$\mathcal{SCYON}$

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`

SCYON Issue No.39 *21 July 2008*

EDITORIAL

Here is the 39th issue of the SCYON newsletter. Todays edition contains 20 abstracts from refereed journals and announcements for conferences in Amsterdam and Vienna in September 2008. We thank all who sent in their contributions and wish everybody a pleasant holiday season.

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circumstances, the editors might actively solicit contributions, usually those spotted on a preprint server, but they do not publish abstracts without the author's consent.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

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 :

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1. Star Forming Regions

Analytical theory for the initial mass function: CO clumps and prestellar cores

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We derive an analytical theory of the prestellar core initial mass function based on an extension of the Press-Schechter statistical formalism applied in cosmology. With the same formalism, we also obtain the mass spectrum for the non self-gravitating clumps produced in supersonic flows. The mass spectrum of the self-gravitating cores reproduces very well the observed initial mass function and identifies the different mechanisms responsible for its behaviour.The theory predicts that the shape of the IMF results from two competing contributions, namely a power-law at large scales and an exponential cut-off (lognormal form) centered around the characteristic mass for gravitational collapse. The cut-off already exists in the case of pure thermal collapse, provided that the underlying density field has a lognormal distribution. Whereas pure thermal collapse produces a power-law tail steeper than the Salpeter value, $dN/d\log M \propto M^{-x}$, with $x \simeq 1.35$, this latter is recovered exactly for the (3D) value of the spectral index of the velocity power spectrum, $n \simeq 3.8$, found in observations and in numerical simulations of isothermal supersonic turbulence. Indeed, the theory predicts that $x = (n+1)/(2n-4)$ for self-gravitating structures and $x = 2-n'/3$ for non self-gravitating structures, where n' is the power spectrum index of $\log(\rho)$. We show that, whereas supersonic turbulence promotes the formation of both massive stars and brown dwarfs, it has an overall negative impact on star formation, decreasing the star formation efficiency. This theory provides a novel theoretical foundation to understand the origin of the IMF and to infer its behaviour in different environments. It also provides a complementary approach and useful guidance to numerical simulations exploring star formation, while making testable predictions.

Accepted by : Astrophysical Journal
For preprints, contact `patrick.hennebelle@lra.ens.fr, chabrier@ens-lyon.fr`
Also available from the URL `http://arxiv.org/abs/0805.0691`
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Current Star Formation in the Ophiuchus and Perseus Molecular Clouds: Constraints and Comparisons from Unbiased Submillimeter and Mid-Infrared Surveys. II

Jes K. Jorgensen ([1,2]), Doug Johnstone ([3,4]), Helen Kirk ([4,3]), Philip C. Myers ([2]), Lori E. Allen ([2]), and Yancy L. Shirley ([5])

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We present a census of the population of deeply embedded young stellar objects (YSOs) in the Ophiuchus molecular cloud complex based on a combination of Spitzer Space Telescope mid-infrared data from the "Cores to Disks" (c2d) legacy team and JCMT/SCUBA submillimeter maps from the COMPLETE team. We have applied a method developed for identifying embedded protostars in Perseus to these datasets and in this way construct a relatively unbiased sample of 27 candidate embedded protostars with envelopes more massive than our sensitivity limit (about 0.1 M_{sun}). As in Perseus, the mid-infrared sources are located close to the center of the SCUBA cores and the narrowness of the spatial distribution of mid-infrared sources around the peaks of the SCUBA cores suggests that no significant dispersion of the newly formed YSOs has occurred. Embedded YSOs are found in 35% of the SCUBA cores - less than in Perseus (58%). On the other hand the mid-infrared sources in Ophiuchus have less red mid-infrared colors, possibly indicating that they are less embedded. We apply a nearest neighbour surface density algorithm to define the substructure in each of the clouds and calculate characteristic numbers for each subregion - including masses, star formation efficiencies, fraction of embedded sources etc. Generally the main clusters in Ophiuchus and Perseus (L1688, NGC1333 and IC348) are found to have higher star formation efficiencies than small groups such as B1, L1455 and L1448, which on the other hand are completely dominated by deeply embedded protostars. We discuss possible explanations for the differences between the regions in Perseus and Ophiuchus, such as different evolutionary timescales for the YSOs or differences, e.g., in the accretion in the two clouds.

Accepted by : Astrophysical Journal
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Also available from the URL `http://arxiv.org/abs/0805.0599`
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Early-type objects in NGC6611 and Eagle Nebula.

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An important question about Be stars is whether Be stars are born as Be stars or whether they become Be stars during their evolution. It is necessary to observe young clusters to answer this question. To this end, observations of stars in NGC6611 and the star-formation region of Eagle Nebula have been carried out with the ESO-WFI in slitless spectroscopic mode and at the VLT-GIRAFFE (R$\simeq$ 6400–17000). The targets for the GIRAFFE observations were pre-selected from the literature and our catalogue of emission-line stars based on the WFI study. GIRAFFE observations allowed us to study accurately the population of the early-type stars with and without emission lines. For this study, we determined the fundamental parameters of OBA stars thanks to the GIRFIT code. We also studied the status of the objects (main sequence or pre-main sequence stars) by using IR data, membership probabilities, and location in HR diagrams. The nature of the early-type stars with emission-line stars in NGC6611 and its surrounding environment is derived. The slitless observations with the WFI clearly indicate a small number of emission-line stars in M16. We observed with GIRAFFE 101 OBA stars, among them 9 are emission-line stars with circumstellar emission in Hα. We found that: W080 could be a new He-strong star, like W601. W301 is a possible classical Be star, W503 is a mass-transfer eclipsing binary with an accretion disk, and the other ones are possible Herbig Ae/Be stars.We also found that the rotational velocities of main sequence B stars are 18% lower than those of pre-main sequence B stars, in good agreement with theory about the evolution of rotational velocities. Combining adaptive optics, IR data, spectroscopy, and radial velocity indications, we found that 27% of the B-type stars are binaries. We also redetermined the age of NGC 6611 found equal to 1.2–1.8 Myears in good agreement with the most recent determinations.

Accepted by : Astronomy & Astrophysics
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The structures of embedded clusters in the Perseus, Serpens and Ophiuchus molecular clouds

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The young stellar population data of the Perseus, Ophiuchus and Serpens molecular clouds are obtained from the *Spitzer* c2d legacy survey in order to investigate the spatial structure of embedded clusters using the nearest neighbour and minimum spanning tree method. We identify the embedded clusters in these clouds as density enhancements and analyse the clustering parameter Q with respect to source luminosity and evolutionary stage. This analysis shows that the older Class 2/3 objects are more centrally condensed than the younger Class 0/1 protostars, indicating that clusters evolve from an initial hierarchical configuration to a centrally condensed one. Only IC 348 and the Serpens core, the older clusters in the sample, shows signs of mass segregation (indicated by the dependence of Q on the source magnitude), pointing to a significant effect of dynamical interactions after a few Myr. The structure of a cluster may also be linked to the turbulent energy in the nat! al cloud as the most centrally condensed cluster is found in the cloud with the lowest Mach number and vice versa. In general these results agree well with theoretical scenarios of star cluster formation by gravoturbulent fragmentation.

Accepted by : Monthly Notices of the Royal Astronomical Society
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2. Galactic Open Clusters

Open Clusters as Galactic Disk Tracers: I. Project Motivation, Cluster Membership and Bulk Three-Dimensional Kinematics

Peter M. Frinchaboy[1,2] **and Steven R. Majewski**[1]
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We have begun a survey of the chemical and dynamical properties of the Milky Way disk as traced by open star clusters. In this first contribution, the general goals of our survey are outlined and the strengths and limitations of using star clusters as a Galactic disk tracer sample are discussed. We also present medium resolution (R ∼15,0000) spectroscopy of open cluster stars obtained with the Hydra multi-object spectrographs on the Cerro Tololo Inter-American Observatory 4-m and WIYN 3.5-m telescopes. Here we use these data to determine the radial velocities of 3436 stars in the fields of open clusters within about 3 kpc, with specific attention to stars having proper motions in the Tycho-2 catalog. Additional radial velocity members (without Tycho-2 proper motions) that can be used for future studies of these clusters were also identified. The radial velocities, proper motions, and the angular distance of the stars from cluster center are used to derive cluster membership probabilities for stars in each cluster field using a non-parametric approach, and the cluster members so-identified are used, in turn, to derive the reliable bulk three-dimensional motion for 66 of 71 targeted open clusters. The high probability cluster members that we identify help to clarify the color-magnitude sequences for many of the clusters, and are prime targets for future echelle resolution spectroscopy as well as astrometric study with the Space Interferometry Mission (SIM Planetquest).

Accepted by : Astronomical Journal
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Be phenomenon in open clusters: Results from a survey of emission-line stars in young open clusters

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Emission-line stars in young open clusters are identified to study their properties, as a function of age, spectral type and evolutionary state. 207 open star clusters were observed using slitless spectroscopy method and 157 emission stars were identified in 42 clusters. We have found 54 new emission-line stars in 24 open clusters, out of which 19 clusters are found to house emission stars for the first time. About 20% clusters harbour emission stars. The fraction of clusters housing emission stars is maximum in both the 0–10 and 20–30 Myr age bin ($\sim$ 40% each). Most of the emission stars in our survey belong to Classical Be class ($\sim$ 92%) while a few are Herbig Be stars ($\sim$ 6%) and Herbig Ae stars ($\sim$ 2%). The youngest clusters to have Classical Be stars are IC 1590, NGC 637 and NGC 1624 (all 4 Myr old) while NGC 6756 (125–150 Myr) is the oldest cluster to have Classical Be stars. The Classical Be stars are located all along the MS in the optical CMDs of clusters of all ages, which indicates that the Be phenomenon is unlikely due to core contraction near the turn-off. The distribution of Classical Be stars as a function of spectral type shows peaks at B1–B2 and B6–B7 spectral types. The Be star fraction (N(Be)/N(B+Be)) is found to be less than 10% for most of the clusters and NGC 2345 is found to have the largest fraction ($\sim$ 26%). Our results indicate there could be two mechanisms responsible for the Classical Be phenomenon. Some are born Classical Be stars (fast rotators), as indicated by their presence in clusters younger than 10 Myr. Some stars evolve to Classical Be stars, witin the MS lifetime, as indicated by the enhancement in the fraction of clusters with Classical Be stars in the 20–30 Myr age bin.

Accepted by : Monthly Notices of the Royal Astronomical Society
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Galactic clusters with associated Cepheid variables. VII. Berkeley 58 and CG Cassiopeiae

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Photoelectric, photographic, and CCD UBV photometry, spectroscopic observations, and star counts are presented for the open cluster Berkeley 58 to examine a possible association with the 4.37d Cepheid CG Cas. The cluster is difficult to separate from the early-type stars belonging to the Perseus spiral arm, in which it is located, but has reasonably well-defined parameters: an evolutionary age of $\sim 10^8$ years, a mean reddening of E(B-V)$_{(B0)}$=0.70 $\pm$ 0.03 s.e., and a distance of 3.03 $\pm$ 0.17 kpc ($V_0 - M_V$ = 12.40$\pm$0.12 s.d.). CG Cas is a likely cluster coronal member on the basis of radial velocity, and its period increase of +0.170+-0.014 s yr^{-1} and large light amplitude describe a Cepheid in the third crossing of the instability strip lying slightly blueward of strip centre. Its inferred reddening and luminosity are E(B-V)=0.64$\pm$0.02 s.e. and $< M_V >$=-3.06 $\pm$ 0.12. A possible K supergiant may also be a cluster member.

Accepted by : Monthly Notices of the Royal Astronomical Society

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Also available from the URL http://lanl.arxiv.org/abs/0805.1084

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3. Galactic Globular Clusters

Globular Clusters in the Outer Galactic Halo: AM-1 and Palomar 14

Aaron Dotter ([1]), Ata Sarajedini, & Soung-Chul Yang ([2])
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AM-1, at 120 kpc, and Pal 14, at 70 kpc, are two of the most distant Galactic globular clusters known. We present Hubble Space Telescope WFPC2 photometry of AM-1 and Pal 14 that reveals unprecedented depth and detail in the color-magnitude diagrams of these two clusters. Absolute and relative age measurements confirm that both are younger than the inner halo globular cluster M 3 by 1.5-2 Gyr, assuming all three clusters have similar compositions. Thus AM-1 and Pal 14 join Pal 3, Pal 4, and Eridanus (studied by Stetson et al.) as distant Galactic globular clusters with red horizontal branches and young ages relative to the inner halo. Within the context of the entire body of research on the ages of second parameter globular clusters, the observed correlation between age and horizontal branch morphology suggests that age is the best candidate for the second parameter. However, this conclusion is tempered by the lack of precise chemical abundance determinations for a significant fraction of second parameter globular clusters.

Accepted by : Astronomical Journal
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Also available from the URL `http://arxiv.org/abs/0807.1103`
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4. Galactic Center Clusters

Origin of the S-Stars in the Galactic Center

Ulf Löckmann, Holger Baumgardt, and Pavel Kroupa
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Over the last 15 years, around a hundred very young stars have been observed in the central parsec of our Galaxy. While the presence of young stars forming one or two stellar discs at approx. 0.1 pc from the super-massive black hole (SMBH) can be understood through star formation in accretion discs, the origin of the S-stars observed a factor of ten closer to the SMBH has remained a major puzzle. Here we show the S-stars to be a natural consequence of dynamical interaction of two stellar discs at larger radii. Due to precession and Kozai interaction, individual stars achieve extremely high eccentricities at random orientation. Stellar binaries on such eccentric orbits are disrupted due to close passages near the SMBH, leaving behind a single S-star on a much tighter orbit. The remaining star may be ejected from the vicinity of the SMBH, thus simultaneously providing an explanation for the observed hyper-velocity stars in the Milky Way halo.

Accepted by : Astrophysical Journal
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5. Extragalactic Clusters

The Early Expansion of Cluster Cores

N. Bastian([1,2]), M. Gieles([3]), S.P. Goodwin([4]), G. Trancho([5]), L.J. Smith([2,6]), I. Konstantopoulos([2]), Yu. Efremov([7])

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The observed properties of young star clusters, such as the core radius and luminosity profile, change rapidly during the early evolution of the clusters. Here we present observations of 6 young clusters in M51 where we derive their sizes using HST imaging and ages using deep Gemini-North spectroscopy. We find evidence for a rapid expansion of the cluster cores during the first 20 Myr of their evolution. We confirm this trend by including data from the literature of both Galactic and extra-galactic embedded and young clusters, and possible mechanisms (rapid gas removal, stellar evolutionary mass-loss, and internal dynamical heating) are discussed. We explore the implications of this result, focussing on the fact that clusters were more concentrated in the past, implying that their stellar densities were much higher and relaxation times correspondingly shorter. Thus, when estimating if a particular cluster is dynamically relaxed, (i.e. when determining if a cluster's mass segregation is due to primordial or dynamical processes), the current relaxation time is only an upper-limit, with relaxation times likely being significantly shorter in the past.

To appear in : http://xxx.lanl.gov/abs/0806.1460
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Age Determination of Six Intermediate-age SMC Star Clusters with HST/ACS

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Accepted by: the Astronomical Journal

We present a photometric analysis of the star clusters Lindsay 1, Kron 3, NGC 339, NGC 416, Lindsay 38, and NGC 419 in the Small Magellanic Cloud (SMC), observed with the *Hubble Space Telescope* Advanced Camera for Surveys (ACS) in the F555W and F814W filters. Our color magnitude diagrams (CMDs) extend ∼3.5 mag deeper than the main-sequence turnoff points, deeper than any previous data. Cluster ages were derived using three different isochrone models: Padova, Teramo, and Dartmouth, which are all available in the ACS photometric system. Fitting observed ridgelines for each cluster, we provide a homogeneous and unique set of low-metallicity, single-age fiducial isochrones. The cluster CMDs are best approximated by the Dartmouth isochrones for all clusters, except for NGC 419 where the Padova isochrones provided the best fit. Using Dartmouth isochrones we derive ages of 7.5±0.5 Gyr (Lindsay 1), 6.5±0.5 Gyr (Kron 3), 6±0.5 Gyr (NGC 339), 6±0.5 Gyr (NGC 416), and 6.5 ± 0.5 Gyr (Lindsay 38). The CMD of NGC 419 shows several main-sequence turn-offs, which belong to the cluster and to the SMC field. We thus derive an age range of 1.2-1.6 Gyr for NGC 419. We confirm that the SMC contains several intermediate-age populous star clusters with ages unlike those of the Large Magellanic Cloud (LMC) and the Milky Way (MW). Interestingly, our intermediate-age star clusters have a metallicity spread of ∼0.6 dex, which demonstrates that the SMC does not have a smooth, monotonic age-metallicity relation. We find an indication for centrally concentrated blue straggler star candidates in NGC 416, while for the other clusters these are not present. Using the red clump magnitudes, we find that the closest cluster, NGC 419 (∼50 kpc), and the farthest cluster, Lindsay 38 (∼67 kpc), have a relative distance of ∼17 kpc, which confirms the large depth of the SMC. The three oldest SMC clusters (NGC 121, Lindsay 1, Kron 3) lie in the north-western part of the SMC, while the youngest (NGC 419) is located near the SMC main body.

For preprints, contact `kglatt(at)ari.uni-heidelberg.de`

Multiple stellar populations in three rich Large Magellanic Cloud star clusters

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We present deep color-magnitude diagrams for three rich intermediate-age star clusters in the LMC, constructed from archival ACS F435W and F814W imaging. All three clusters exhibit clear evidence for peculiar main-sequence turn-offs. NGC 1846 and 1806 each possess two distinct turn-off branches, while the turn-off for NGC 1783 shows a much larger spread in color than can be explained by the photometric uncertainties. We demonstrate that although all three clusters contain significant populations of unresolved binary stars, these cannot be the underlying cause of the observed turn-off morphologies. The simplest explanation is that each cluster is composed of at least two different stellar populations with very similar metal abundances but ages separated by up to ~ 300 Myr. The origin of these unusual properties remains unidentified; however, the fact that at least three massive clusters containing multiple stellar populations are now known in the LMC suggests a potential! ly significant formation channel.

To appear in : ApJ Letters (2008, 681, L17);
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Young star clusters in interacting galaxies - NGC 1487 and NGC 4038/4039

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Accepted by: A&A

We estimate the dynamical masses of several young ($\approx$ 10 Myr) massive star clusters in two interacting galaxies, NGC 4038/4039 ("The Antennae") and NGC 1487, under the assumption of virial equilibrium. These are compared with photometric mass estimates from K-band photometry assuming a standard Kroupa IMF. The clusters were selected to have near-infrared colours dominated by red supergiants, hence old enough to have survived the earliest phases of cluster evolution when the interstellar medium is rapidly swept out from the cluster, supported by there being no obvious Hα emission associated with the clusters. All but one of the Antennae clusters have dynamical and photometric mass estimates that are within a factor ≈ 2 of one another, implying both that standard IMFs provide a good approximation to the IMF of these clusters and that there is no significant extra-virial motion, as would be expected if they were rapidly dispersing. These results suggest that almost all of the Antennae clusters in our sample have survived the gas removal phase as bound or marginally bound objects. Two of the three NGC 1487 clusters studied here have M_{dyn} estimates that are significantly greater than the photometric mass estimates. At least one of these two clusters, and one in the Antennae, may be actively in the process of dissolving. The process of dissolution contributes a component of non-virial motion to the integrated velocity measurements, resulting in an estimated M_{dyn} that is too high relative to the amount of measured stellar light. The dissolution candidates in both galaxies are amongst the clusters with the lowest pressures/densities measured in our sample.

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The Initial Mass Function of the Stellar Association NGC 602 in the Small Magellanic Cloud with Hubble Space Telescope ACS Observations

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We present our photometric study of the stellar association NGC 602 in the wing of the Small Magellanic Cloud (SMC). The data were taken in the filters F555W and F814W using the Advanced Camera for Surveys (ACS) on-board the Hubble Space Telescope (HST). Photometry was performed using the ACS module of the stellar photometry package DOLPHOT. We detected more than 5,500 stars with a magnitude range of $14 \leq m_{555} \leq 28$ mag. Three prominent stellar concentrations are identified with star counts in the observed field, the association NGC 602 itself, and two clusters, one of them not being currently in any known catalog. The Color-Magnitude Diagrams (CMDs) of both clusters show features typical for young open clusters, while that of the association reveals bright main sequence (MS) and faint pre-main sequence (PMS) stars as the members of the system. We construct the initial mass spectrum (IMS) of the association by applying an age-independent method of counting the PMS stars within evolutionary tracks, while for the bright MS stars we transform their magnitudes to masses with the use of mass-luminosity relations. The IMS of NGC 602 is found to be well represented by a single-power law, corresponding to an Initial Mass Function (IMF) of slope $\Gamma \approx -1.2$ for $1 \leq M/M\odot \leq 45$. This indicates that the shape of the IMF of a star forming system in the SMC for stars with masses higher than $1M\odot$ seems to be quite similar to the field IMF in the solar neighborhood.

Accepted by : Astrophysical Journal

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Also available from the URL `http://www.astro.uni-bonn.de/~dgoulier/Science/NGC602/ms.pdf` *or by anonymous ftp at* `ftp://`

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Extending the baseline: Spitzer Mid-Infrared Photometry of Globular Cluster Systems in the Centaurus A and Sombrero Galaxies

Lee Spitler, Duncan Forbes, Mike Beasley
Swinburne University, Swinburne University, Instituto de Astrofisica de Canarias

Spitzer IRAC mid-infrared photometry is presented for the globular cluster (GC) systems of the NGC 5128 ("Centaurus A") and NGC 4594 ("Sombrero") galaxies. Existing optical photometric and spectroscopic are combined with this new data in a comprehensive optical to mid-IR colour catalogue of 260 GCs. Empirical colour-metallicity relationships are derived for all optical to mid-IR colour combinations.

These colours prove to be very effective quantities to test the photometric predictions of simple stellar population (SSP) models. In general, four SSP models show larger discrepancies between each other and the data at bluer wavelengths, especially at high metallicities. Such differences become very important when attempting to use colour-colour model predictions to constrain the ages of stellar populations. Furthermore, the age-substructure determined from colour-colour diagrams and 91 NGC 5128 GCs with spectroscopic ages from Beasley et al. (2008) are inconsistent, suggesting any apparent GC system age-substructure implied by a colour-colour analysis must be verified independently.

Unlike blue wavebands, certain optical to mid-IR colours are insensitive to the flux from hot horizontal branch stars and thus provide an excellent metallicity proxy. The NGC 5128 GC system shows strong bimodality in the optical R-band to mid-IR colour distributions, hence proving it is bimodal in metallicity. In this new colour space, a colour-magnitude trend, a "blue tilt", is found in the NGC 5128 metal-poor GC data. The NGC 5128 young GCs do not contribute to this trend. In the NGC 4594 GC system, a population of abnormally massive GCs at intermediate metallicities show bluer optical to optical colours for their optical to mid-IR colours, suggesting they contain extended horizontal branches and/or are younger than typical GCs. Analysis of optical to mid-IR colours for a ultra-compact dwarf galaxy suggests its metallicity is just below solar.

Accepted by : Monthly Notices of the Royal Astronomical Society
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Also available from the URL `http://adsabs.harvard.edu/abs/2008arXiv0806.4390S`
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6. Dynamical evolution - Simulations

Lifetimes of tidally limited star clusters with different radii

Mark Gieles ([1]) & Holger Baumgardt ([2])
([1]) ESO ([2]) Bonn

We study the escape rate, dN/dt, from clusters with different radii in a tidal field using analytical predictions and direct N-body simulations. We find that dN/dt depends on the ratio R=r_h/r_j, where r_h is the half-mass radius and r_j the radius of the zero-velocity surface. For $R > 0.05$, the "tidal regime", there is almost no dependence of dN/dt on R. To first order this is because the fraction of escapers per relaxation time, t_rh, scales approximately as $R^{1.5}$, which cancels out the $r_h^{1.5}$ term in t_{rh}. For $R < 0.05$, the "isolated regime", dN/dt scales as $R^{-1.5}$. Clusters that start with their initial R, R_i, in the tidal regime dissolve completely in this regime and their t_{dis} is insensitive to the initial r_h. We predicts that clusters that start with $R_i < 0.05$ always expand to the tidal regime before final dissolution. Their t_{dis} has a shallower dependence on R_i than what would be expected when t_{dis} is a constant times t_{rh}. For realistic values of R_i, the lifetime varies by less than a factor of 1.5 due to changes in R_i. This implies that the "survival" diagram for globular clusters should allow for more small clusters to survive. We note that with our result it is impossible to explain the universal peaked mass function of globular cluster systems by dynamical evolution from a power-law initial mass function, since the peak will be at lower masses in the outer parts of galaxies. Our results finally show that in the tidal regime t_{dis} scales as $N^{0.65}$/w, with w the angular frequency of the cluster in the host galaxy.

To appear in : astro-ph/0806.2327
For preprints, contact `mgieles@eso.org`
Also available from the URL `http://arxiv.org/abs/0806.2327`
or by anonymous ftp at `ftp://`

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Evidence for primordial mass segregation in globular clusters

Holger Baumgardt[1], Guido de Marchi[2] & Pavel Kroupa[1]
([1]) AIfA, Bonn ([2]) ESA

We have studied the dissolution of initially mass segregated and unsegregated star clusters due to two-body relaxation in external tidal fields, using Aarseth's collisional N-body code NBODY4 on GRAPE6 special-purpose computers. When extrapolating results of initially not mass segregated models to globular clusters, we obtain a correlation between the time until destruction and the slope of the mass function, in the sense that globular clusters which are closer to dissolution are more strongly depleted in low-mass stars. This correlation fits observed mass functions of most globular clusters. The mass functions of several globular clusters are however more strongly depleted in low-mass stars than suggested by these models. Such strongly depleted mass functions can be explained if globular clusters started initially mass segregated. Primordial mass segregation also explains the correlation between the slope of the stellar mass function and the cluster concentration which was recently discovered by De Marchi et al. (2007). In this case, it is possible that all globular clusters started with a mass function similar to that seen in young open clusters in the present-day universe, at least for stars below m=0.8 Msun. This argues for a near universality of the mass function for different star formation environments and metallicities in the range $-2 < [Fe/H] < 0$. We finally describe a novel algorithm which can initialise stationary mass segregated clusters with arbitrary density profile and amount of mass segregation.

To appear in : Astrophysical Jounral
For preprints, contact `holger@astro.uni-bonn.de`
Also available from the URL `http://arxiv.org/abs/0806.0622`
or by anonymous ftp at `ftp://`

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The Main Sequence of Star Clusters

Andreas H.W. Kuepper, Pavel Kroupa, Holger Baumgardt
Argelander Institute for Astronomy, University of Bonn, Germany

A novel way of looking at the evolution of star clusters is presented. With a dynamical temperature, given by the mean kinetic energy of the cluster stars, and a dynamical luminosity, which is defined as the kinetic energy of the stars leaving the cluster in analogy to the energy of photons emitted by a star, the dissolution of star clusters is studied using a new dynamical temperature-luminosity diagram for star clusters. The investigation contains a parameter-space study of open clusters of up to N = 32768 single-mass stars with different initial density distributions, half-mass radii, tidal conditions and binary fractions. The clusters show a strong correlation between dynamical temperature and dynamical luminosity and most of the investigated cluster families share a common sequence in such a dynamical temperature-luminosity diagram. Deviations from this sequence are analyzed and discussed. After core collapse, the position of a cluster within this diagram can be defined by three parameters: the mass, the tidal conditions and the binary fraction. Due to core collapse all initial conditions are lost and the remaining stars adjust to the given tidal conditions. Binaries as internal energy sources influence this adjustment. A further finding concerns the Lagrange radii of star clusters: Throughout the investigated parameter space nearly all clusters show a constant half-mass radius for the time after core collapse until dissolution. Furthermore, the ratio of half-mass radius to tidal radius evolves onto a common sequence which only depends on the mass left in the cluster.

To appear in : Monthly Notices of the Royal Astronomical Society
For preprints, contact `akuepper@astro.uni-bonn.de`
Also available from the URL `http://arxiv.org/abs/0806.3973`
or by anonymous ftp at `ftp://`

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Intermediate Mass Black Hole Induced Quenching of Mass Segregation in Star Clusters

Michael Gill ([1]), Michele Trenti ([2]), M. Coleman Miller ([1]), Roeland van der Marel ([2]), Douglas Hamilton ([1]), Massimo Stiavelli ([2])

(1) University of Maryland, College Park, (2) Space Telescope Science Institute

In many theoretical scenarios it is expected that intermediate-mass black holes (IMBHs, with masses M $\sim$ 100-10000 solar masses) reside at the centers of some globular clusters. However, observational evidence for their existence is limited. Several previous numerical investigations have focused on the impact of an IMBH on the cluster dynamics or brightness profile. Here we instead present results from a large set of direct N-body simulations including single and binary stars. These show that there is a potentially more detectable IMBH signature, namely on the variation of the average stellar mass between the center and the half-light radius. We find that the existence of an IMBH quenches mass segregation and causes the average mass to exhibit only modest radial variation in collisionally relaxed star clusters. This differs from when there is no IMBH. To measure this observationally requires high resolution imaging at the level of that already available from the Hubble Space Telescope (HST) for the cores of a large sample of galactic globular clusters. With a modest additional investment of HST time to acquire fields around the half-light radius, it will be possible to identify the best candidate clusters to harbor an IMBH. This test can be applied only to globulars with a half-light relaxation time less than or equal to 1 Gyr, which is required to guarantee efficient energy equipartition due to two-body relaxation.

Accepted by : Astrophysical Journal
For preprints, contact `trenti@stsci.edu`
Also available from the URL `http://`
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7. Miscellaneous

Galaxies with Wolf-Rayet signatures in the low-redshift Universe - A survey using the Sloan Digital Sky Survey

J. Brinchmann ([1], [2]) D. Kunth ([3]) F. Durret
([1]) Leiden Observatory ([2]) CAUP ([3]) IAP

We have carried out a search for Wolf-Rayet galaxies in all galaxies with EW(Hb)>2AA in the SDSS DR6. We identify Wolf-Rayet features using a mixture of automatic and visual classification and find a total of 570 galaxies with significant Wolf-Rayet (WR) features and a further 1115 potential candidates, several times more than even the largest heterogeneously assembled catalogues. We discuss in detail the properties of galaxies showing Wolf-Rayet features with a focus on their empirical properties. We are able to accurately quantify the incidence of Wolf-Rayet galaxies with redshift and show that the likelihood of otherwise similar galaxies showing Wolf-Rayet features increases with increasing metallicity, but that WR features are found in galaxies of a wide range in morphology. The large sample allows us to show explicitly that there are systematic differences in the metal abundances of WR and non-WR galaxies. The most striking result is that, below EW(Hb)=100AA,

Wolf-Rayet galaxies show an elevated N/O relative to non-WR galaxies. We interpret this as a rapid enrichment of the ISM from WR winds. We also show that the model predictions for WR features strongly disagree with the observations at low metallicity; while they do agree quite well with the data at solar abundances. We discuss possible reasons for this and show that models incorporating binary evolution reproduce the low-metallicity results reasonably well. Finally we combine the WR sample with a sample of galaxies with nebular He II 4686 to show that, at 12 + log O/H¡ 8, the main sources of He II ionising photons appears to be O stars, arguing for a less dense stellar wind at these metallicities, while at higher abundances WN stars might increasingly dominate the ionisation budget.

Accepted by : Astronomy & Astrophysics
For preprints, contact `jarle@strw.leidenuniv.nl`
Also available from the URL `http://www.strw.leidenuniv.nl/~jarle/WRinSDSS/`
or by anonymous ftp at

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Second Announcement

MODEST-8b
Amsterdam, September 15th to 19th

Multiscale Multiphysics Scientific Environment
Towards realistic modeling of dense stellar systems in MUSE

This is the second announcement for our 5-day workshop in order to continue the development and discuss the future of MUSE - a Multi-scale Multi-physics Software Environment (see http://muse.li). More information about the workshop can be found at the website:

http://modesta.science.uva.nl/modest/modest8b/

The meeting will be held from September 15th to 19th at the

Astronomical Institute 'Anton Pannekoek'
and Section Computational Science
University of Amsterdam
Kruislaan 403
1098SJ Amsterdam

If you have not done so, you are invited to register for the meeting

http://modesta.science.uva.nl/modest/modest8b/register.html

The dead-line for registration is July 31th and we kindly ask you to register as early as possible. There is no registration fee due for this workshop.

********* BEGIN IMPORTANT INFORMATION **********

If you plan to attend the meeting we recommend that you make your hotel reservation as soon as possible. Our workshop takes place the same week a big business conference is held in Amsterdam and the city has blocked a lot of hotel rooms for this event.
Hotels in Amsterdam can best be found via the usual on-line booking services. The meeting venue can be easily reached by public transport from hotels in/near the city centre. A possible low-budget alternative is the StayOkay Hostel Amsterdam-Zeeburg (http://www.stayokay.com/). Some more information can be found on the MODEST-8b web site

http://modesta.science.uva.nl/modest/modest8b/

********* END IMPORTANT INFORMATION **********

The scientific programme is focused on continuing the development of MUSE and most of the time during the workshop the participants will work in small groups on writing MUSE code. A few talks

on MUSE-related topics and an introduction to GRID computing with MUSE will round off the programme. Further details of the programme will be announced at a later time. We kindly ask the participants to bring their own laptops.

A workshop dinner and a sightseeing-tour of Amsterdam are also planned in addition to the scientific programme. We will have an informal welcome reception on the Sunday before the meeting. Details will be announced at a later time.

Best wishes
the organisers

Second Announcement

Star Clusters - Witnesses of Cosmic History
September 8-12, 2008, Vienna, Austria

Dear Colleagues,

We would like to remind you about the Symposium entitled "Star Clusters - Witnesses of Cosmic History" within the JENAM 2008 meeting at the beginning of September in Vienna.

The Symposium takes place on Thursday the 11th of September 2008 from 14:30 to 18:30 and on Friday the 12th of September 2008 from 09:45 to 18:30 (of course with breaks).

The announcement and further infos can be found here:

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

We are still looking for oral contributions (15 to 20 minutes). If you are willing to give a talk, please sent an eMail to "ernst.paunzen@univie.ac.at" including the title and a short abstract (two or three lines).

With best regards,

Ernst Paunzen (on behalf of the SOC)