SCYON

The Star Clusters Young & Old Newsletter

edited by Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

SCYON can be found at URL:
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EDITORIAL

This is the 51st issue of the SCYON newsletter. This issue contains 11 abstracts from refereed publications, an announcement for the AMUSE workshop in Leiden in July 2011 and a job offer for a postdoctoral fellowship from the University of Queensland, Australia.

As usual, we thank all who sent us their contributions.

Holger Baumgardt and Ernst Paunzen

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@univie.ac.at.

A "Call for abstracts" is sent out approximately one week before the next issue of the newsletter is finalised. This call contains the deadline for abstract submissions for that coming issue and the LaTeX abstract template.
Depending on circumstances, the editors might actively solicit contributions, usually those spotted on a preprint server, but they do not publish abstracts without the author's consent.

We implicitly encourage further dissemination of the letter to institutes and astronomers who may benefit from it.

The editors

SCYON Mirrors

The official Scyon mirror site in Australia is hosted at the Centre for Astrophysics & Supercomputing of the University of Swinburne by Duncan Forbes and his team :
HTTP://ASTRONOMY.SWIN.EDU.AU/SCYON/)

1. Star Forming Regions

The Ara OB1a association: Stellar population and star formation history

G. Baume ([1]) G. Carraro ([2]) F. Comeron ([3]) G.C. D'Elia ([1])
([1]) La Plata ([2]) ESO Chile ([3]) ESO Garching

The Ara OB1a association is a nearby complex in the fourth Galactic quadrant where a number of young/embedded star clusters are projected close to more evolved, intermediate age clusters. It is also rich in interstellar matter, and contains evidence of the interplay between massive stars and their surrounding medium, such as the rim HII region NGC 6188. Aims: We provide robust estimates of the fundamental parameters (age and distance) of the two most prominent stellar clusters, NGC 6167 and NGC 6193, that may be used as a basis for studing the star formation history of the region. Methods: The study is based on a photometric optical survey (UBVIHa) of NGC 6167 and NGC 6193 and their nearby field, complemented with public data from 2MASS-VVV, UCAC3, and IRAC-Spitzer in this region. Results: We produce a uniform photometric catalogue and estimate more robustly the fundamental parameters of NGC 6167 and NGC 6193, in addition to the IRAS 16375-4854 source. As a consequence, all of them are located at approximately the same distance from the Sun in the Sagittarius-Carina Galactic arm. However, the ages we estimate differ widely: NGC 6167 is found to be an intermediate-age cluster (20-30 Myr), NGC 6193 a very young one (1-5 Myr) with PMS, H? emitters and class II objects, and the IRAS 16375-4854 source is the youngest of the three containing several YSOs. Conclusions: These results support a picture in which Ara OB1a is a region where star formation has proceeded for several tens of Myr until the present. The difference in the ages of the different stellar groups can be interpreted as a consequence of a triggered star formation process. In the specific case of NGC 6193, we find evidence of possible non-coeval star formation.

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Star formation efficiency as a function of metallicity: from star clusters to galaxies

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We explore how the star formation efficiency in a protocluster clump is regulated by metallicity dependent stellar winds from the newly formed massive OB stars ($M_\star \geq 5$ M$_\odot$) on their main sequence. The model describes the co-evolution of the mass function of gravitationally bound cores and of the IMF in a protocluster clump. Dense cores are generated uniformly in time at different locations in the clump, and contract over lifetimes that are a few times their free fall times. The cores collapse to form stars that power strong stellar winds whose cumulative kinetic energy evacuates the gas from the clump and quenches further core and star formation. This sets the final star formation efficiency, SFE_f. Models are run with various metallicities in the range $Z/Z_\odot = [0.1, 2]$. We find that the SFE_f decreases strongly with increasing metallicity. The SFE_f-metallicity relation is well described by a decaying exponential whose exact parameters d! epend weakly on the value of the core formation efficiency. We find that there is almost no dependence of the SFE_f-metallicity relation on the clump mass. This is due to the fact that an increase (decrease) in the clump mass leads to an increase (decrease) in the feedback from OB stars which is opposed by an increase (decrease) in the gravitational potential of the clump.The clump mass-cluster mass relations we find for all of the different metallicity cases imply a negligible difference between the exponent of the mass function of the protocluster clumps and that of the young clusters mass function. By normalizing the SFEs to their value for the solar metallicity case, we compare our results to $SFE-$metallicity relations derived on galactic scales and find a good agreement. As a by-product of this study, we also provide ready-to-use prescriptions for the power of stellar winds of main sequence OB stars in the mass range $[5, 80]$ M$_\odot$ in the metallicity range! we have considered.

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Also available from the URL `http://arxiv.org/abs/1102.3839`
or by anonymous ftp at

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2. Galactic Open Clusters

Three new bricks in the wall: Berkeley 23, Berkeley 31, and King 8

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A comprehensive census of Galactic open cluster properties places unique constraints on the Galactic disc structure and evolution. In this framework we investigate the evolutionary status of three poorly-studied open clusters, Berkeley 31, Berkeley 23 and King 8, all located in the Galactic anticentre direction. To this aim, we make use of deep LBT observations, reaching more than 6 mag below the main sequence Turn- Off. To determine the cluster parameters, namely age, metallicity, distance, reddening and binary fraction, we compare the observational colour-magnitude diagrams (CMDs) with a library of synthetic CMDs generated with different evolutionary sets (Padova, FRANEC and FST) and metallicities. We find that Berkeley 31 is relatively old, with an age between 2.3 and 2.9 Gyr, and rather high above the Galactic plane, at about 700 pc. Berkeley 23 and King 8 are younger, with best fitting ages in the range 1.1-1.3 Gyr and 0.8-1.3 Gyr, respectively. The position above the Galactic plane is about 500- 600 pc for the former, and 200 pc for the latter. Although a spectroscopic confirmation is needed, our analysis suggests a sub-solar metallicity for all three clusters.

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The substellar mass function in the central region of the open cluster Praesepe from deep LBT observations

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Studies of the mass function (MF) of open clusters of different ages allow us to probe the efficiency with which brown dwarfs evaporate from clusters to populate the field. Surveys of older clusters (age > 100 Myr) are not affected so severely by several problems encountered in young clusters, such as intra-cluster extinction and large uncertainties in brown dwarf models. We present the results of a deep photometric survey to study the MF of the central region of the old open cluster Praesepe (age 590^{+150}_{-120} Myr, distance $190^{+6.0}_{-5.8}$ pc), down to the substellar regime. We performed an optical (riz and Y-band) photometric survey of Praesepe using the Large Binocular Telescope Camera covering an area of $0.59\,\mathrm{deg}^2$ in the cluster centre from $i \sim 19.0$ mag ($\sim 100\,M_{\rm Jup}$) down to a 5σ detection limit at $i \sim 25.6$ mag ($\sim 40\,M_{\rm Jup}$). The survey is approximately 95% complete at $i = 23.8$ mag and $z = 22.0$ mag ($\sim 55\,M_{\rm Jup}$). We identify 59 cluster member candidates, of which 37 are substellar, by comparing with the predictions of a dusty atmosphere model. The MF of those candidates rises from the substellar boundary until $\sim 67\,M_{\rm Jup}$ and then declines. This is quite different from the form inferred for other open clusters older than 50 Myr, but seems to be similar to those found in very young open clusters, the MFs of which peak at $\sim 10\,M_{\rm Jup}$. Either Praesepe really does have a different MF from other clusters or they had similar initial MFs but a different dynamical evolution. Since most of the candidates are faint, we lack astrometric or pectroscopic follow-ups to test their memberships. However, the contaminations by field dwarfs, galaxies, or giants are found to have little effect on the shape of MF and therefore the MF of 'real' cluster members should have similar characteristics.

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3. Galactic Globular Clusters

In search of massive single–population Globular Clusters

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The vast majority of globular clusters so far examined shows the chemical signatures of hosting (at least) two stellar populations. According to recent ideas, this feature requires a two–step process, in which the nuclearly processed matter from a "first generation" (FG) of stars gives birth to a "second generation" (SG) bearing the fingerprint of a fully CNO–cycled matter. Since, as observed, the present population of most globular clusters is made up largely of SG stars, a substantial fraction of the FG ($\geq 90\%$) must be lost. Nevertheless, two types of clusters dominated by a simple stellar population (FG clusters) should exist: either clusters initally too small to be able to retain a cooling flow and form a second generation (FG–only clusters), or massive clusters that could retain the CNO processed ejecta and form a SG, but were unable to lose a significant fraction of their FG (mainly–FG clusters). Identification of mainly–FG clusters may provide an estimate of the fraction of the initial mass involved in the formation of the SG.

We attempt a first classification of FG clusters, based on the morphology of their horizontal branches (HBs), as displayed in the published catalogues of photometric data for 106 clusters. We select, as FG candidates, the clusters in which the HB can be reproduced by the evolution of an almost unique mass. We find that less than 20% of clusters with [Fe/H]<–0.8 appear to be FG, but only ∼10% probably had a mass sufficient to form at all an SG. This small percentage confirms on a wider database the spectroscopic result that the SG is a dominant constituent of today's clusters, suggesting that its formation is an ingredient necessary for the survival of globular clusters during their dynamical evolution in the Galactic tidal field.

In more detail we show that Pal 3 turns out to be a good example of FG–only cluster. Instead, HB simulations and space distribution of its components, indicate that M 53 is a "mainly–FG" cluster, that evolved in dynamical isolation and developed a small SG in its core thanks to its large mass. Mainly–FG candidates may be also NGC 5634, NGC 5694 and NGC 6101. In contrast, NGC 2419 contains >30% of SG stars, and its present dynamical status bears less information on its formation process than the analysis of the chemical abundances of its stars and of its HB morphology.

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For preprints, contact dantona@oa-roma.inaf.it
Also available in astro–ph ....

The oxygen vs. sodium (anti)correlation(s) in Omega Centauri

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Recent exam of large samples of Omega Centauri giants shows that it shares with mono-metallic globular clusters the presence of the sodium versus oxygen anticorrelation, within each subset of stars with iron content in the range –1.9≤[Fe/H]≤–1.3. These findings suggest that, while the second generation formation history in Omega Centauri is more complex than that of mono-metallic clusters, it shares some key steps with those simpler cluster. In addition, the giants in the range –1.3<[Fe/H]≤–0.7 show a *direct* O–Na correlation, at moderately low O, but Na up to 20 times solar. These peculiar Na abundances are not shared by stars in other environments often assumed to undergo a similar chemical evolution, such as in the field of the Sagittarius dwarf galaxy. These O and Na abundances match well the yields of the massive asymptotic giant branch stars (AGB) in the same range of metallicity, suggesting that the stars at [Fe/H]>–1.3 in Omega Centauri are likely to have formed directly *from the pure ejecta of massive AGBs of the same metallicities*. This is possible if the massive AGBs of [Fe/H]>–1.3 in the progenitor system evolve when all the pristine gas surrounding the cluster has been exhausted by the previous star formation events, or the proto–cluster interaction with the Galaxy caused the loss of a significant fraction of its mass, or of its dark matter halo, and the supernova ejecta have been able to clear the gas out of the system. The absence of dilution in the metal richer populations lends further support to a scenario of the formation of second generation stars in cooling flows from massive AGB progenitors. We suggest that the entire formation of Omega Centauri took place in a few 10^8yr, and discuss the problem of a prompt formation of s–process elements.

Accepted by The Astrophysical Journal

For preprints, contact dantona@oa-roma.inaf.it

Also available as arXiv:1105.0366v1 ....

On the dynamical evolution of globular clusters

Michel Henon (translated by Florent Renaud)
IAP Paris Strasbourg & IoA Cambridge

This paper is an English translation of Michel Hénon's thesis, "Sur l'évolution dynamique des amas globulaires" originally published in French in the Annales d'Astrophysique, Vol. 24, p.369 (1961).

To appear in : Originally published in the Annales d'Astrophysique
For preprints, contact florent.renaud@astro.unistra.fr
Also available from the URL http://adsabs.harvard.edu/abs/2011arXiv1103.3499H
or by anonymous ftp at ftp://

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Spitzer spectra of evolved stars in omega Centauri and their low-metallicity dust production

Iain McDonald ([1,2]); Jacco Th. van Loon ([2]); Gregory C. Sloan ([3]); Andrea K. Dupree ([4]); Albert A. Zijlstra ([1]); Martha L. Boyer ([5]); Robert D. Gehrz ([6]); Evans, Aneurin ([2]); Charles E. Woodward ([6]); Christian I. Johnson ([7])

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Dust production is explored around 14 metal-poor ([Fe/H] = -1.91 to -0.98) giant stars in the Galactic globular cluster omega Centauri using new Spitzer IRS spectra. This sample includes the cluster?s post-AGB and carbon stars and is thus the first representative spectral study of dust production in a metal-poor ([Fe/H] $<$ 1) population. Only the more metal rich stars V6 and V17 ([Fe/H] = -1.08, -1.06) exhibit silicate emission, while the five other stars with mid-infrared excess show only a featureless continuum which we argue is caused by metallic iron dust grains. We examine the metallicity of V42, and find it is likely part of the metal-rich population ([Fe/H] $\sim$ 0.8). Aside from the post-AGB star V1, we find no star from the cluster's bulk, metal-poor ([Fe/H] $<$ 1.5) population - including the carbon stars - to be producing detectable amounts of dust. We compare the dust production to the stars' H-alpha line profiles obtained at the Magellan/Clay telescope at Las Campanas Observatory, finding pulsation shocking in the strongest pulsators (V6, V17 and V42), but evidence of outflow in all other stars. We conclude that the onset of dust production does not signify a fundamental change in the material leaving the star. Our data add to a growing body of evidence that metallic iron dominates dust production in metal-poor, oxygen-rich stars, but that dust is probably not the primary accelerant of winds in this mass-metallicity regime.

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4. Extragalactic Clusters

Spatially Resolved Kinematics of an Ultra-Compact Dwarf Galaxy

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(5) Departamento de Astronoma y Astrofsica, Pontificia Universidad Catlica de Chile

We present the internal kinematics of UCD3, the brightest known ultra-compact dwarf galaxy (UCD) in the Fornax cluster, making this the first UCD with spatially resolved spectroscopy. Our study is based on seeing-limited observations obtained with the ARGUS Integral Field Unit of the VLT/FLAMES spectrograph under excellent seeing conditions (0.5 - 0.67 arcsec FWHM). The velocity field of UCD3 shows the signature of weak rotation, comparable to that found in massive globular clusters. Its velocity dispersion profile is fully consistent with an isotropic velocity distribution and the assumption that mass follows the light distribution obtained from Hubble Space Telescope imaging. In particular, there is no evidence for the presence of an extended dark matter halo contributing a significant ($>\sim$ 33% within R $<$ 200 pc) mass fraction, nor for a central black hole more massive than $\sim$ 5% of the UCD's mass. While this result does not exclude a galaxian origin for UCD3, we conclude that its internal kinematics are fully consistent with it being a massive star cluster.

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Also available from the URL `http://arxiv.org/abs/1104.2593`
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5. Dynamical evolution - Simulations

Formation of Massive Black Holes in Dense Star Clusters. II. IMF and Primordial Mass Segregation

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A promising mechanism to form intermediate-mass black holes (IMBHs) is the runaway merger in dense star clusters, where main-sequence stars collide and form a very massive star (VMS), which then collapses to a black hole. In this paper we study the effects of primordial mass segregation and the importance of the stellar initial mass function (IMF) on the runaway growth of VMSs using a dynamical Monte Carlo code for N-body systems with N as high as 10^6 stars. Our code now includes an explicit treatment of all stellar collisions. We place special emphasis on the possibility of top-heavy IMFs, as observed in some very young massive clusters. We find that both primordial mass segregation and the shape of the IMF affect the rate of core collapse of star clusters and thus the time of the runaway. When we include primordial mass segregation we generally see a decrease in core collapse time ($t_{\rm cc}$). Moreover, primordial mass segregation increases the average mass in the core, thus reducing the central relaxation time, which also decreases $t_{\rm cc}$. The final mass of the VMS formed is always close to $\sim 10^{-3}$ of the total cluster mass, in agreement with the previous studies and is reminiscent of the observed correlation between the central black hole mass and the bulge mass of the galaxies. As the degree of primordial mass segregation is increased, the mass of the VMS increases at most by a factor of 3. Flatter IMFs generally increase the average mass in the whole cluster, which increases $t_{\rm cc}$. For the range of IMFs investigated in this paper, this increase in $t_{\rm cc}$ is to some degree balanced by stellar collisions, which accelerate core collapse. Thus there is no significant change in $t_{\rm cc}$ for the somewhat flatter global IMFs observed in very young massive clusters.

Submitted to: Astrophysical journal, ApJ

For preprints, contact sanghamitragoswami2012@u.northwestern.edu

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Evolution of the binary population in young dense star clusters

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Context: Field stars are not always single stars, but can often be found in bound double systems. Since binary frequencies in the birth places of stars, young embedded clusters, are sometimes even higher than on average the question arises of how binary stars form in young dense star clusters and how their properties evolve to those observed in the field population.

Aims: We assess, the influence of stellar dynamical interactions on the primordial binary population in young dense cluster environments.

Methods: We perform numerical N-body simulations of the Orion Nebula Cluster like star cluster models including primordial binary populations using the simulation code nbody6++.

Results: We find two remarkable results that have yet not been reported: The first is that the evolution of the binary frequency in young dense star clusters is independent predictably of its initial value. The time evolution of the normalized number of binary systems has a fundamental shape. The second main result is that the mass of the primary star is of vital importance to the evolution of the binary. The more massive a primary star, the lower the probability that the binary is destroyed by gravitational interactions. This results in a higher binary frequency for stars more massive than 2 $M_\odot$ compared to the binary frequency of lower mass stars. The observed increase in the binary frequency with primary mass is therefore most likely not due to differences in the formation process but can be entirely explained as a dynamical effect.

Conclusions: Our results allow us to draw conclusions about the past and the future number of binary systems in young dense star clusters and demonstrate that the present field stellar population has been influenced significantly by its natal environments.

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Second Announcement
for the
AMUSE User Workshop
Leiden, June 27 - July 1, 2011

1.) General information

You are cordially invited for a 5-day workshop on the use of the Astrophysical Multipurpose Software Environment (AMUSE). The aim of the workshop is to bring together current and potential users of AMUSE to share experiences and give feedback. If you have used AMUSE or are interested in doing numerical astrophysical research over different physical domains (from gravitational dynamics to radiative transfer), please join us. During the workshop we will present an overview of the software and give several tutorials on getting started and doing research with AMUSE. Most of the time will be spent in hands-on sessions. We hope this workshop will give you a solid foundation for future research with AMUSE.

The AMUSE software combines existing numerical codes. These codes can be used together for astrophysical research by writing scripts in the python languages. You have access to the full python functionality and flexibility and a large set of proven astrophysical codes (gravitational dynamics, stellar evolution, hydrodynamics and radiative transfer). All software is open source (GPL licensed) and can be downloaded from the http://www.amusecode.org site.

If you have used AMUSE or similar software and want to give a talk, tutorial or short presentation at the workshop, please contact us at `amuse_workshop@strw.leidenuniv.nl`.

2.) Date and Venue

The workshop will be held from June 27th to July 1st in Leiden:

Leiden Observatory
University of Leiden
Niels Bohrweg 2
NL-2333 CA Leiden
The Netherlands

3.) Organization & Contact

The organizing committee consists of:

Marco Spaans
Vincent Icke
Gijs Nelemans
Simon Portegies Zwart
Inti Pelupessy
Marcell Marosvolgyi
Arjen van Elteren
Nathan de Vries

to be contacted at: amuse_workshop@strw.leidenuniv.nl

4.) Registration

Participating in the workshop is free of charge. Registration can be done by sending an email to amuse_workshop@strw.leidenuniv.nl providing personal information (name, position & affiliation). The registration deadline is June 1st. Early registration is appreciated.

5.) Program

The development team will provide an overview of the current status of AMUSE, and we can schedule a limited number of contributed talks. Most of the program will consist of hands-on workshop sessions where small groups will work on scientific applications, implement new modules, or discuss the further development of AMUSE. We will provide a detailed program in the weeks before the workshop.

6.) Other information

- Travelling to Leiden

Leiden is easily reached by train. The nearest airport is Amsterdam Schiphol Airport (20 min by train), other nearby airports are: Rotterdam (30 min), Eindhoven (1:45) and Brussel (2:30). The institute itself is a 25 min walk or short bus ride from the train station and city center. Detailed information can be found on:

http://www.strw.leidenuniv.nl/about/directions.php?node=72

- Accommodation

The following nearby hotels are available:

Hotel Bastion Leiden / Oegstgeest
http://www.bastionhotel.nl/en/ourhotels/oegstgeest/
Hotel Het Haagsche Schouw
http://www.hotelleiden.nl
Hotel Tulip Inn
http://www.tulipinnleidencentre.nl
Hotel De Doelen
http://www.hoteldedoelen.com
Hotel Mayflower
http://www.hotelmayflower.nl/
Hotel Nieuw Minerva
http://www.nieuwminerva.nl

The cost will be about Euro 100 per night. If needed, contact us for more assistance or information.

- Financial support

Contact the organizing committee if you need (partial) financial support.

- Website

More information can be found via: http://www.amusecode.org/ or directly at:

http://www.amusecode.org/trac/wiki/amuse_workshop3

Postdoctoral Research Fellowship in Observational Globular Cluster Research

University of Queensland, Brisbane, Australia

The Discipline of Physics (http://www.phys.uq.edu.au) within the School of Mathematics and Physics seeks to appoint a Postdoctoral Research Fellow Level A for a period of two years.

As the successful applicant, you will conduct research on an Australian Research Council founded Discovery Project with the Chief Investigators Professor Michael Drinkwater and Dr Holger Baumgardt. The title of the project is "Dark Matter in the Smallest Galaxies". You should have demonstrated research capability in one or more of the areas of optical and near-infrared photometry of galaxies and their stellar populations, spectroscopy of extragalactic stellar systems and observational or theoretical studies of star clusters.

The successful applicant will develop new search strategies to detect ultra-compact dwarf galaxy candidates in distant galaxy clusters. They will then follow-up these observations with multi-object spectroscopy to confirm the nature of the UCD candidates. For objects with the highest signal-to-noise they will also determine their physical properties.

The successful applicant will participate in all aspects of the project; present research results at seminars and conferences, and will, in collaboration with the project leader, write scholarly papers for publication in peer-reviewed academic journals.

Participation is also required in the co-supervision of PhD students working on the project.

Applicants must possess the appropriate qualifications (PhD level or equivalent) in astrophysics plus have an excellent research record.

This is a full-time, fixed term appointment at Academic Research level A for 2 years (negotiable). The remuneration package will be in the range of $67,958 - $72,949 p.a., plus employer superannuation contributions of up to 17% (total package will be in the range $79,511 - $85,351 p.a.).

To discuss this role please contact Professor Michael Drinkwater on +61 7 3365 3428 or email: `m.drinkwater@uq.edu.au`

Closing data for applications is the 15th of July 2011. Applications should be submitted via the University of Queensland job site. Visit `http://www.uq.edu.au/uqjobs/` and search by the job number for more information on how to apply.

URL: `http://uqjobs.uq.edu.au/jobDetails.asp?sJobIDs=492044`
Job No: 492044