SCYON

The Star Clusters Young & Old Newsletter

edited by Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

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EDITORIAL

This is the 46th issue of the SCYON newsletter and the first for the year 2010. In total we have 24 abstracts from refereed publications. We also have conference announcements for the MODEST 10 meeting in Beijing in September, and a Summer School and Workshop on Computational Gravitational Dynamics in Leiden in May 2010. We would finally like to bring to your attention a special edition of *Philosophical Transactions of the Royal Society*, reviewing various aspects of star cluster research (see p. 32 of this Newsletter for more details).

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.

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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 :

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

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1. Star Forming Regions

A Universal Stellar Initial Mass Function? A Critical Look at Variations

Nate Bastian ([1]), Kevin R. Covey([2,3]), Michael R. Meyer([4,5])
([1]) IoA, Cambridge, (2) Cornell, (3) Harvard-Smithsonian CfA, (4) ETH Zurich, (5) Steward Observatory

Few topics in astronomy initiate such vigorous discussion as whether or not the initial mass function (IMF) of stars is universal, or instead sensitive to the initial conditions of star formation. The distinction is of critical importance: the IMF influences most of the observable properties of stellar populations and galaxies, and detecting variations in the IMF could provide deep insights into the process by which stars form. In this review, we take a critical look at the case for IMF variations, with a view towards whether other explanations are sufficient given the evidence. Studies of the field, local young clusters and associations, and old globular clusters suggest that the vast majority were drawn from a "universal" IMF: a power-law of Salpeter index ($\Gamma = 1.35$) above a few solar masses, and a log normal or shallower power-law ($\Gamma \sim 0 - 0.25$) between a few tenths and a few solar masses (ignoring the effects of unresolved binaries). The shape and univer! sality of the IMF at the stellar-substellar boundary is still under investigation and uncertainties remain large, but most observations are consistent with a IMF that declines ($\Gamma < -0.5$) well below the hydrogen burning limit. Observations of resolved stellar populations and the integrated properties of most galaxies are also consistent with a "universal IMF", suggesting no gross variations in the IMF over much of cosmic time. There are indications of "non-standard" IMFs in specific local and extragalactic environments, which clearly warrant further study. Nonetheless, there is no clear evidence that the IMF varies strongly and systematically as a function of initial conditions after the first few generations of stars.

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The IMF of stellar clusters: effects of accretion and feedback

Sami Dib ([1]) Mohsen Shadmehri ([2]) Paolo Padoan ([3]) Maheswar G. ([4]) D. K. Ojha ([5]) Fazeleh Khajenabi ([6])

([1]) Service d'Astrophysique, DSM/Irfu, CEA/Saclay, F-91191, Gif-sur-Yvette, Cedex, France ([2]) Department of Mathematical Physics, National University Ireland, Co kildare, Maynooth, Ireland ([3]) ICREA-ICC, University of Barcelona, Spain ([4]) Aryabhatta Research Institute of Observational Sciences, Manora Peak, Nainital 263129, India ([5]) Tata Institute for Fundamental Research (TIFR), Homi Bhabha Road, Mumbai-400005, India ([6]) School of Physics, University College Dublin, Belfield, Dublin 4, Ireland

We have developed a model which describes the co-evolution of the mass function of dense gravitationally bound cores and of the stellar mass function in a protocluster clump. In the model, dense cores are injected, at a uniform rate, at different locations in the clump and evolve under the effect of gas accretion. Gas accretion onto the cores follows a time-dependent accretion rate that describes accretion in a turbulent medium. Once the accretion timescales of cores of a given age, of a given mass, and located at a given distance from the protocluster clumps center exceed their contraction timescales, they are turned into stars. The stellar initial mass function (IMF) is thus built up from successive generations of cores that undergo this accretion-collapse process. We also include the effect of feedback by the newly formed massive stars through their stellar winds. A fraction of the wind's energy is assumed to counter gravity and disperse the gas from the protocluster and as a consequence, quench further star formation. The latter effect sets the final IMF of the cluster. We apply our model to a clump that is expected to resemble the progenitor clump of the Orion Nebula Cluster (ONC). The ONC is the only known cluster for which a well determined IMF exists for masses ranging from the sub-stellar regime to very massive stars. Our model is able to reproduce both the shape and normalization of the ONC's IMF and the mass function of dense submillimeter cores in Orion. The complex features of the ONC's present day IMF, namely, a shallow slope in the mass range $\sim [0.3 - 2.5]$ $M_{\odot}$, a steeper slope in the mass range $\sim [2.5 - 12]$ $M_{\odot}$, and a nearly flat tail at the high mass end are reproduced. The model predicts a 'rapid' star formation process with an age spread for the stars of 2.3×10^5 yr which is consistent with the fact that 80 percent of the ONC's stars have ages of ≤ 0.3 Myr. The model also predicts a primordial mass segregation with the most massive stars being born in the region between 2 and 4 times the core radius of the cluster. In parallel, the model also reproduces, at the time the IMF is set and star formation quenched, the mass distribution of dense cores in the Orion star forming complex. We study the effects of varying some of the model parameters on the resulting IMF and we show that the IMF of stellar clusters is expected to show significant variations, provided variations in the clumps and cores physical properties exist.

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Hard diffuse X-ray emission in the star-forming region ON2: discovery with XMM-Newton

L. M. Oskinova, R. A. Gruendl, R. Ignace, Y.-H. Chu, W.-R. Hamann, A. Feldmeier
University of Potsdam, University of Illinois, East Tennessee State University

We obtained X-ray XMM-Newton observations of the open cluster Berkely 87 and the massive star-forming region (SFR) ON 2. In addition, archival infrared Spitzer Space Telescope observations were used. It is likely that the SFR ON 2 and Berkeley 87 are at the same distance, 1.23 kpc, and hence are associated. The XMM-Newton observations detected X-rays from massive stars in Berkeley 87 as well as diffuse emission from the SFR ON 2. The two patches of diffuse X-ray emission are encompassed in the shell-like H II region GAL 75.84+0.40 in the northern part of ON 2 and in the ON 2S region in the southern part of ON 2. The diffuse emission from GAL 75.84+0.40 suffers an absorption column equivalent to $A_V \approx 28$ mag. Its spectrum can be fitted either with a thermal plasma model at T < 30 MK or by an absorbed power-law model with $\gamma \approx -2.6$. The X-ray luminosity of GAL 75.84+0.40 is $L_X \approx 1 \cdot 10^{32}$ erg/s. The diffuse emission from ON 2S is adjacent to the ultra-compact H II (UCHII) region Cygnus 2N, but does not coincide with it or with any other known UCHII region. It has a luminosity of $L_X \approx 6 \cdot 10^{31}$ erg/s. The spectrum can be fitted with an absorbed power-law model with $\gamma \approx -1.4$. We adopt the view of Turner and Forbes (1982) that the SFR ON 2 is physically associated with the massive star cluster Berkeley 87 hosting the WO type star WR 142. We suggest that SFR ON 2 emits hard diffuse X-rays by a synchrotron mechanism, invoked by the co-existence of strongly shocked stellar winds and turbulent magnetic fields in the star-forming complex.

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2. Galactic Open Clusters

Breaking the curtain: the old open cluster VdB-Hagen 67 in the background of the Vela Molecular Ridge

Giovanni Carraro ([1]) Edgardo Costa ([2])
([1]) ESO Chile ([2]) Universidad de Chile

We present optical and infrared photometry for VdB-Hagen 67, an overlooked old open cluster located at $l = 273.76^o$, $b = -0.375^o$ ($RA = 09h : 26m : 45s$, $DEC = -51^o : 16' : 00''$, J2000.0) in the fourth Galactic quadrant, in the direction of the Vela Molecular Ridge. VdB-Hagen 67 is immersed in a dense stellar field which is characterized by highly patchy extinction, and A_V in the line of sight to the cluster is larger than 3 mag. The cluster looks symmetric and it clearly stands out from the general Galactic field. By mean of a star count analysis, both in the optical and IR, we have estimated that its radius of about 2 arcmin. Before this study only very general information was available for this cluster, but here we have determined its fundamental parameters. The age of VdB-Hagen 67, has been estimated both empirically and with theoretical isochrones, and turns out to be about 1.3 Gyrs. The difficulty to separate cluster members from interlopers prevented us form estimating its metallicity. No traces of sub-giant or red giant branch stars are visible in its field-star-decontaminated CMDs; VdB-Hagen 67 is an old, poorly populated, star cluster on the verge of dissolving into the general Galactic field. We derive a heliocentric distance of $\sim$7.5 kpc and a galactocentric distance of $\sim$11.5 kpc. With the exception of FSR 1415 at 8.6 kpc, and with an age of $\sim$2.5 Gyr (Momany et al. 2008), no other old clusters are known so far from the Sun in this Galactic sector. We argue that in this region of the Galactic plane several other distant clusters of this age have to exist, but have not been unraveled mainly because of the significant extinction produced by the dense Vela Molecular Ridge.

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For preprints, contact `gcarraro@eso.org`
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The young open cluster Trumpler 3

G. Maciejewski[1,2] and Ł. Bukowiecki[1]
[1]Toruń Centre for Astronomy, N. Copernicus University, Gagarina 11, PL-87100 Toruń, Poland
[2]Astrophysikalisches Institut und Universitäts-Sternwarte, Schillergässchen 2-3, D-07745 Jena, Germany

We present a photometric and spectroscopic study of the poorly investigated open cluster Trumpler 3. Basic parameters such as the age of 70 ± 10 Myr, the color excess $E(B-V) = 0.30 \pm 0.02$ mag, the distance of 0.69 ± 0.03 kpc and the limiting radius of 12' were redetermined and compared with previous preliminary studies. The distance of 0.65 ± 0.09 kpc was determined independently by spectral parallaxes. Simultaneously, our analysis allowed us to estimate a total number of members to be $N_{\rm tot} = 570 \pm 90$ and a total mass of the cluster to be $M_{\rm tot} = 270 \pm 40$ $M_\odot$. We also determined a state of cluster's dynamical evolution. We conclude that Trumpler 3 is a young low-massive stellar ensemble with a typical mass function slope, located near to the outer edge of the Galaxy's Orion Spur. As a result of a wide-field search for short period variable stars, 24 variables were discovered in the cluster's area. Only one of them – a variable of the γ-Dor type – was found to be a likely cluster member.

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See also `http://www.astri.uni.torun.pl/~gm/OCS/tr3.html`

A photometric and spectroscopic investigation of star formation in the very young open cluster NGC6383

Rauw, G., De Becker, M., Manfroid, J.
Institut d'Astrophysique & Geophysique, Universite de Liege, Liege, Belgium

The very young open cluster NGC 6383 centered on the O-star binary HD 159176 is an interesting place for studying the impact of early-type stars with strong radiation fields and powerful winds on the formation processes of low-mass stars. To investigate this process, it is necessary to determine the characteristics (age, presence, or absence of circumstellar material) of the population of low-mass pre-main-sequence (PMS) stars in the cluster. We obtained deep $U\,B\,V\,(R\,I)_c\,H\alpha$ photometric data of the entire cluster as well as medium-resolution optical spectroscopy of a subsample of X-ray selected objects. Our spectroscopic data reveal only very weak Hα emission lines in a few X-ray selected PMS candidates. We photometrically identify a number of Hα emission candidates but their cluster membership is uncertain. We find that the fainter objects in the field of view have a wide range of extinction (up to $A_V = 20$), one X-ray selected OB star having $A_V \simeq 8$. Our investigation uncovers a population of PMS stars in NGC 6383 that are probably coeval with HD 159176. In addition, we detect a population of reddened objects that are probably located at different depths within the natal molecular cloud of the cluster. Finally, we identify a rather complex spatial distribution of Hα emitters, which is probably indicative of a severe contamination by foreground and background stars.

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Young massive star clusters

Portegies Zwart, McMillan, Gieles
Sterrewacht Leiden, Drexel University, ESO

Young massive clusters are dense aggregates of young stars that form the fundamental building blocks of galaxies. Several examples exist in the Milky Way Galaxy and the Local Group, but they are particularly abundant in starburst and interacting galaxies. The few young massive clusters that are close enough to resolve are of prime interest for studying the stellar mass function and the ecological interplay between stellar evolution and stellar dynamics. The distant unresolved clusters may be effectively used to study the star-cluster mass function, and they provide excellent constraints on the formation mechanisms of young cluster populations. Young massive clusters are expected to be the nurseries for many unusual objects, including a wide range of exotic stars and binaries. So far only a few such objects have been found in young massive clusters, although their older cousins, the globular clusters, are unusually rich in stellar exotica. In this review we focus on star clusters younger than $\sim$ 100 Myr, more than a few current crossing times old, and more massive than $\sim 10^4$ Msun, irrespective of cluster size or environment. We describe the global properties of the currently known young massive star clusters in the Local Group and beyond, and discuss the state of the art in observations and dynamical modeling of these systems. In order to make this review readable by observers, theorists, and computational astrophysicists, we also review the cross-disciplinary terminology.

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A statistical method to determine open cluster metallicities

Harald Pöhnl and Ernst Paunzen

The study of open cluster metallicities helps to understand the local stellar formation and evolution throughout the Milky Way. Its metallicity gradient is an important tracer for the Galactic formation in a global sense. Because open clusters can be treated in a statistical way, the error of the cluster mean is minimized. Our final goal is a semi-automatic statistical robust method to estimate the metallicity of a statistically significant number of open clusters based on Johnson BV data of their members, an algorithm that can easily be extended to other photometric systems for a systematic investigation. This method incorporates evolutionary grids for different metallicities and a calibration of the effective temperature and luminosity. With cluster parameters (age, reddening and distance) it is possible to estimate the metallicity from a statistical point of view. The iterative process includes an intrinsic consistency check of the starting input parameters and allows us to modify them. We extensively tested the method with published data for the Hyades and selected sixteen open clusters within 1000pc around the Sun with available and reliable Johnson BV measurements. In addition, Berkeley 29, with a distance of about 15kpc was chosen. For several targets we are able to compare our result with published ones which yielded a very good coincidence (including Berkeley 29).

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The Dynamical Evolution of the Pleiades

Joseph M. Converse and Steven W. Stahler
Department of Astronomy, U. of California, Berkeley, CA 94720

We present the results of a numerical simulation of the history and future development of the Pleiades. This study builds on our previous one that established statistically the present-day structure of this system. Our simulation begins just after molecular cloud gas has been expelled by the embedded stars. We then follow, using an N-body code, the stellar dynamical evolution of the cluster to the present and beyond. Our initial state is that which evolves, over the 125 Myr age of the cluster, to a configuration most closely matching the current one. We find that the original cluster, newly stripped of gas, already had a virial radius of 4 pc. This configuration was larger than most observed, embedded clusters. Over time, the cluster expanded further and the central surface density fell by about a factor of two. We attribute both effects to the liberation of energy from tightening binaries of short period. Indeed, the original binary fraction was close to unity. The ancient Pleiades also had significant mass segregation, which persists in the cluster today. In the future, the central density of the Pleiades will continue to fall. For the first few hundred Myr, the cluster as a whole will expand because of dynamical heating by binaries. The expansion process is aided by mass loss through stellar evolution, which weakens the system's gravitational binding. At later times, the Galactic tidal field begins to heavily deplete the cluster mass. It is believed that most open clusters are eventually destroyed by close passage of a giant molecular cloud. Barring that eventuality, the density falloff will continue for as long as 1 Gyr, by which time most of the cluster mass will have been tidally stripped away by the Galactic field.

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3. Galactic Globular Clusters

Is Dust Forming on the Red Giant Branch in 47 Tuc?

Martha L. Boyer ([1]) Jacco Th. van Loon ([2]) Iain McDonald ([3]) Karl D. Gordon ([1]) Brian Babler ([4]) Miwa Block ([5]) Steve Bracker ([4]) Charles Engelbracht ([5]) Joe Hora ([6]) Remy Indebetouw ([7]) Marilyn Meade ([4]) Margaret Meixner ([1]) Karl Misselt ([5]) Marta Sewilo ([1]) Bernie Shiao ([1]) Barbara Whitney ([8])

([1]) STScI, 3700 San Martin Drive, Baltimore, MD 21218 USA; mboyer@stsci.edu ([2]) Astrophysics Group, Lennard-Jones Laboratories, Keele University, Staffordshire ST5 5BG, UK ([3]) Jodrell Bank Centre for Astrophysics, Alan Turing Building, University of Manchester, M13 9PL, UK ([4]) Department of Astronomy, University of Wisconsin, Madison, 475 North Charter Street, Madison, WI 53706-1582 USA ([5]) Steward Observatory, University of Arizona, 933 North Cherry Avenue, Tucson, AZ 85721 USA ([6]) Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS 65, Cambridge, MA 02138-1516 USA ([7]) Department of Astronomy, University of Virginia, P.O. Box 3818, Charlottesville, VA 22903-0818 USA ([8]) Space Science Institute, 4750 Walnut Street, Suite 205, Boulder, CO 80301 USA

Using Spitzer IRAC observations from the SAGE-SMC Legacy program and archived Spitzer IRAC data, we investigate dust production in 47 Tuc, a nearby massive Galactic globular cluster. A previous study detected infrared excess, indicative of circumstellar dust, in a large population of stars in 47 Tuc, spanning the entire Red Giant Branch (RGB). We show that those results suffered from effects caused by stellar blending and imaging artifacts and that it is likely that no stars below about 1 mag from the tip of the RGB are producing dust. The only stars that appear to harbor dust are variable stars, which are also the coolest and most luminous stars in the cluster.

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

Sandro Villanova([1]) Giovanni Carraro([2]) Riccardo Scarpa([3]) Gianni Marconi([2])
([1]) Universidad de Concepcion ([2]) ESO-Chile ([3]) IAC-GTC

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

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4. Extragalactic Clusters

Mass loss and expansion of ultra compact dwarf galaxies through gas expulsion and stellar evolution for top-heavy stellar initial mass functions

J. Dabringhausen[1], M. Fellhauer[2], P. Kroupa[1]

(1) Argelander-Institut für Astronomie, Universität Bonn, Auf dem Hügel 73, 53121 Bonn, Germany, (2) Departamento de Astronomia, Universidad de Concepcion, Casilla 160-C, Concepcion, Chile

The dynamical V-band mass-to-light ratios of ultra compact dwarf galaxies (UCDs) are higher than predicted by simple stellar population models with the canonical stellar initial mass function (IMF). One way to explain this finding is a top-heavy IMF, so that the unseen mass is provided by additional remnants of high-mass stars. A possible explanation for why the IMF in UCDs could be top-heavy while this is not the case in less massive stellar systems is that encounters between proto-stars and stars become probable in forming massive systems. However, the required number of additional stellar remnants proves to be rather high, which raises the question of how their progenitors would affect the early evolution of a UCD. We have therefore calculated the first 200 Myr of the evolution of the UCDs, using the particle-mesh code Superbox. It is assumed that the stellar populations of UCDs were created in an initial starburst, which implies heavy mass loss during the following ≈ 40 Myr due to primordial gas expulsion and supernova explosions. This mass loss is modelled by reducing the mass of the particles according to tabulated mass loss histories which account for different IMFs, star formation efficiencies (SFEs), heating efficiencies (HEs), initial masses and initial extensions of the computed UCDs. For each combination of SFE and HE we find objects that roughly resemble UCDs at the end of the simulation. For low SFEs, the IMF would have to be steeper than in the case of very high SFEs for the models not to expand too much. However, the main conclusion is that the existence of UCDs does not contradict the notion that their stellar populations formed rapidly and with a top-heavy IMF. We find tentative evidence that the UCDs may have had densities as high as $10^8 \mathrm{M}_\odot\,\mathrm{pc}^{-3}$ at birth. This will have to be confirmed by follow-up modelling.

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Assessment of Stellar Stratification in Three Young Star Clusters in the Large Magellanic Cloud

Dimitrios A. Gouliermis[1], Dougal Mackey[2], Yu Xin[3] and Boyke Rochau[1]

[1]Max Planck Institute for Astronomy, Königstuhl 17, 69117 Heidelberg, Germany, [2]Institute for Astronomy, University of Edinburgh, Royal Observatory, Blackford Hill, Edinburgh, EH9 3HJ, UK, [3]Argelander-Institut für Astronomie, Rheinische Friedrich-Wilhelms-Universität Bonn, Auf dem Hügel 71, 53121 Bonn, Germany

We present a comprehensive study of stellar stratification in young star clusters in the Large Magellanic Cloud (LMC). We apply our recently developed *effective radius method* for the assessment of stellar stratification on imaging data obtained with the Advanced Camera for Surveys of three young LMC clusters to characterize the phenomenon and develop a comparative scheme for its assessment in such clusters. The clusters of our sample, NGC 1983, NGC 2002 and NGC 2010, are selected on the basis of their youthfulness, and their variety in appearance, structure, stellar content, and surrounding stellar ambient. Our photometry is complete for magnitudes down to $m_{814} \simeq 23$ mag, allowing the calculation of the structural parameters of the clusters, the estimation of their ages and the determination of their stellar content. Our study shows that each cluster in our sample demonstrates stellar stratification in a quite different manner and at different degree from the others. Specifically, NGC 1983 shows to be *partially* segregated with the effective radius increasing with fainter magnitudes only for the faintest stars of the cluster. Our method on NGC 2002 provides evidence of *strong* stellar stratification for both bright and faint stars; the cluster demonstrates the phenomenon with the highest degree in the sample. Finally, NGC 2010 is *not segregated*, as its bright stellar content is not centrally concentrated, the relation of effective radius to magnitude for stars of intermediate brightness is rather flat, and we find no evidence of stratification for its faintest stars. For the parameterization of the phenomenon of stellar stratification and its quantitative comparison among these clusters, we propose the slope derived from the change in the effective radius over the corresponding magnitude range as indicative parameter of the *degree of stratification* in the clusters. A positive value of this slope indicates mass segregation in the cluster, while a negative or zero value signifies the lack of the phenomenon.

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The ACS Fornax Cluster Survey. IX. The Color-Magnitude Relation of Globular Cluster Systems

S. Mieske ([1]), A. Jordan ([2]), P. Cote ([3]), E. Peng ([4]), L. Ferrarese ([3]), J. Blakeslee ([3]), S. Mei ([5]), H. Baumgardt ([6]), J. Tonry ([7]), L. Infante ([2]), M. West ([1])

([1]) ESO, ([2]) Universidad Catolica, ([3]) Hertzberg Institute of Astrophysics, ([4]) Peking University ([5]) University of Paris ([6]) University of Bonn ([7]) University of Hawaii

We investigate the color-magnitude relation for globular clusters (GCs) – the so-called "blue tilt" – detected in the ACS Fornax Cluster Survey and using the combined sample of GCs from the ACS Fornax and Virgo Cluster Surveys. We find a tilt of $\gamma_z = d(g-z)/dz = -0.0257 \pm 0.0050$ for the full GC sample of the Fornax Cluster Survey (∼5800 GCs). This is slightly shallower than the value $\gamma_z = -0.0459 \pm 0.0048$ found for the Virgo Cluster Survey GC sample (∼11100 GCs). The slope for the merged Fornax and Virgo datasets (∼16900 GCs) is $\gamma_z = -0.0293 \pm 0.0085$, corresponding to a mass-metallicity relation of $Z \sim M^{0.43}$. We find that the blue tilt sets in at GC masses in excess of M $\sim 2 \cdot 10^5$ $M_\odot$. The tilt is stronger for GCs belonging to high-mass galaxies ($M_* > 5 \cdot 10^{10} M_\odot$) than for those in low-mass galaxies ($M_* < 5 \cdot 10^{10} M_\odot$). It is also more pronounced for GCs with smaller galactocentric distances. Our findings suggest a range of mass-metallicity relations $Z_{GC} \sim M_{GC}^{(0.3-0.7)}$ which vary as a function of host galaxy mass/luminosity. We compare our observations to a recent model of star cluster self-enrichment with generally favorable results. We suggest that, within the context of this model, the proto-cluster clouds out of which the GCs formed may have had density profiles slightly steeper than isothermal and/or star formation efficiencies somewhat below 0.3. We caution, however, that the significantly different appearance of the CMDs defined by the GC systems associated with galaxies of similar mass and morphological type pose a challenge to any single mechanism that seeks to explain the blue tilt. We therefore suggest that the merger/accretion histories of individual galaxies have played a non-negligible role determining the distribution of GCs in the CMDs of individual GC systems.

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The Star Cluster Population of the Collisional Ring Galaxy NGC 922

Anne Pellerin ([1,2]), Gerhardt R. Meurer ([2,3]), Kenji Bekki ([4,3]), Debra M. Elmegreen ([5]), O. Ivy Wong ([6]), and Patricia M. Knezek ([7])

[1] Texas A & M University, USA [2] Johns Hopkins University, USA [3] ICRAR/University of Western Australia, Australia [4] University of New South Wales, Australia [5] Vassar College, USA [6] Yale University, USA [7] WIYN Consortium Inc., USA

We present a detailed study of the star cluster population detected in the galaxy NGC922, one of the closest collisional ring galaxies known to date, using HST/WFPC2 UBVI photometry, population synthesis models, and N-body/SPH simulations.We find that 69star-forming complexes observed in NGC922 with those of a distant ring galaxy from the GOODS field indicates very similar masses and sizes, suggesting similar origins.

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Also available from the URL http://people.physics.tamu.edu/pellerin/Pellerin_etal_NGC922.pdf and http://lanl.arxiv.org/abs/1002.0009

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5. Dynamical evolution - Simulations

The formation of very wide binaries during the star cluster dissolution phase

M.B.N. Kouwenhoven ([1,2]), S.P. Goodwin ([2]), Richard J. Parker ([2]), M.B. Davies ([3]), D. Malmberg ([3]), P. Kroupa ([4])

([1]) Kavli Institute for Astronomy and Astrophysics at Peking University, Yi He Yuan Lu 5, Hai Dian District, Beijing 100871, P.R. China

([2]) University of Sheffield, Hicks Building, Hounsfield Road, Sheffield S3 7RH, United Kingdom

([3]) Lund Observatory, Box 43, SE-221 00, Lund, Sweden

([4]) Argelander Institute for Astronomy, University of Bonn, Auf dem Huegel 71, 53121 Bonn, Germany

Over the past few decades, numerous wide (¿1000 au) binaries in the Galactic field and halo have been discovered. Their existence cannot be explained by the process of star formation or by dynamical interactions in the field, and their origin has long been a mystery. We explain the origin of these wide binaries by formation during the dissolution phase of young star clusters: an initially unbound pair of stars may form a binary when their distance in phase-space is small. Using N-body simulations, we find that the resulting wide binary fraction in the semi-major axis range 1000 au - 0.1 pc for individual clusters is 1-30cluster size. The resulting eccentricity distribution is thermal, and the mass ratio distribution is consistent with gravitationally-focused random pairing. As a large fraction of the stars form in primordial binaries, we predict that a large number of the observed 'wide binaries' are in fact triple or quadruple systems. By integrating over the initial cluster mass distribution, we predict a binary fraction of a few per cent in the semi-major axis range 1000 au - 0.1 pc in the Galactic field, which is smaller than the observed wide binary fraction. However, this discrepancy may be solved when we consider a broad range of cluster morphologies.

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For preprints, contact kouwenhoven@kiaa.pku.edu.cn

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6. Miscellaneous

On The Multiplicity of the Zero-Age Main-Sequence O Star Herschel 36

Julia I. Arias[1], Rodolfo H. Barbá[1,2], Roberto C. Gamen[3], Nidia I. Morrell[4], Jesús Maíz Apellániz[5], Emilio, J. Alfaro[5], Alfredo Sota[5], Nolan R. Walborn[6], and Christian Moni Bidin[7]

[1]Departamento de Física, Universidad de La Serena, Benavente 980, La Serena, Chile, [2]Instituto de Ciencias Astronómicas de la Tierra, y del Espacio (ICATE-CONICET), Av. Espaa 1512 Sur, J5402DSP, San Juan, Argentina, [3]Instituto de Astrofísica de La Plata, CONICET; Facultad de Cs Astronómicas y Geofísicas, Universidad Nac. de La Plata, Paseo del Bosque S/N, La Plata, Argentina, [4]Las Campanas Observatory, The Carnegie Observatories, Casilla 601, La Serena, Chile, [5]Instituto de Astrofísica de Andalucía-CSIC, Glorieta de la Astronomía s/n, Granada 18008, Spain, [6]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA, [7]Departamento de Astronomía, Universidad de Concepción, Casilla 160-C, Concepción, Chile

We present the analysis of high-resolution optical spectroscopic observations of the zero-age main-sequence O star Herschel 36 spanning six years. This star is definitely a multiple system, with at least three components detected in its spectrum. Based on our radial-velocity (RV) study, we propose a picture of a close massive binary and a more distant companion, most probably in wide orbit about each other. The orbital solution for the binary, whose components we identify as O9 V and B0.5 V, is characterized by a period of 1.5415 ± 0.0006 days. With a spectral type O7.5 V, the third body is the most luminous component of the system and also presents RV variations with a period close to 498 days. Some possible hypotheses to explain the variability are briefly addressed and further observations are suggested.

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For preprints, contact julia@dfuls.cl

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Searching Beyond the Obscuring Dust Between the Cygnus-Aquila Rifts for Cepheid Tracers of the Galaxy's Spiral Arms

Daniel J. Majaess, David G. Turner, David J. Lane

Saint Mary's University, Halifax, Nova Scotia, Canada. The Abbey Ridge Observatory, Stillwater Lake, Nova Scotia, Canada.

A campaign is described, open to participation by interested AAVSO members, of follow-up observations for newly-discovered Cepheid variables in undersampled and obscured regions of the Galaxy, a primary objective being to use these supergiants to clarify the Galaxy's spiral nature. Preliminary multiband photometric observations are presented for three Cepheids discovered beyond the obscuring dust between the Cygnus and Aquila Rifts ($40^\circ \leq l \leq 50^\circ$), a region reputedly tied to a segment of the Sagittarius-Carina arm which appears to cease unexpectedly. The data confirm the existence of exceptional extinction along the line of sight at upwards of Av 6 magnitudes (d$\sim$2 kpc, l$\sim47^\circ$), however, the noted paucity of optical spiral tracers in the region does not arise solely from incompleteness owing to extinction. A hybrid spiral map of the Galaxy comprised of classical Cepheids, young open clusters and H II regions, and molecular clouds presents a consistent picture of the Milky Way and confirms that the three Cepheids do not populate the main portion of the Sagittarius-Carina arm, which does not emanate locally from this region. The Sagittarius-Carina arm, along with other distinct spiral features, is found to deviate from the canonical logarithmic spiral pattern. Revised parameters are also issued for the Cepheid BY Cas, and it is identified on the spiral map as lying in the foreground to most young associations in Cassiopeia. A Fourier analysis of the light curve of BY Cas implies overtone pulsation, and the Cepheid is probably unassociated with the open cluster NGC 663 since the distances, ages, and radial velocities do not match.

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Type II Cepheids as Extragalactic Distance Candles

Daniel J. Majaess, David G. Turner, David J. Lane

Saint Mary's University, Halifax, Nova Scotia, Canada. The Abbey Ridge Observatory, Stillwater Lake, Nova Scotia, Canada.

Extragalactic type II Cepheids are tentatively identified in photometric surveys of IC 1613, M33, M101, M106, M31, NGC 4603, and the SMC. Preliminary results suggest that type II Cepheids may play an important role as standard candles, in constraining the effects of metallicity on Cepheid parameters, and in mapping extinction.

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For preprints, contact dmajaess@ap.smu.ca ; turner@ap.smu.ca

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RR Lyrae and Type II Cepheid Variables Adhere to a Common Distance Relation

Daniel J. Majaess

Saint Mary's University, Halifax, Nova Scotia, Canada. The Abbey Ridge Observatory, Stillwater Lake, Nova Scotia, Canada.

Preliminary evidence is presented reaffirming that SX Phe, RR Lyrae, and Type II Cepheid variables may be characterized by a common Wesenheit period-magnitude relation, to first order. Reliable distance estimates to RR Lyrae variables and Type II Cepheids are ascertained from a single VI-based reddening-free relation derived recently from OGLE photometry of LMC Type II Cepheids. Distances are computed to RR Lyrae (d∼260 pc), and variables of its class in the galaxies IC 1613, M33, Fornax dSph, LMC, SMC, and the globular clusters M3, M15, M54, omega Cen, NGC 6441, and M92. The results are consistent with literature estimates, and in the particular cases of the SMC, M33, and IC 1613, the distances agree with that inferred from classical Cepheids to within the uncertainties: no corrections were applied to account for differences in metallicity. Moreover, no significant correlation was observed between the distances computed to RR Lyrae variables in omega Cen and their metallicity, despite a considerable spread in abundance across the sample. In sum, concerns regarding a sizeable metallicity effect are allayed when employing VI-based reddening-free Cepheid and RR Lyrae relations.

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VISTA Variables in the Via Lactea (VVV): The public ESO near-IR variability survey of the Milky Way

D. Minniti[1,2], P.W. Lucas[3], J.P. Emerson[4], R.K. Saito[1], M. Hempel[1], P. Pietrukowicz[1,5], A.V. Ahumada[6,7,8], M.V. Alonso[6], J. Alonso-Garcia[9], J.I. Arias[10], R.M. Bandyopadhyay[11], R.H. Barbá[10], B. Barbuy[12], L.R. Bedin[13], E. Bica[14], J. Borissova[15], L. Bronfman[16], G. Carraro[7], M. Catelan[1], J.J. Clariá[6], N. Cross[17], R. de Grijs[18,19], I. Dékány[20], J.E. Drew[3,21], C. Fariña[22], C. Feinstein[22], E. Fernández Lajús[22], R.C. Gamen[10], D. Geisler[23], W. Gieren[23], B. Goldman[24], O.A. Gonzalez[25], G. Gunthardt[10], S. Gurovich[6], N.C. Hambly[17], M.J. Irwin[26], V.D. Ivanov[7], A. Jordán[1], E. Kerins[27], K. Kinemuchi[10,23], R. Kurtev[15], M. López-Corredoira[28], T. Maccarone[29], N. Masetti[30], D. Merlo[6], M. Messineo[31,32], I.F. Mirabel[33,34], L. Monaco[7], L. Morelli[35], N. Padilla[1], T. Palma[6], M.C. Parisi[6], G. Pignata[36], M. Rejkuba[25], A. Roman-Lopes[10], S.E. Sale[21], M.R. Schreiber[15], A.C. Schröder[37,38], M. Smith[39], L. Sodré Jr.[12], M. Soto[10], M. Tamura[40], C. Tappert[15], M.A. Thompson[3], I. Toledo[1], M. Zoccali[1], G. Pietrzynski[23]

[1]Departamento de Astronomía y Astrofísica, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, Casilla 306, Santiago 22, Chile
[2]Vatican Observatory, Vatican City State V-00120, Italy
[3]Centre for Astrophysics Research, Science and Technology Research Institute, University of Hertfordshire, Hatfield AL10 9AB, UK
[4]Astronomy Unit, School of Mathematical Sciences, Queen Mary, University of London, Mile End Road, London, E1 4NS, UK
[5]Nicolaus Copernicus Astronomical Center, ul. Bartycka 18, 00-716 Warszawa, Poland
[6]Observatorio Astronómico de Córdoba, Universidad Nacional de Córdoba, Laprida 854, 5000 Córdoba, Argentina
[7]European Southern Observatory, Av. Alonso de Córdova 3107, Casilla 19, Santiago 19001, Chile
[8]Consejo Nacional de Investigaciones Científicas y Técnicas, Av. Rivadavia 1917 - CP C1033AAJ - Buenos Aires, Argentina
[9]Department of Astronomy, University of Michigan, Ann Arbor, MI 48109-1090, USA
[10]Departamento de Física, Universidad de La Serena, Benavente 980, La Serena, Chile
[11]Department of Astronomy, University of Florida, 211 Bryant Space Science Center P.O. Box 112055, Gainesville, FL, 32611-2055, USA
[12]Universidade de São Paulo, IAG, Rua do Matão 1226, Cidade Universitária, São Paulo 05508-900, Brazil
[13]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
[14]Universidade Federal do Rio Grande do Sul, IF, CP 15051, Porto Alegre 91501-970, RS, Brazil
[15]Departamento de Física y Astronomía, Facultad de Ciencias, Universidad de Valparaíso, Ave. Gran Bretaã 1111, Playa Ancha, Casilla 5030, Valparaíso, Chile
[16]Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile
[17]Institute for Astronomy, The University of Edinburgh, Royal Observatory, Blackford Hill, Edinburgh EH9 3HJ, UK
[18]The Department of Physics and Astronomy, University of Sheffield, Hicks Building, Hounsfield Road, Sheffield, S3 7RH, UK
[19]National Astronomical Observatories, Chinese Academy of Sciences, 20A Datun Road, Chaoyang District, Beijing 100021, China
[20]Konkoly Observatory of the Hungarian Academy of Sciences, H-1525 Budapest, PO Box 67, Hungary
[21]Astrophysics Group, Imperial College London, Blackett Laboratory, Prince Consort Road, London SW7 2AZ, UK
[22]Facultad de Ciencias Astronómicas y Geofísicas, Universidad Nacional de La Plata, and Instituto de Astrofísica La Plata, Paseo del Bosque S/N, B1900FWA, La Plata, Argentina
[23]Departmento de Astronomía, Universidad de Concepción, Casilla 160-C, Concepción, Chile
[24]Max Planck Institute for Astronomy, Königstuhl 17, 69117 Heidelberg, Germany [25]European Southern Observatory, Karl-Schwarzschild-Strasse 2, D-85748 Garching, Germany
[26]Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK
[27]Jodrell Bank Centre for Astrophysics, The University of Manchester, Oxford Road, Manchester M13 9PL, UK
[28]Instituto de Astrofísica de Canarias, Vía Láctea s/n, E38205 - La Laguna (Tenerife), Spain
[29]School of Physics and Astronomy, University of Southampton, Highfield, Southampton, SO17 1BJ, UK
[30]Istituto di Astrofisica Spaziale e Fisica Cosmica di Bologna, via Gobetti 101, 40129 Bologna, Italy

[31]Chester F. Carlson Centre for Imaging Science, Rochester Institute of Technology, 54 Lomb Memorial Drive, Rochester NY 14623, USA
[32]The Astrophysics and Fundamental Physics Missions Division, Research and Scientific Support Department, Directorate of Science and Robotic Exploration, ESTEC, Postbus 299, 2200 AG Noordwijk, The Netherlands
[33]Service d'Astrophysique - IRFU, CEA-Saclay, 91191 Gif sur Yvette, France
[34]Instituto de Astronomía y Física del Espacio, Casilla de Correo 67, Sucursal 28, Buenos Aires, Argentina
[35]Dipartimento di Astronomia, Universitá di Padova, vicolo dell'Osservatorio 3, 35122 Padova, Italy
[36]Departamento de Ciencias Fisicas, Universidad Andres Bello, Av. República 252, Santiago, Chile
[37]Department of Physics & Astronomy, University of Leicester, University Road, Leicester, LE1 7RH, UK
[38]Hartebeesthoek Radio Astronomy Observatory, PO Box 443, Krugersdorp 1740, South Africa
[39]The University of Kent, Canterbury, Kent, CT2 7NZ, UK
[40]Division of Optical and Infrared Astronomy, National Astronomical Observatory of Japan 2-21-1 Osawa, Mitaka, Tokyo, 181-8588, Japan

We describe the public ESO near-IR variability survey (VVV) scanning the Milky Way bulge and an adjacent section of the mid-plane where star formation activity is high. The survey will take 1929 h of observations with the 4-m VISTA telescope during 5 years (2010-2014), covering $\sim 10^9$ point sources across an area of 520 deg^2, including 33 known globular clusters and $\sim$ 350 open clusters. The final product will be a deep near-IR atlas in five passbands (0.9-2.5 μm) and a catalogue of more than 10^6 variable point sources. Unlike single-epoch surveys that, in most cases, only produce 2-D maps, the VVV variable star survey will enable the construction of a 3-D map of the surveyed region using well-understood distance indicators such as RR Lyrae stars, and Cepheids. It will yield important information on the ages of the populations. The observations will be combined with data from MACHO, OGLE, EROS, VST, Spitzer, HST, Chandra, INTEGRAL, WISE, Fermi LAT, XMM-Newton, GAIA and ALMA for a complete understanding of the variable sources in the inner Milky Way. This public survey will provide data available to the whole community and therefore will enable further studies of the history of the Milky Way, its globular cluster evolution, and the population census of the Galactic Bulge and center, as well as the investigations of the star forming regions in the disk. The combined variable star catalogues will have important implications for theoretical investigations of pulsation properties of stars.

Contact dante@astro.puc.cl (D. Minniti), P.W.Lucas@herts.ac.uk (P.W. Lucas)
URL http://arxiv.org/abs/0912.1056
Link http://vvvsurvey.org/

A New Lower Main Sequence Eclipsing Binary with Detached Components

M.Rozyczka[1], J.Kaluzny[1], P.Pietrukowicz[1,2], W.Pych[1], B.Mazur[1], M.Catelan[2] and I.B. Thompson[3]

[1]Nicolaus Copernicus Astronomical Center, ul. Bartycka 18, 00-716 Warsaw, Poland; [2]Departamento de Astronomía y Astrofísica, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, Macul, Santiago, Chile; [3]The Observatories of the Carnegie Institution of Washington, 813 Santa Barbara Street, Pasadena, CA91101, USA

We present an analysis of NGC2204-S892 – a new detached eclipsing binary composed of two late K dwarfs. Based on three photometric campaigns launched in 2008 we obtained 5 light curves (3 in V, 1 in B and 1 in I), and derived an orbital period of 0.451780±0.000001 d. We also obtained 20 VLT/UVES spectra, enabling accurate radial velocity measurements. The derived masses and radii of the components ($m_1 = 0.733 \pm 0.005\ M_\odot$ and $R_1 = 0.72 \pm 0.01\ R_\odot$; $m_2 = 0.662 \pm 0.005\ M_\odot$ and $R_2 = 0.68 \pm 0.02\ R_\odot$) are consistent with the empirical mass-radius relationship established recently for lower main sequence stars in binary systems; in particular we find that both stars are oversized compared to theoretical models. NGC2204-S892 is very active: both components show variable emission in Hα and Hβ and are heavily spotted, causing the light curve to show appreciable changes on a timescale of weeks. Our results add to the increasing evidence that the observed inflation of the radii of K and M stars is related to high levels of magnetic activity.

Key words: *binaries: eclipsing – stars: individual: NGC2204-S892 – stars: low-mass – stars: K-type*

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Acta Astronomica .....

The PL calibration for Milky Way Cepheids and its implications for the distance scale

David G. Turner
Saint Mary's University, Halifax, Nova Scotia, Canada.

The rationale behind recent calibrations of the Cepheid PL relation using the Wesenheit formulation is reviewed and reanalyzed, and it is shown that recent conclusions regarding a possible change in slope of the PL relation for short-period and long-period Cepheids are tied to a pathological distribution of HST calibrators within the instability strip. A recalibration of the period-luminosity relation is obtained using Galactic Cepheids in open clusters and groups, the resulting relationship, described by log L/Lsun=2.415(±0.035)+1.148(±0.044)log P, exhibiting only the moderate scatter expected from color spread within the instability strip. The relationship is confirmed by Cepheids with HST parallaxes, although without the need for Lutz-Kelker corrections, and in general by Cepheids with revised Hipparcos parallaxes, albeit with concerns about the cited precisions of the latter. A Wesenheit formulation of W_v=-2.259(±0.083)-4.185(±0.103)log P for Galactic Cepheids is tested successfully using Cepheids in the inner regions of the galaxy NGC 4258, confirming the independent geometrical distance established for the galaxy from OH masers. Differences between the extinction properties of interstellar and extragalactic dust may yet play an important role in the further calibration of the Cepheid PL relation and its application to the extragalactic distance scale.

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MODEST-10

Encounters and interactions in dense stellar systems modeling, computing, and observations

The first main MODEST meeting in Asia; the first in China

30 August - 3 September 2010, Beijing, China

Dense stellar clusters are the birth places of stars and planetary systems, and form the building blocks of galaxies. The complex interplay between stellar dynamics, stellar evolution, and hydrodynamics is a challenge for astrophysical modelling and computer simulations. In recent years, significant progress has been made in the fields of N-body dynamics, hydrodynamics, radiative transport, and stellar evolution, and powerful hardware (GPUs and GRAPEs) has become available to vastly speed up simulations. In addition, a wealth of observational data have become available, and will emerge in the near future (LAMOST, GAIA). The combination of these advances has increased our understanding related to a range of fundamental topics in astronomy: star cluster formation and evolution, star formation, planetary dynamics, stellar structure and evolution, dynamics of the Galactic centre, the formation and evolution of galaxies, and cosmology. At the same time, fresh problems have emerged which challenge the basic paradigm of almost all recent work. Once regarded as an example of simple stellar populations, born simultaneously, rich clusters are known to have a more complicated history, which affects everything, from their dynamical evolution to their composition.

Understanding the formation and evolution of star clusters is a challenging task which requires the collaboration and the exchange of ideas of astronomers, physicists, and computer scientists with observational and theoretical expertise in Galactic and extragalactic astronomy, stellar dynamics, hydrodynamics, stellar evolution, and software/hardware development.

The MODEST (Modeling Dense Stellar Clusters; http://manybody.org/modest) collaboration is a loosely knit international collaboration between various groups working in stellar dynamics, stellar evolution, stellar hydrodynamics, and related research areas. One of the main activities of the collaboration is to provide a software framework for large-scale simulations of dense stellar systems, in which existing codes for dynamics, stellar evolution, and hydrodynamics can be easily coupled, and place them in the appropriate observational context.

In recent years, China has experienced a significant development in both fundamental and computational science. Given the bright future for these fields, it is appropriate for the MODEST-10 meeting to be held in China. During the workshop, we will look back at the progress made during the first ten yours of MODEST, and set our goals for the upcoming decade. This MODEST-10 workshop focuses primarily on, but is not limited to:

1. The formation and evolution of star clusters, from birth to death, including the issues of infant mortality, stellar multiplicity, the initial mass function, mass segregation, and the effect of tidal fields
2. Resolved globular clusters and globular cluster systems in nearby and distant galaxies
3. Dwarf galaxies, the formation of tidal dwarfs and nuclear star clusters
4. Exotic objects in dense stellar systems (blue stragglers, contact binaries, black holes, and other compact objects)
5. The dynamics of planetary systems in star cluster environments
6. Modeling of galactic nuclei, including our own Galactic centre; the interaction between stars, star clusters and supermassive black holes

7. Comparison between observations and simulations; preparing for large surveys in the upcoming decade
8. High-performance computational facilities (GPUs, GRAPEs, supercomputers) and innovative computing environments (grids, MUSE)

The MODEST-10 workshop will be held from **30 August to 3 September 2010** in Beijing, China. It is jointly organized by the National Astronomical Observatories (NAOC), Chinese Academy of Sciences, and the Kavli Institute for Astronomy and Astrophysics (KIAA) at Peking University. Pre-registration is possible at **http://modest2010.bao.ac.cn**, and further information can be obtained by contacting modest10@kiaa.pku.edu.cn.

Summer school and workshop on Computational Gravitational Dynamics

We aim at bringing together a wide range of computational gravitational dynamicists to discuss the recent progress and possibilities for interdisciplinary research in this field. We intend to bridge the gaps between planetary dynamics, star cluster dynamics, galaxy dynamics and cosmology.

The first week (May 3-10) has the form of a school for graduate students. The second week (May 10-13) is in the form of a workshop for experts. (Students whom participated in the first week are invited to participate in the workshop.)

Advanced School and Workshop on Computational Gravitational Dynamics

Keywords:

- Computational astrophysics
- N-body methods
- Planetary dynamics
- Star cluster dynamics
- Galactic nuclei
- Galaxy dynamics
- Large scale structure
- Cosmology

The advanced school will be held from Monday 3 May to Friday 7 May, and is intended for advanced MSc students of young PhD students. Students at the school will work in triplets under the supervision of a key researcher. Together they will work for one week with the possibility to finish the work in the second week (10 to 13 May). The results of the project will be presented at the workshop in the second week and published in a peer reviewed proceedings.

The workshop will be held from Monday 10 May to Thursday 13 May, and is intended for advanced postdoctoral fellows and professional researchers. We aim at bringing together a wide range of computational gravitational dynamicists to discuss the recent progress and possibilities for interdisciplinary research in this field. We notice that planetary dynamicists rarely interact with cosmologists on the numerical details used in their scientific production software, even though the underlying physics is quite comparable. We intend to bridge this gap.

We will have review talks of a number of invited key researchers, and short contributed presentations of cross disciplinary researchers, followed by extensive discussions.

More information regarding the school and worskhop can be found at
`http://www.lorentzcenter.nl/lc/web/2010/400/info.php3?wsid=400`

Sincerely yours,
Simon Portegies Zwart (Leiden Observatory, Netherlands)
Steve McMillan (Department of Physics, Drexel University, U.S.A.)
Alice Quillen (Dept. of Physics and Astronomy Rochester, U.S.A.)
Joachim Stadel (Institute of Theoretical Physics, Zurich, Switzerland)

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

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Star clusters as tracers of galactic star-formation histories

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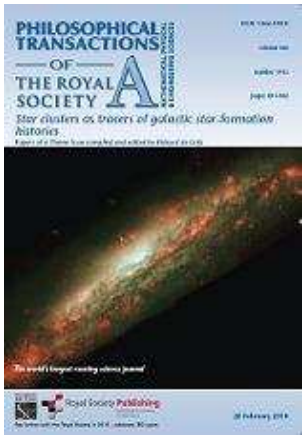

It is widely accepted that stars form in groups, from binary systems up to very large clusters containing millions of stars. Over time, clusters dissolve or are destroyed and their member stars become part of the general makeup of a galaxy's bulk stellar population. Star clusters are thus among the basic building blocks of galaxies. In turn, star cluster populations - from young associations and open clusters to old globular clusters - are powerful tracers of the formation, assembly and evolutionary history of their parent galaxies.

Although their importance (for instance, in mapping out the Milky Way) has been recognised for decades, major progress in this area has only become possible in recent years. This is largely thanks to significant new resources in theory, simulations and observations, including breakthroughs in computational power, the maturing of Hubble Space Telescope-driven science, deep and more precise data for large numbers of Galactic clusters, an explosion of 'astrometric' data and the coming online of observing facilities enabling access to hitherto unavailable spectral regions.

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