005.0384K

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Title: VLT Kinematics for omega Centauri: Further Support for a Central Black Hole

Eva Noyola[1,2], Karl Gebhardt[3], Markus Kissler-Patig[4], Nora Lützgendorf[4], Behrang Jalali[4], P. Tim de Zeeuw[4,5], Holger Baumgardt[6]

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The Galactic globular cluster omega Centauri is a prime candidate for hosting an intermediate mass black hole. Recent measurements lead to contradictory conclusions on this issue. We use VLT-FLAMES to obtain new integrated spectra for the central region of omega Centauri. We combine these data with existing measurements of the radial velocity dispersion profile taking into account a new derived center from kinematics and two different centers from the literature. The data support previous measurements performed for a smaller field of view and show a discrepancy with the results from a large proper motion data set. We see a rise in the radial velocity dispersion in the central region to 22.8 ± 1.2 km/s, which provides a strong sign for a central black hole. Isotropic dynamical models for omega Centauri imply black hole masses ranging from 3.0 to 5.2×10^4 solar masses depending on the center. The best-fitted mass is $(4.7 \pm 1.0) \times 10^4$ solar masses.

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Also available from the URL `http://arxiv.org/abs/1007.4559`

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4. Galactic Center Clusters

The Origin of S-stars and a Young Stellar Disk: Distribution of Debris Stars of a Sinking Star Cluster

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Within the distance of 1 pc from the Galactic center (GC), more than 100 young massive stars have been found. The massive stars at 0.1-1 pc from the GC are located in one or two disks, while those within 0.1 pc from the GC, S-stars, have an isotropic distribution. How these stars are formed is not well understood, especially for S-stars. Here, we propose that a young star cluster with an intermediate-mass black hole (IMBH) can form both the disks and S-stars. We performed a fully self-consistent N-body simulation of a star cluster near the GC. Stars that escaped from the tidally disrupted star cluster were carried to the GC due to a 1:1 mean motion resonance with the IMBH formed in the cluster. In the final phase of the evolution, the eccentricity of the IMBH becomes very high. In this phase, stars carried by the 1:1 resonance with the IMBH were dropped from the resonance and their orbits are randomized by a chaotic Kozai mechanism. The mass function of these carried stars is extremely top-heavy within 10". The surface density distribution of young massive stars has a slope of ∼V1.5 within 10" from the GC. The distribution of stars in the most central region is isotropic. These characteristics agree well with those of stars observed within 10" from the GC.

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Disks in the Arches cluster – survival in a starburst environment

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Deep Keck/NIRC2 HK'L' observations of the Arches cluster near the Galactic center reveal a significant population of near-infrared excess sources. We combine the L'-band excess observations with K'-band proper motions, to confirm cluster membership of excess sources in a starburst cluster for the first time. The robust removal of field contamination provides a reliable disk fraction down to our completeness limit of H=19 mag, or about 5 Msun at the distance of the Arches. Of the 24 identified sources with K'-L' > 2.0 mag, 21 have reliable proper motion measurements, all of which are proper motion members of the Arches cluster. VLT/SINFONI K'-band spectroscopy of three excess sources reveals strong CO bandhead emission, which we interpret as the signature of dense circumstellar disks. The detection of strong disk emission from the Arches stars is surprising in view of the high mass of the B-type main sequence host stars of the disks and the intense starburst environment. We find a disk fraction of 6 +/- 2% among B-type stars in the Arches cluster. A radial increase in the disk fraction from 3 to 10% suggests rapid disk destruction in the immediate vicinity of numerous O-type stars in the cluster core. A comparison between the Arches and other high- and low-mass star-forming regions provides strong indication that disk depletion is significantly more rapid in compact starburst clusters than in moderate star-forming environments.

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5. Extragalactic Clusters

The Formation of Spheroids in Early-Type Spirals: Clues From Their Globular Clusters

Aparna Maybhate[1], Paul Goudfrooij[1], Rupali Chandar[2], and Thomas H. Puzia[3]
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We use deep Hubble Space Telescope images taken with the Advanced Camera for Surveys (ACS) in the F475W and F814W filters to investigate the globular cluster systems in four edge-on Sa spiral galaxies covering a factor of 4 in luminosity. The specific frequencies of the blue globular clusters in the galaxies in our sample fall in the range 0.34 − 0.84, similar to typical values found for later-type spirals. The number of red globular clusters associated with the bulges generally increases with the bulge luminosity, similar to what is observed for elliptical galaxies, although the specific frequency of bulge clusters is a factor of 2-3 lower for the lowest luminosity bulges than for the higher luminosity bulges. We present a new empirical relation between the fraction of red globular clusters and total bulge luminosity based on the elliptical galaxies studied by ACSVCS (ACS Virgo Cluster Survey), and discuss how this diagram can be used to assess the importance that dissipative processes played in building spiral bulges. Our results suggest a picture where dissipative processes, which are expected during gas-rich major mergers, were more important for building luminous bulges of Sa galaxies, whereas secular evolution may have played a larger role in building lower-luminosity bulges in spirals.

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6. Dynamical evolution - Simulations

On the mass-radius relation of hot stellar systems

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Most globular clusters have half-mass radii of a few pc with no apparent correlation with their masses. This is different from elliptical galaxies, for which the Faber-Jackson relation suggests a strong positive correlation between mass and radius. Objects that are somewhat in between globular clusters and low-mass galaxies, such as ultra-compact dwarf galaxies, have a mass-radius relation consistent with the extension of the relation for bright ellipticals. Here we show that at an age of 10 Gyr a break in the mass-radius relation at $\sim 10^6$ Msun is established because objects below this mass, i.e. globular clusters, have undergone expansion driven by stellar evolution and hard binaries. From numerical simulations we find that the combined energy production of these two effects in the core comes into balance with the flux of energy that is conducted across the half-mass radius by relaxation. An important property of this 'balanced' evolution is that the cluster half-mass radius is independent of its initial value and is a function of the number of bound stars and the age only. It is therefore not possible to infer the initial mass-radius relation of globular clusters and we can only conclude that the present day properties are consistent with the hypothesis that all hot stellar systems formed with the same mass-radius relation and that globular clusters have moved away from this relation because of a Hubble time of stellar and dynamical evolution.

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Mass loss rates and the mass evolution of star clusters

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We describe the interplay between stellar evolution and dynamical mass loss of evolving star clusters, based on the principles of stellar evolution and cluster dynamics and on a grid of N-body simulations of cluster models. The cluster models have different initial masses, different orbits, including elliptical ones, and different initial density profiles. We use two sets of cluster models: initially Roche-lobe filling and Roche-lobe underfilling. We identify four distinct mass loss effects: (1) mass loss by stellar evolution, (2) loss of stars induced by stellar evolution and (3) relaxation-driven mass loss before and (4) after core collapse. Both the evolution-induced loss of stars and the relaxation-driven mass loss need time to build up. This is described by a delay-function of a few crossing times for Roche-lobe filling clusters and a few half mass relaxation times for Roche-lobe underfilling clusters. The relaxation-driven mass loss can be described by a simple power law dependence of the mass dM/dt =-$M^{1-\gamma}$/t0, (with M in Msun) where t0 depends on the orbit and environment of the cluster. γ is 0.65 for clusters with a King-parameter W0=5 and 0.80 for more concentrated clusters with W0=7. For initially Roche-lobe underfilling clusters the dissolution is described by the same gamma=0.80. The values of the constant t0 are described by simple formulae that depend on the orbit of the cluster. The mass loss rate increases by about a factor two at core collapse and the mass dependence of the relaxation-driven mass loss changes to gamma=0.70 after core collapse. We also present a simple recipe for predicting the mass evolution of individual star clusters with various metallicities and in different environments, with an accuracy of a few percent in most cases. This can be used to predict the mass evolution of cluster systems.

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7. Miscellaneous

The edge of the young Galactic disk

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(1) ESO-Chile (2) La Plata University (3) Chile University (4) Lisbon University

In this work we report and discuss the detection of two distant diffuse stellar groups in the third Galactic quadrant. They are composed of young stars, with spectral types ranging from late O to late B, and lie at galactocentric distances between 15 and 20 kpc. These groups are located in the area of two cataloged open clusters (VdB-Hagen 04 and Ruprecht 30), projected towards the Vela-Puppis constellations, and within the core of the Canis Major over-density. Their reddening and distance has been estimated analyzing their color-color and color-magnitude diagrams, derived from deep UBV photometry. The existence of young star aggregates at such extreme distances from the Galactic center challenges the commonly accepted scenario in which the Galactic disc has a sharp cut-off at about 14 kpc from the Galactic center, and indicates that it extends to much greater distances (as also supported by recent detection of CO molecular complexes well beyond this distance). While the groups we find in the area of Ruprecht 30 are compatible with the Orion and Norma-Cygnus spiral arms, respectively, the distant group we identify in the region of VdB-Hagen 4 lies in the external regions of the Norma-Cygnus arm, at a galactocentric distance (∼20 kpc) where no young stars had been detected so far in the optical

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The galaxy-wide IMF - from star clusters to galaxies

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Over the past years observations of young and populous star clusters have shown that the stellar initial mass function (IMF) can be conveniently described by a two-part power-law with an exponent $\alpha_2 = 2.3$ for stars more massive than about 0.5 $M_\odot$ and an exponent of $\alpha_1 = 1.3$ for less massive stars. A consensus has also emerged that most, if not all, stars form in stellar groups and star clusters, and that the mass function of these can be described as a power-law (the embedded cluster mass function, ECMF) with an exponent $\beta \approx 2$. These two results imply that the integrated galactic IMF (IGIMF) for early-type stars cannot be a Salpeter power-law, but that they must have a steeper exponent. An application to star-burst galaxies shows that the IGIMF can become top-heavy. This has important consequences for the distribution of stellar remnants and for the chemo-dynamical and photometric evolution of galaxies. In this contribution the IGIMF theory is described, and the accompanying contribution by Pflamm-Altenburg, Weidner & Kroupa (this volume) documents the applications of the IGIMF theory to galactic astrophysics.

To appear in the proceedings of the conference/workshop UP: Have Observations Revealed a Variable Upper End of the Initial Mass Function?, held in Sedona, USA 20/06 – 25/06/2010, ASP conference series

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Numerical Modeling of Dense Star Clusters

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Studying the evolution of dense star clusters, such as old globular clusters, is of great interest for a variety of branches of Astronomy, as well as Cosmology. The high central densities and high masses of globular clusters make them hotbeds for strong dynamical interactions. These interactions can create all sorts of exotic sources, such as X-ray binaries, millisecond radio pulsars, type Ia supernovae, and blue straggler stars. Moreover, bright star clusters are important targets for extragalactic Astronomy. Detailed observations of the spatial distribution of globular clusters in a galaxy can constrain, for example, the potential of the dark matter halo, and give clues to the assembly history of the galaxy. The very low metallicities of many clusters indicate that they are among the oldest bright objects in our local universe, providing a direct window into the major star-formation episodes in the early universe.

Decades of numerical modeling of dense stellar clusters has taught us a lot about the basic physical processes governing their dynamical evolution. However, until recently, numerical simulations remained limited either by the number of stars they can treat or by the omission of some physical processes. The Northwestern group's Heńon-type Monte Carlo code (CMC) has recently been updated to include both single and binary stellar evolution, in addition to the already existing treatments of two-body relaxation, strong scattering of binaries, stellar collisions, and tidal mass loss. Using CMC it is now possible to perform highly realistic N-body simulations of star clusters including all important physics and with up to $N \sim 10^6$, covering the full range of sizes for observed globular clusters. The new CMC has been validated and calibrated extensively with comparisons to previous direct N-body results.

Here we present the first large set of simulations done using the updated CMC, adopting what we consider the most plausible initial conditions for Galactic clusters. These are based on the latest data collected from young massive star cluster observations in the local universe. For the first time a comprehensive set of (more than 100) simulated clusters is created that can be compared fairly directly with observed Milky Way globular clusters. Without any fine tuning the model clusters show excellent agreement with the overall observed distributions of structural properties for Galactic globular clusters, such as the core radii, half-light radii, concentrations, and central densities. This agreement supports our hypothesis that currently observed massive young clusters (for example, in M51) closely resemble the progenitors of the old Galactic globulars.

All stars in these simulations have their individual stellar properties, such as the stellar radius and stellar luminosity, tracked in detail. Thus, our results not only let us study the global cluster properties, but also the properties of specific objects, such as blue stragglers. Here we present the first results from our latest simulations concerning the products of stellar collisions and mergers. All blue straggler stars in the models are identified. For each one we determine the formation channel by examining its complete past dynamical history. We find that for central densities greater than $\sim 10^3\,\mathrm{M_\odot pc^{-3}}$, the dominant formation channel is stellar collisions. Although binary stellar evolution (mass transfer in a binary or evolution-driven mergers) is not the dominant channel for creating blue stragglers, binaries do play a crucial role in their formation. Indeed most collisions creating these blue stragglers are in fact binary-mediated. Distributions of the dynamical ages of all blue stragglers are also determined. Depending on the cluster properties, the median dynamical age of the blue stragglers can vary between $\sim 1 - 3\,\mathrm{Gyr}$ in our models.

This is the abstract from the PhD thesis of Sourav Chatterjee, done under the supervision of Prof. Frederic A. Rasio at Northwestern University, Evanston, IL, USA. The thesis was defended on September 17, 2010.

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ESO Workshop

Dynamics of Low-Mass Stellar Systems - From Star Clusters to Dwarf Galaxies

April 4-8, 2011, Santiago, Chile

SCOPE

At the low-mass end of stellar systems, there used to be a well known dichotomy. On the one hand, there are star clusters with typical sizes of a few pc, whose internal dynamics can generally be well described by the Newtonian Gravity law. On the other hand, there are the much more extended dwarf galaxies with sizes of several hundred pc, whose dynamics appear to be dark matter dominated and which are usually related to cosmological substructures. These classical boundaries have been blurred by the recent discovery of new classes of stellar groupings, such as ultrafaint dSphs, ultramassive Super Star Clusters, Ultra Compact Dwarf Galaxies (UCDs), and dark matter poor Tidal Dwarf Galaxies (TDGs). These discoveries and the confirmation of multiple stellar populations in a number of Galactic globular clusters have reinforced the question to which extent star clusters and dwarf galaxies actually share common origins and are intimately linked in their dynamical evolution.

In this context, recent years have seen a particularly large effort in the astronomical community to thoroughly investigate the internal dynamics of low-mass stellar systems in the Milky Way and Andromeda. Extensive measurements of dwarf spheroidal galaxy kinematics have yielded crucial input for structure formation theories particularly on the clustering properties of dark matter on small scales. Similar observing campaigns regarding Milky Way star clusters are providing strong constraints on theories of modified gravity and on the shape of the $M_{BH} - \sigma$ relation at low masses. Proper motion studies of the Galactic halo have revealed a marked phase-space correlation of dSph orbits which is challenging canonical structure formation paradigms, and alternative explanations to dark matter have been put forward regarding the large velocity dispersions found for dSphs.

Beyond the Local Group, space-based imaging has been extensively used to investigate the dynamical evolution of star cluster populations in a number of star forming galaxies. The initial cluster mass function is distinctly different from the mass function of old globular clusters which is still not very well understood.Also, star clusters and dwarf galaxies have been used as dynamical tracers in galaxies and galaxy clusters, constraining the gravitational potential on large scales. Finally, peculiar internal dynamics were found for UCDs – objects at the phase transition between star clusters and dwarf galaxies – suggesting either dark matter clustering on scales below those suggested for dSphs, or a significant IMF variation.

All this shows that the dynamics of low-mass stellar systems is not only an interesting subject in its own right, but is also intimately linked to global theories of structure formation, the physics of gravity, and the shape of the stellar initial mass function. Given the wealth of new information gathered most recently in this field, the time is ripe to hold a dedicated meeting on this topic. We aim at bringing together a mix of astronomers from both observations and theory that work on the dynamics of dwarf galaxies and star clusters.

FORMAT

The meeting is planned for 5 days and we would like to constrain the number of people to about 60-80 participants to increase the scientific efficiency. We plan to have 15-20 invited keynote presentations, and ∼30-40 contributed talks. There will also be space for posters. We plan to have one afternoon off for excursion with subsequent conference banquet, and should finish the meeting on Friday April 8 around lunchtime.

PROGRAM

- Dynamics of dwarf galaxies in the context of LCDM and alternative theories
  - Observed kinematics of classical dSphs, ultrafaint dSphs and tidal dwarfs
  - Dynamical modelling of dwarf galaxies
  - Dynamics of dwarf galaxies in alternative theories of structure formation
- Dynamics of compact stellar systems
  - Dynamical modelling of compact stellar systems
  - The mass function of young star clusters and globular clusters
  - Tests of Newtonian dynamics in star clusters
  - Internal dynamics of UCDs
- The dwarf galaxy - star cluster interface
  - Star clusters as progenitors of dwarf galaxies
  - The formation of UCDs
- The $M_{BH} - \sigma$ relation of low-mass stellar systems
  - The influence of black holes (BHs) on the dynamics of low-mass stellar systems
  - Observational constraints on BH masses in star clusters and dwarf galaxies
- Star clusters and dwarf galaxies as test particles in galaxy (cluster) potentials
  - Star cluster and dwarf galaxy dynamical evolution in a tidal field [theory]
  - The kinematics of globular cluster systems
  - Observational constraints on the accretion of globular clusters
  - The role of galaxy interactions in shaping the observed dwarf galaxy and star cluster populations

Poster sessions are foreseen.

Confirmed keynote speakers include: J. Anderson, H. Baumgardt, P. Cote, P.A. Duc, B. Elmegreen, M. Fellhauer, M. Geha, G. Gilmore, M. Hilker, A. Jordan, A. Kuepper, P. Kroupa, S. Larsen, T. Richtler, R. Scarpa, M. Walker, M. Wilkinson

VENUE

The workshop will take place at the ESO premises in Santiago, which since recently also host the new ALMA headquarter building. Since the meeting will take place after the end of the Chilean holiday season, most of the tourists will have returned home already, but you can still expect pleasantly warm climate with very low rain probability.

HOTEL

Estimated hotel costs at Hotel Director, close to ESO, would be between EUR 65 (single room) - 100 (suite). There are also other hotels that will be described later in the web page.

PROCEEDINGS

We will have online conference proceedings (presentations put up on the web).

FINANCIAL MATTERS

The workshop fee will be 150 Euro (195 USD, 104000 CLP), and will be waived for students. The registration fee needs to be paid in advance via credit card.

DEADLINES

Registration deadline: January 15th, 2011

Registration fee payment: February 28th, 2011

Refund of payment if cancellation done by March 11, 2011

CONTACT

Website: http://www.eso.org/sci/meetings/dynamics2011/index.html

Mail: dynamics2011@eso.org

Postdoctoral position on stellar cluster dynamics in Grenoble

Applications are invited for a postdoctoral position at the Laboratoire d'Astrophysique de Grenoble in the framework of DESC (Dynamical Evolution of Stellar Clusters), a research project funded by the French National Research Agency (ANR).

The Laboratoire d'Astrophysique de Grenoble (LAOG) carries out observational and theoretical research in various field of astrophysics including the chemistry of interstellar medium, star and planet formation, and high energy phenomena. The LAOG is also involved in the technical development of major high angular resolution instruments for the VLT, VLTI and E-ELT.

The proposed research project will focus on numerical investigations of the early dynamical evolution of open clusters, with the aim to constrain the stellar cluster formation process(es). A special emphasis will be given to the comparison between simulations and observations, in the context of the preparation to the astrometric space mission Gaia. The successful candidate will be working in the star formation group in LAOG which has a vast experience in young cluster observations, including large scale photometric surveys and spectroscopic studies; and in collaboration with the Galaxy team in Strasbourg, which has strong expertise in gravitational dynamics and N-body numerical simulations.

Applicants must have a PhD and should have experience in N-body simulations or radiative transfer. Background in star formation theories or in stellar cluster observational studies will be an asset. The position is for two to three years, starting preferentially before the end of 2010. The gross yearly salary will be 32 KEuro, plus 1 KEuro for relocation expenses.

Applications should include a curriculum vitae, a list of publications and a statement of research interests and experience. The applicants should also arrange for two letters of recommendation to be sent independently. All materials should be directed to Estelle Moraux by October 15, 2010, either electronically to emoraux at obs.ujf-grenoble.fr or by mail at the following address: Estelle Moraux, Laboratoire d'Astrophysique de Grenoble, Universite Joseph Fourier, BP 53, 38041 Grenoble Cedex 9, France

Any enquiries should be adressed to Estelle Moraux (emoraux at obs.ujf-grenoble.fr). Additional informations on LAOG can also be obtained from http://www-laog.obs.ujf-grenoble.fr/

ESA Postdoctoral Fellowships in Space Science

The European Space Agency awards several postdoctoral fellowships each year. The aim of these fellowships is to provide young scientists, holding a PhD or the equivalent degree, with the means of performing space science research in fields related to the ESA Science Programme. Areas of research include planetary science, astronomy and astrophysics, solar and solar-terrestrial science, plasma physics and fundamental physics. The fellowships have a duration of two years and are tenable at the European Space Research and Technology Centre (ESTEC) in Noordwijk, Netherlands, or at the European Space Astronomy Centre (ESAC) in Villafranca del Castillo, near Madrid, Spain.

Applications are now solicited for fellowships in space science to begin in the summer or fall of 2011. Preference will be given to applications submitted by candidates within five years of receiving their PhD. Candidates not holding a PhD yet are encouraged to apply, but they must provide evidence of receiving their degree before starting the fellowship.

The deadline for applications is 1 October 2010.

More information on the ESA Research Fellowship programme in Space Science, on the conditions and eligibility, as well as the application form can be found on the world-wide web at this address: http://www.rssd.esa.int/fellowship

Questions on the scientific aspects of the ESA Fellowship Programme in Space Science not answered in the above pages can be sent by e-mail to the fellowship coordinator, Guido De Marchi, at the address fellowship@rssd.esa.int