
SCYON

The Star Clusters Young & Old Newsletter

edited by Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

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

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EDITORIAL

This is the 30th issue of the SCYON newsletter. Today's edition contains 32 abstracts from refereed journals and 7 conference proceedings. It also contains one PhD summary, two conference announcements and job offers from Utrecht and Northwestern universities, making this edition even larger than the last one.

Given the large editions we had recently, we will from now on split the abstracts from refereed journals into different sections. We hope that this will make them easier to read. We will also stop distributing the newsletter as an email attachment and will only make it available via the Internet. Please let us know if this causes any inconvenience for you.

As usual, we would like to thank all those who sent in their contributions.

Holger Baumgardt, Ernst Paunzen and Pavel Kroupa

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CONTENTS

Editorial	1
SCYON policy	2
Mirror sites	2
Abstract from/submitted to REFEREED JOURNALS	3
1. Star Forming Regions	3
2. Embedded Clusters.....	13
3. Galactic Open Clusters.....	14
4. Galactic Globular Clusters	19
5. Extragalactic Clusters.....	25
6. Dynamical evolution - Simulations.....	30
7. Miscellaneous	35
Abstracts of CONFERENCE PROCEEDINGS	36
Ph.D. (dissertation) summaries	43
Conference / announcements.....	44
Jobs	46

SCYON POLICY

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

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

Concerning possible infringements to copyright laws, we understand that the authors themselves are taking responsibility for the material they send us. We make no claim whatsoever to owning the material that is posted at our url or circulated by email. The newsletter SCYON is a free service. It does not substitute for our personal opinions, nor does it reflect in any way the views of our respective institutes of affiliations.

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

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

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

A “Call for abstracts” is sent out approximately one week before the next issue of the newsletter is finalised. This call contains the deadline for abstract submissions for that coming issue and the LaTeX abstract template.

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

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

The editors

SCYON Mirrors

The official Scyon mirror site in Australia is hosted at the Centre for Astrophysics & Supercomputing of the University of Swinburne by Duncan Forbes and his team :

[HTTP://ASTRONOMY.SWIN.EDU.AU/SCYON/](http://ASTRONOMY.SWIN.EDU.AU/SCYON/))

1. Star Forming Regions

Unbinned maximum-likelihood estimators for low-count data: Applications to faint X-ray spectra in the Taurus Molecular Cloud

Kaspar Arzner Manuel Güdel Kevin Briggs Alessandra Telleschi Manfred Schmidt
Marc Audard Luigi Scelsi Elena Franciosini

Paul Scherrer Institut Hochschule Zuerich Columbia University NY / Uni Geneva INAF / Uni Palermo

Traditional binned statistics such as χ^2 suffer from information loss and arbitrariness of the binning procedure, which is especially important at low count rates as encountered in the XMM Extended Survey of the Taurus Molecular Cloud (XEST). We point out that the underlying statistical quantity (the log likelihood L) does not require any binning beyond the one implied by instrumental readout channels, and we propose to use it for low-count data. The performance of L in the model classification and point estimation problems is explored by Monte-Carlo simulations of *Chandra* and XMM X-ray spectra, and is compared to the performances of the binned Poisson statistic (C), Pearson's χ^2 and Neyman's χ_N^2 , the Kolmogorov-Smirnov, and Kuiper's statistics. It is found that the unbinned log likelihood L performs best with regard to the expected chi-square distance between true and estimated spectra, the chance of a successful identification among discrete candidate models, the area under the receiver-operator curve of reduced (two-model) binary classification problems, and generally also with regard to the mean square errors of individual spectrum parameters. The χ^2 (χ_N^2) statistics should only be used if more than 10 (15) predicted counts per bin are available. From the practical point of view, the computational cost of evaluating L is smaller than for any of the alternative methods if the forward model is specified in terms of a Poisson intensity and normalization is a free parameter. The maximum- L method is applied to 14 XEST observations, and confidence regions are discussed. The unbinned results are compared to binned XSPEC results, and found to generally agree, with exceptions explained by instability under re-binning and by background fine structures. In particular, HO Tau is found by the unbinned method to be rather cool ($kT \sim 0.2$ keV), which may be a sign of shock emission. The maximum- L method has no lower limit on the available counts, and allows to treat weak sources which are beyond the means of binned methods.

Accepted by : Astronomy & Astrophysics

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Also available from the URL http://www.astro.phys.ethz.ch/papers/arzner/arzner_p_nf.html
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Gamma rays from molecular clouds

S. Gabici ⁽¹⁾, F. A. Aharonian ⁽¹⁾ and P. Blasi ⁽²⁾

⁽¹⁾ MPIK - Heidelberg ⁽²⁾ INAF - Firenze

It is believed that the observed diffuse gamma ray emission from the galactic plane is the result of interactions between cosmic rays and the interstellar gas. Such emission can be amplified if cosmic rays penetrate into dense molecular clouds. The propagation of cosmic rays inside a molecular cloud has been studied assuming an arbitrary energy and space dependent diffusion coefficient. If the diffusion coefficient inside the cloud is significantly smaller compared to the average one derived for the galactic disk, the observed gamma ray spectrum appears harder than the cosmic ray spectrum, mainly due to the slower penetration of the low energy particles towards the core of the cloud. This may produce a great variety of gamma ray spectra.

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VLT/Flames observations of the star forming region NGC 6530

L. Prisinzano⁽¹⁾, F. Damiani⁽¹⁾, G. Micela⁽¹⁾, I. Pillitteri⁽²⁾

⁽¹⁾ INAF-Osservatorio Astronomico di Palermo, Piazza del Parlamento, 1 90134 Palermo, Italy ⁽²⁾ Dipartimento di Scienze Fisiche ed Astronomiche, Universita' di Palermo, Piazza del Parlamento 1, I-90134 Palermo Italy

Mechanisms regulating the evolution of pre-main sequence stars can be understood by studying stellar properties such as rotation, disk accretion, internal mixing and binarity. To investigate such properties, we studied a sample of 332 candidate members of the massive and populous star forming region NGC 6530.

We want to select cluster members by using different membership criteria, to study the properties of pre-main sequence stars with or without circumstellar disks.

We use intermediate resolution spectra including the Li I 6707.8 Angstroms line to derive radial and rotational velocities, binarity and to measure the Equivalent Width of the lithium line; these results are combined with X-ray data to study the cluster membership. Optical-IR data and H α spectra, these latter available for a subsample of our targets, are used to classify CTTS and WTTS and to compare the properties of stars with and without disks.

We find a total of 237 certain members including 53 binaries. The rotational velocity distributions of stars with IR excesses are statistically different from that of stars without IR excesses, while the fraction of binaries with disks is significantly smaller than that of single stars. Stars with evidence for accretion show circumstellar disks; youth of cluster members is confirmed by the lithium abundance consistent with the initial content.

As indicated by the disk-locking picture, stars with disks have in general rotational velocities lower than stars without disks. Binaries in NGC 6530 seem to have undergone a significant disk evolution.

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Slow Star Formation in Dense Gas: Evidence and Implications

Mark R. Krumholz and Jonathan C. Tan

⁽¹⁾ Department of Astrophysical Sciences, Princeton University ⁽²⁾ Department of Astronomy, University of Florida

It has been known for more than 30 years that star formation in giant molecular clouds (GMCs) is slow, in the sense that only 1% of the gas forms stars every free-fall time. This result is entirely independent of any particular model of molecular cloud lifetime or evolution. Here we survey observational data on higher density objects in the interstellar medium, including infrared dark clouds and dense molecular clumps, to determine if these objects form stars slowly like GMCs, or rapidly, converting a significant fraction of their mass into stars in one free-fall time. We find no evidence for a transition from slow to rapid star formation in structures covering three orders of magnitude in density. This has important implications for models of star formation, since competing models make differing predictions for the characteristic density at which star formation should transition from slow to rapid. The data are inconsistent with models that predict that star clusters form rapidly and in free-fall collapse. Magnetic- and turbulence-regulated star formation models can reproduce the observations qualitatively, and the turbulence-regulated star formation model of Krumholz & McKee quantitatively reproduces the infrared-HCN luminosity correlation recently reported by Gao & Solomon. Slow star formation also implies that the process of star cluster formation cannot be one of global collapse, but must instead proceed over many free-fall times. This suggests that turbulence in star-forming clumps must be driven, and that the competitive accretion mechanism does not operate in typical cluster-forming molecular clumps.

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Also available from the URL <http://xxx.lanl.gov/abs/astro-ph/0606277>

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Infrared study of the Southern Galactic star forming region associated with IRAS 14416-5937

S. Vig, S.K. Ghosh, D.K. Ojha and R. P. Verma

Tata Institute of Fundamental Research, Mumbai 400 005, India

Aims: We have carried out an infrared study of the southern Galactic massive star forming region associated with IRAS 14416-5937. **Methods:** This star forming region has been mapped simultaneously in two far infrared bands at 150 & 210 micron using the TIFR 1-m balloon borne telescope with 1' angular resolution. We have used 2MASS JHKs as well as Spitzer-GLIMPSE data of this region to study the stellar populations of the embedded young cluster. This region comprises of two sources, designated as A & B and separated by 2 pc. The spectrum of a region located close to the source A obtained using the Long Wavelength Spectrometer (LWS) on-board the Infrared Space Observatory (ISO), is presented. Emission from warm dust and from Unidentified Infrared Bands (UIBs) is estimated using the mid-infrared data of the MSX survey. **Results:** The spatial distributions of (1) the temperature of cool dust and (2) optical depth at 200 micron have been obtained taking advantage of the similar beams in both the TIFR bands. A number of atomic fine structure lines have been detected in the ISO-LWS spectrum, which have been used to estimate the electron density and the effective temperature of the ionising radiation in this region. From the near and mid infrared images, we identify a dust lane due north-west of source A. The dust lane is populated by Class I type sources. Class II type sources are found further along the dust lane as well as below it. Self consistent radiative transfer models of the two sources (A and B) are in good agreement with the observed spectral energy distributions. **Conclusions:** The spatial distribution of young stellar objects in and around the dust lane suggests that active star formation is taking place along the dust lane and is possibly triggered by the expanding HII regions of A and B.

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An X-ray Census of Young Stars in the Massive Southern Star-Forming Complex NGC 6357

Junfeng Wang^[1], Leisa K. Townsley^[1], Eric D. Feigelson^[1], Konstantin V. Getman^[1],
Patrick S. Broos^[1], Gordon P. Garmire^[1], and Masahiro Tsujimoto^[2]

^[1]Pennsylvania State University ^[2]Rikkyo University, Japan

We present the first high spatial resolution X-ray study of the massive star forming region NGC 6357, obtained in a 38 ks Chandra/ACIS observation. Inside the brightest constituent of this large HII region complex is the massive open cluster Pismis 24. It contains two of the brightest and bluest stars known, yet remains poorly studied; only a handful of optically bright stellar members have been identified. We investigate the cluster extent and Initial Mass Function and detect 800 X-ray sources with a limiting sensitivity of 10^{30} ergs s^{-1} ; this provides the first reliable probe of the rich intermediate-mass and low-mass population of this massive cluster, increasing the number of known members from optical study by a factor of 50. The high luminosity end ($\log L_h[2-8 \text{ keV}] \geq 30.3$ ergs s^{-1}) of the observed X-ray luminosity function in NGC 6357 is clearly consistent with a power law relation as seen in the Orion Nebula Cluster and Cepheus B, yielding the first estimate of NGC 6357's total cluster population, a few times the known Orion population. We investigate the structure of the cluster, finding small-scale substructures superposed on a spherical cluster with 6 pc extent, and discuss its relationship to the nebular morphology. The long-standing $L_x - 10^{-7}L_{bol}$ correlation for O stars is confirmed. Twenty-four candidate O stars and one possible new obscured massive YSO or Wolf-Rayet star are presented. Many cluster members are estimated to be intermediate-mass stars from available infrared photometry (assuming an age of 1 Myr), but only a few exhibit K-band excess. We report the first detection of X-ray emission from an Evaporating Gaseous Globule at the tip of a molecular pillar; this source is likely a B0-B2 protostar.

Accepted by : Astrophysical Journal

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Evidence for Mass-dependent Circumstellar Disk Evolution in the 5 Myr-old Upper Scorpius OB Association

John M. Carpenter ⁽¹⁾ Eric E. Mamajek ⁽²⁾ Lynne A. Hillenbrand ⁽¹⁾ Michael R. Meyer ⁽³⁾

⁽¹⁾ Caltech ⁽²⁾ Harvard-CfA ⁽³⁾ U. Arizona

We present 4.5, 8, and 16 micron photometry from the *Spitzer Space Telescope* for 204 stars in the Upper Scorpius OB Association. The data are used to investigate the frequency and properties of circumstellar disks around stars with masses between ~ 0.1 and $20M_{\odot}$ at an age of ~ 5 Myr. We identify 35 stars that have emission at 8 micron or 16 micron in excess of the stellar photosphere. The lower mass stars (about 0.1 - $1.2M_{\odot}$) appear surrounded by primordial optically thick disks based on the excess emission characteristics. Stars more massive than $\sim 1.8M_{\odot}$ have lower fractional excess luminosities suggesting that the inner about 10 AU of the disk has been largely depleted of primordial material. None of the G and F stars (about 1.2 - $1.8M_{\odot}$) in our sample have an infrared excess at wavelengths ≤ 16 micron. These results indicate that the mechanisms for dispersing primordial optically thick disks operate less efficiently on average for low mass stars, and that longer time scales are available for the buildup of planetary systems in the terrestrial zone for stars with masses smaller $\sim 1M_{\odot}$.

To appear in : ApJ Letters

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Also available from the URL <http://arxiv.org/abs/astro-ph/0609372>

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Near Infrared Polarization Images of the Orion Nebula

M. Tamura ^(1,2), R. Kandori ⁽¹⁾, N. Kusakabe ⁽²⁾, Y. Nakajima ⁽¹⁾, J. Hashimoto ^(1,3),
C. Nagashima ⁽⁴⁾, T. Nagata ⁽⁵⁾, T. Nagayama ⁽⁵⁾, H. Kimura ⁽⁶⁾, T. Yamamoto ⁽⁶⁾, J.
H. Hough ⁽⁷⁾, P. Lucas ⁽⁷⁾, A. Chrysostomou ⁽⁷⁾, J. Bailey ⁽⁸⁾

⁽¹⁾National Astronomical Observatory of Japan, Japan ⁽²⁾Department of Astronomical Science, Graduate University
for Advanced Studies (Sokendai), Japan ⁽³⁾Department of Physics, Tokyo University of Science, Tokyo, Japan
⁽⁴⁾Department of Astrophysics, Faculty of Sciences, Nagoya University, Japan ⁽⁵⁾Department of Astronomy, Kyoto
University, Japan ⁽⁶⁾Institute of Low Temperature Science, Hokkaido University, Japan ⁽⁷⁾Centre for Astrophysics
Research, University of Hertfordshire, UK ⁽⁸⁾Australian Centre for Astrobiology, Macquarie University, Australia

Wide-field ($8' \times 8'$) and deep near-infrared (JHKs bands) polarization images of the Orion nebulae (IRNe) around young stellar objects (YSOs), both massive and low-mass. We found the IRNe around both IRC2 and BN to be very extensive, suggesting that there might be two extended (> 0.7 pc) bipolar/monopolar IRNe in these sources. We discovered at least 13 smaller-scale (0.01 - 0.1 pc) IRNe around less-massive YSOs including the famous source θ^2 Ori C. We also suggest the presence of many unresolved (< 690 AU) systems around low-mass YSOs and young brown dwarfs showing possible intrinsic polarizations. Wide-field infrared polarimetry is thus demonstrated to be a powerful technique in revealing IRNe and hence potential disk/outflow systems among high-mass to substellar YSOs.

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The structure of the cometary globule CG 12: a high latitude star forming region

L. K. Haikala^{1,2} M. Olberg³

¹ Observatory, PO Box 14, University of Helsinki, Finland ² Swedish-ESO Submillimetre Telescope, European Southern Observatory, Casilla 19001, Santiago, Chile ³ Onsala Space Observatory, S43900 Onsala, Sweden

The structure of the high galactic latitude Cometary Globule 12 (CG12) has been investigated by means of radio molecular line observations. Detailed, high signal to noise ratio maps in C18O (1-0), C18O (2-1) and molecules tracing high density gas, CS (3-2), DCO+ (2-1) and H13CO+ (1-0), are presented. The C18O line emission is distributed in a 10' long North-South elongated lane with two strong maxima, CG12 N(orth) and CG12 S(outh). In CG12 S the high density tracers delineate a compact core, DCO+ core, which is offset by 15'' from the C18O maximum. The observed strong C18O emission traces the surface of the DCO+ core or a separate, adjacent cloud component. The driving source of the collimated molecular outflow detected by White (1993) is located in the DCO+ core. The C18O lines in CG12 S have low intensity wings possibly caused by the outflow. The emission in high density tracers is weak in CG12 N and especially the H13CO+, DCO+ and N2H+ lines are +0.5 km/s offset in velocity with respect to the C18O lines. Evidence is presented that the molecular gas is highly depleted. The observed strong C18O emission towards CG12 N originates in the envelope of this depleted cloud component or in a separate entity seen in the same line of sight. The C18O lines in CG 12 were analyzed using Positive Matrix Factorization, PMF. The shape and the spatial distribution of the individual PMF factors fitted separately to the C18O (1-0) and (2-1) transitions were consistent with each other. The results indicate a complex velocity and line excitation structure in the cloud. Besides separate cloud velocity components the C18O line shapes and intensities are influenced by excitation temperature variations caused by e.g, the molecular outflow or by molecular depletion. Assuming a distance of 630 pc the size of the CG 12 compact head, 1.1 pc by 1.8 pc, and the C18O mass larger than 100 Msun are comparable to those of other nearby low/intermediate mass star formation regions.

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The chemical composition of the Galactic regions M8 and M17. A revision based on deep VLT echelle spectrophotometry

J. Garcia-Rojas ⁽¹⁾, C. Esteban ⁽¹⁾, A. Peimbert ⁽²⁾, M. Rodriguez ⁽³⁾, M. Peimbert ⁽²⁾, M.T. Ruiz ⁽⁴⁾

⁽¹⁾ IAC, Spain ⁽²⁾ IA-UNAM, Mexico ⁽³⁾ INAOE, Mexico ⁽⁴⁾ Dep. Astronomy. Univ. Chile

We present new echelle spectrophotometry of the Galactic H II regions M8 and M17. The data have been taken with the VLT UVES echelle spectrograph in the 3100 to 10400 angstroms range. We have measured the intensities of 375 and 260 emission lines in M8 and M17 respectively, increasing significantly the number of emission lines measured in previous spectrophotometric studies of these nebulae. Most of the detected lines are permitted lines. Electron temperatures and densities have been determined using different diagnostics. We have derived He+, C++, O+ and O++ ionic abundances from pure recombination lines. We have also derived abundances from collisionally excited lines for a large number of ions of different elements. Highly consistent estimations of t2 have been obtained by using different independent indicators, the values are moderate and very similar to those obtained in other Galactic H II regions. We report the detection of deuterium Balmer emission lines, up to D ϵ , in M8 and show that their intensities are consistent with continuum fluorescence as their main excitation mechanism.

To appear in : Revista Mexicana Astronomia y Astrofisica

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2. Embedded Clusters**A systematic survey for infrared star clusters with $|b| < 20^\circ$ using 2MASS****Froebrich, D. ^(1,4), Scholz, A. ⁽²⁾, Raftery, C.L. ⁽³⁾**

⁽¹⁾ Dublin Institute for Advanced Studies, Merrion Square 5, Dublin 2, Ireland ⁽²⁾ University of Toronto, 60 St. George Street, Toronto, Canada ⁽³⁾ Trinity College Dublin, College Green, Dublin 2 Ireland ⁽⁴⁾ Centre for Astrophysics and Space Science, University of Kent, Canterbury, CT2 7NQ, UK

We used star density maps obtained from 2MASS to obtain a sample of star clusters in the entire Galactic Plane with $|b| < 20^\circ$. A total of 1788 star cluster candidates are identified in this survey. Among those are 681 previously known open clusters and 86 globular clusters. A statistical analysis indicates that our sample of 1021 new cluster candidates has a contamination of about 50%. Star cluster parameters are obtained by fitting a King profile to the star density. These parameters are used to statistically identify probable new globular cluster candidates in our sample. A detailed investigation of the projected distribution of star clusters in the Galaxy demonstrates that they show a clear tendency to cluster on spatial scales in the order of 12-25pc, a typical size for molecular clouds.

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3. Galactic Open Clusters

Spitzer 24 Micron Observations of Open Cluster IC 2391 and Debris Disk Evolution of FGK Stars

N. Siegler ⁽¹⁾, J. Muzerolle ⁽¹⁾, E. T. Young ⁽¹⁾, G. H. Rieke ⁽¹⁾, E. E. Mamajek ⁽²⁾, D. E. Trilling ⁽¹⁾, N. Gorlova ⁽¹⁾, and K. Y. L. Su ⁽¹⁾

⁽¹⁾ Steward Observatory, University of Arizona ⁽²⁾ Harvard-Smithsonian Center for Astrophysics

We present 24 micron Spitzer/MIPS photometric observations of the 50 Myr open cluster IC 2391. Thirty-four cluster members ranging in spectral type from B3-M5 were observed in the central square degree of the cluster. Excesses indicative of debris disks were discovered around 1 A star, 6 FGK stars, and possibly 1 M dwarf. For the cluster members observed to their photospheric limit, we find a debris disk frequency of 10 (-3,+17)% for B-A stars and 31 (-9,+13)% for FGK stars using a 15% relative excess threshold. Relative to a model of decaying excess frequency, the frequency of debris disks around A-type stars appears marginally low for the cluster's age while that of FGK stars appears consistent. Scenarios that may qualitatively explain this result are examined. We conclude that planetesimal activity in the terrestrial region of FGK stars is common in the first 50 Myr and decays on timescales of 100 Myr. Despite luminosity differences, debris disk evolution does not appear to depend strongly on stellar mass.

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Faint open clusters with 2MASS: BH 63, Lyngå 2, Lyngå 12 and King 20

E. Bica, C. Bonatto and R. Blumberg

Universidade Federal do Rio Grande do Sul, Instituto de Física, CP¹5051, Porto Alegre 91501-970, RS, Brazil

Structural and dynamical parameters of faint open clusters are probed with quality 2MASS-photometry and analytical procedures developed for bright clusters. We derive fundamental parameters of the faint open clusters Lynga2, BH63, Lynga12 and King20, the last three of which have no prior determinations. We also focus on the structure and dynamical state of these clusters. J, H and Ks 2MASS photometry with errors smaller than 0.2mag are used to build CMDs, radial density profiles, colour-colour diagrams, luminosity and mass functions. Colour-magnitude filters are used to isolate probable member stars. Field-star decontamination is applied to Lynga2, Lynga12 and King20. Reddening values are in the range $0.22 < E(B-V) < 1.9$, with BH63 the most reddened object. Ages of Lynga2, King20, Lynga12 and BH63 are 90, 200, 560 and well-represented by King profiles. Lynga2 and BH63 are very small with core and limiting radii of 0.12pc and 1.5pc. Yet, they fit in the small-radii tail of the open cluster size distribution. Lynga12 and King20 have R_c 0.43pc and R_{lim} 3.9pc. Lynga2 and Lynga12 are inside the Solar circle. Total stellar masses (extrapolating the MFs to stars with 0.08 M_{sun}) range from 340 M_{sun} (BH63) to 2300 M_{\odot} (Lynga12). Observed masses are 1/4 of these values. In all clusters the core mass function is flatter than the halo's. Faint open clusters can be probed with 2MASS when associated with colour-magnitude filters and field-star decontamination. BH63 appears to be in an advanced dynamical state, both in the core and halo. To a lesser degree the same applies to King20. Marginal evidence of dynamical evolution is present in the cores of Lynga2 and Lynga12.

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Multi-site campaign on the open cluster M67. I. Observations and photometric reductions

D. Stello ^(1, 2 and 5), T. Arentoft ^(1, 2 and 8), T. R. Bedding ⁽²⁾, M. Y. Bouzid ⁽⁴⁾, H. Bruntt ^(1, 2 and 5), Z. Csubry ⁽⁶⁾, Z. E. Dind ⁽²⁾, S. Frandsen ^(1 and 8), R. L. Gilliland ⁽³⁾, A. P. Jacob ⁽²⁾, H. R. Jensen ⁽¹⁾, Y. B. Kang ⁽⁷⁾, S.-L. Kim ⁽⁷⁾, L. L. Kiss ⁽²⁾, H. Kjeldsen ^(1 and 8), J.-R. Koo ⁽⁷⁾, J.-A. Lee ⁽⁷⁾, C.-U. Lee ⁽⁷⁾, J. Nuspl ⁽⁶⁾, C. Sterken ⁽⁴⁾, R. Szabo ⁽⁶⁾

⁽¹⁾ Institut for Fysik og Astronomi, Aarhus University, Denmark, ⁽²⁾ School of Physics, University of Sydney, Australia, ⁽³⁾ Space Telescope Science Institute, Baltimore, USA ⁽⁴⁾ Vrije Universiteit Brussel, Belgium, ⁽⁵⁾ Department of Physics, US Air Force Academy, Colorado Springs, USA ⁽⁶⁾ Konkoly Observatory of the Hungarian Academy of Sciences, Budapest, Hungary, ⁽⁷⁾ Korea Astronomy and Space Science Institute, Daejeon, Korea, ⁽⁸⁾ Danish AsteroSeismology Centre, Aarhus Universitet, Danmark

We report on an ambitious multi-site campaign aimed at detecting stellar variability, particularly solar-like oscillations, in the red giant stars in the open cluster M67 (NGC 2682). During the six-week observing run, which comprised 164 telescope nights, we used nine 0.6-m to 2.1-m class telescopes located around the world to obtain uninterrupted time-series photometry. We outline here the data acquisition and reduction, with emphasis on the optimisation of the signal-to-noise of the low amplitude (50-500 micromag) solar-like oscillations. This includes a new and efficient method for obtaining the linearity profile of the CCD response at ultra high precision (10 parts per million). The noise in the final time series is 0.50 mmag per minute integration for the best site, while the noise in the Fourier spectrum of all sites combined is 20 micromag. In addition to the red giant stars, this data set proves to be very valuable for studying high-amplitude variable stars such as eclipsing binaries, W UMa systems and delta Scuti stars.

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Blue Straggler Stars in Galactic Open Clusters and the Simple Stellar Population Model

Y. Xin, L. Deng and Z. Han

¹. National Astronomical Observatories/Yunnan Observatory, Chinese Academy of Sciences, PO Box 110, Kunming, Yunnan Province, 650011, China ². National Astronomical Observatories, Chinese Academy of Sciences, Beijing, 100012, China

Blue straggler stars present as secure members in the Galactic open clusters form a major challenge to the conventional picture of evolutionary population synthesis based on the stellar evolution theory of single stars, as illustrated in our previous work. Expansion of our sample in the current work to include younger age clusters provides a larger data base to expose the question raised for the simple stellar population model. The working sample now includes 97 Galactic open clusters of ages ranging from 0.1 to several Gyrs. The contributions of blue straggler stars to the integrated light of the host clusters are calculated on an individual cluster base. A data base of observational constrained simple stellar population model is made which has a larger age coverage than our previous work. It is shown in this work that the general existence of blue stragglers in star clusters of our sample dramatically altered the predictions of conventional stellar population model in terms of spectral energy distribution. The integrated spectral energy distributions of the synthetic spectra of the clusters are enhanced towards shorter wavelengths, therefore the results of the present work will cast new lights in understanding the properties of stellar populations.

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Correlation between the spatial distribution of the circumstellar disks and the massive stars in the open cluster NGC 6611

M.G. Guarcello, L. Prisinzano, G. Micela, F. Damiani, G. Peres, S. Sciortino

Osservatorio Astronomico di Palermo

Context: the observations of young stars with circumstellar disks suggest that the disks are dissipated, starting from the inner region, by the radiation of the central star and eventually by the formation of rocky planetesimals, over a time scale of several million years. It was also shown that strong UV radiation emitted by nearby massive stars can heat a circumstellar disk up to some thousand degrees inducing the photoevaporation of the gas. This process strongly reduces the dissipation time scale. Aims: the aim of this work is to study if there exists a correlation between the spatial distribution of stars with circumstellar disks and the position of massive stars with spectral class earlier than B5, in the open cluster NGC 6611. Methods: for our purpose, we created a multiband catalog of the cluster, down to $V \sim 23$, using optical data from a WFI observation at 2.2m of ESO in the BVI bands, the 2MASS public point source catalog and an archival X-ray observation made with CHANDRA/ACIS. We selected the stars with infrared excess (due to the emission of a circumstellar disk) using suitable color indices independent from extinction, and studied their spatial distribution. Results: we found that the spatial distribution of the stars with K band excess (due to the presence of a circumstellar disk) is anti correlated with that of the massive stars: the disks are more frequent at large distances from these stars. We argue that this is in agreement with the hypothesis that the circumstellar disks are heated by the UV radiation from the massive stars and photoevaporated.

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4. Galactic Globular Clusters

Deep FORS1 observations of the double Main Sequence of omega Centauri

A. Sollima ⁽¹⁾, F. R. Ferraro ⁽¹⁾, M. Bellazzini ⁽²⁾, L. Origlia ⁽²⁾, O. Straniero ⁽³⁾, E. Pancino ⁽²⁾

⁽¹⁾ Universita' di Bologna ⁽²⁾ INAF Osservatorio Astronomico di Bologna ⁽³⁾ INAF Osservatorio Astronomico di Collurania, Teramo

We present the results of a deep photometric survey performed with FORS1@VLT aimed at investigating the complex Main Sequence structure of the stellar system omega Centauri. We confirm the presence of a double Main Sequence and identify its blue component (bMS) over a large field of view up to 26' from the cluster center. We found that bMS stars are significantly more concentrated toward the cluster center than the other "normal" MS stars. The bMS morphology and its position in the CMD have been used to constrain the helium overabundance required to explain the observed MS morphology.

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Deep HST Photometry of NGC 6388: Age and Horizontal Branch Luminosity

M. Catelan (PUC-Chile), P. B. Stetson (DAO-NRC), B. J. Pritzl (Macalester), H. A. Smith (Michigan State), K. Kinemuchi (Wyoming), A. C. Layden (Bowling Green), A. V. Sweigart (NASA-GSFC), R. M. Rich (UCLA)

Using the Hubble Space Telescope, we have obtained the first color-magnitude diagram (CMD) to reach the main-sequence turnoff of the Galactic globular cluster NGC 6388. From a comparison between the cluster CMD and 47 Tucanae's, we find that the bulk of the stars in these two clusters have nearly the same age and chemical composition. On the other hand, our results indicate that the blue horizontal branch and RR Lyrae components in NGC 6388 are intrinsically overluminous, which must be due to one or more, still undetermined, non-canonical second parameter(s) affecting a relatively minor fraction of the stars in NGC 6388.

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New Abundances for Old Stars Atomic Diffusion at Work in NGC 6397

Andreas Korn ¹, Frank Grundahl ², Olivier Richard ³, Paul Barklem ¹, Lyudmila Mashonkina ⁴, Remo Collet ¹, Nikolai Piskunov ¹, Bengt Gustafsson ¹

¹ Uppsala Astronomical Observatory, Sweden; ² Århus University, Denmark; ³ University of Montpellier II, France; ⁴ Institute of Astronomy, Moscow, Russia

A homogeneous spectroscopic analysis of unevolved and evolved stars in the metal-poor globular cluster NGC 6397 with FLAMES-UVES reveals systematic trends of stellar surface abundances that are likely caused by atomic diffusion. This finding helps to understand, among other issues, why the lithium abundances of old halo stars are significantly lower than the abundance found to be produced shortly after the Big Bang.

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A probable stellar solution to the cosmological lithium discrepancy

Andreas Korn ¹, Frank Grundahl ², Olivier Richard ³, Paul Barklem ¹, Lyudmila Mashonkina ⁴, Remo Collet ¹, Nikolai Piskunov ¹, Bengt Gustafsson ¹

¹ Uppsala Astronomical Observatory, Sweden; ² Århus University, Denmark; ³ University of Montpellier II, France; ⁴ Institute of Astronomy, Moscow, Russia

The measurement of the cosmic microwave background has strongly constrained the cosmological parameters of the Universe. When the measured density of baryons (ordinary matter) is combined with standard Big Bang nucleosynthesis calculations, the amounts of hydrogen, helium and lithium produced shortly after the Big Bang can be predicted with unprecedented precision. The predicted primordial lithium abundance is a factor of two to three higher than the value measured in the atmospheres of old stars. With estimated errors of 10 to 25%, this cosmological lithium discrepancy seriously challenges our understanding of stellar physics, Big Bang nucleosynthesis or both. Certain modifications to nucleosynthesis have been proposed, but found experimentally not to be viable. Diffusion theory, however, predicts atmospheric abundances of stars to vary with time, which offers a possible explanation of the discrepancy. Here we report spectroscopic observations of stars in the metal-poor globular cluster NGC6397 that reveal trends of atmospheric abundance with evolutionary stage for various elements. These element-specific trends are reproduced by stellar-evolution models with diffusion and turbulent mixing. We thus conclude that diffusion is predominantly responsible for the low apparent stellar lithium abundance in the atmospheres of old stars by transporting the lithium deep into the star.

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The orbits of 48 globular clusters in a Milky-Way-Like Barred Galaxy

Christine Allen⁽¹⁾, Edmundo Moreno⁽¹⁾, Barbara Pichardo^(1,2)

⁽¹⁾Instituto de Astronomia, Universidad Nacional Autonoma de Mexico, ⁽²⁾Institute for Theoretical Physics,
University of Zurich

The effect of a barred potential (such as the one of the Milky Way) on the galactic orbits of forty-eight globular clusters for which absolute proper motions are known is studied. The orbital characteristics are compared with those obtained for the case of an axisymmetric galactic potential. Tidal radii are computed and discussed for both the better known axisymmetric case and that including a bar. The destruction rates due to bulge and disk shocking are calculated and compared in both galactic potentials.

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A population of binaries in the Asymptotic Giant Branch of 47 Tucanae?

Giacomo Beccari ^{1,2,3} Francesco R. Ferraro ⁴ Barbara Lanzoni ¹ Michele Bellazzini ¹

¹) INAF-Osservatorio Astronomico di Bologna, via Ranzani ¹, I-40127 Bologna, Italy, giacomo.beccari@bo.astro.it ²)

Dipartimento di Scienze della Comunicazione, ³) Università degli Studi di Teramo, Italy INAF-Osservatorio Astronomico di Collurania, Via Mentore Maggini, I-⁶4100 Teramo, Italy ⁴) Dipartimento di Astronomia, Università degli Studi di Bologna, via Ranzani ¹, I-40127 Bologna, Italy, francesco.ferraro³@unibo.it

We have used a set of archived Hubble Space Telescope/ACS images to probe the evolved populations of the globular cluster 47 Tucanae. We find an excess of Asymptotic Giant Branch (AGB) stars in the cluster core. We interpret this feature as the signature of an extra-population likely made by the progeny of massive stars originated by the evolution of binary systems. Indeed the comparison with theoretical tracks suggests that the AGB population of 47 Tuc can be significantly contaminated by more massive stars currently experiencing the first ascending Red Giant Branch.

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5. Extragalactic Clusters**Dynamical masses of two young globular clusters in the blue compact galaxy ESO 338-IG04****Gran Ostlin** ⁽¹⁾, **Robert J. Cumming** ⁽¹⁾, **Nils Bergvall** ⁽²⁾⁽¹⁾ Stockholm Observatory, ⁽²⁾ Uppsala Astronomical Observatory

We present high-resolution echelle spectroscopy, obtained with the UVES spectrograph on ESO/VLT, of two luminous star clusters in the metal-poor blue compact galaxy ESO 338-IG04 at a distance of 37.5 Mpc. Cross-correlating with template stars, we obtain line-of-sight velocity dispersions of 33 and 17 km/s. By combining with size estimates from Hubble Space Telescope images we infer dynamical masses of 1.3×10^7 and 4.0×10^6 solar masses for the two clusters, making them among the most massive known. The less massive cluster is the faintest cluster for which a dynamical mass has yet been obtained. In both clusters we detect Balmer absorption lines which we use to estimate their ages. From the younger (~ 6 Myr) and more massive cluster, we detect He II 4686 emission of intermediate width, indicating the presence of very massive O-stars. Moreover, analysis of the [O III] 5007 and H α emission lines from the region near the younger cluster indicates that it is associated with a bubble expanding at ~ 40 km/s. We also see from the Na I D absorption lines indications of neutral gas flows towards the younger cluster. We compare the dynamical masses with those derived from photometry and discuss implications for the stellar initial mass function (IMF) in each cluster. Both clusters are compatible with rather normal IMFs which will favour their long-term survival and evolution into massive bona fide globular clusters.

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ACS photometry of the globular cluster B514

S. Galleti, L. Federici, M. Bellazzini, A. Buzzoni and F. Fusi Pecci

INAF - Osservatorio Astronomico di Bologna, via Ranzani ¹, I-40127, Bologna, Italy

We present deep F606W, F814W ACS photometry of the recently discovered globular cluster B514, the outermost known globular in the M31 galaxy. The cluster appears quite extended and member stars are unequivocally identified out to ~ 200 pc from the center. The Color Magnitude Diagram reveals a steep Red Giant Branch (RGB), and a Horizontal Branch (HB) extending blue ward of the instability strip, indicating that B514 is a classical old metal-poor globular cluster. The RGB locus and the position of the RGB Bump are both consistent with a metallicity $[Fe/H] \sim -1.8$, in excellent agreement with spectroscopic estimates. A preliminary estimate of the integrated absolute V magnitude ($M_V \leq -9.1$) suggests that B514 is among the brightest globulars of M31.

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A study of the B and Be star population in the field of the LMC open cluster NGC2004 with VLT-FLAMES

C. Martayan¹, A.M. Hubert¹, M. Floquet¹, J. Fabregat², Y. Frémat³, C. Neiner⁴, 1, P. Stee⁵, J. Zorec⁶

¹: GEPI, UMR8111 du CNRS, Observatoire de Paris-Meudon, 92195 Meudon Cedex, France ²: Universidad de València, Instituto de Ciencia de los Materiales, P.O. Box 22085, 46071 València, Spain ³: Observatoire Royal de Belgique, 3 rue Circulaire, 1180 Bruxelles, Belgium ⁴: Instituut voor Sterrenkunde, KU Leuven, Celestijnenlaan 220B, 3001 Belgium ⁵: Observatoire de la Côte d'Azur, avenue Nicolas Copernic, 06130 Grasse, France ⁶: Institut d'Astrophysique de Paris (IAP), 98bis boulevard Arago, 75014 Paris, France

Observations of hot stars belonging to the young cluster LMC-NGC2004 and its surrounding region have been obtained with the VLT-GIRAFFE facilities in MEDUSA mode. 25 Be stars were discovered; the proportion of Be stars compared to B-type stars is found to be of the same order in the LMC and in the Galaxy fields. 23 hot stars were discovered as spectroscopic binaries (SB1 and SB2), 5 of these are found to be eclipsing systems from the MACHO database, with periods of a few days. About 75% of the spectra in our sample are polluted by hydrogen ($H\alpha$ and $H\gamma$), S II and N II nebular lines. These lines are typical of H II regions. They could be associated with patchy nebulosities with a bi-modal distribution in radial velocity, with higher values ($+335 \text{ km s}^{-1}$) preferentially seen inside the southern part of the known bubble LMC4 observed in H I at 21 cm.

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Effects of metallicity, star-formation conditions, and evolution in B and Be stars. I: Large Magellanic Cloud, field of NGC2004.

C. Martayan¹ and Y. Frémat² and A.-M. Hubert¹ and M. Floquet¹ and J. Zorec³ and C. Neiner^{1,4}

GEPI, UMR 8111 du CNRS, Observatoire de Paris-Meudon, 92195 Meudon Cedex, France and Royal Observatory of Belgium, 3 avenue circulaire, 1180 Brussels, Belgium and Institut d'Astrophysique de Paris (IAP), 98bis boulevard Arago, 75014 Paris, France and Instituut voor Sterrenkunde, KU Leuven, Celestijnenlaan 200B, 3001 Belgium

To statistically study the effects of the metallicity, star-formation conditions, and evolution on the behaviour of massive stars and, more particularly, of B and Be stars, we observed large samples of stars in the Magellanic Clouds for the first time. In this article we present the first part of this study. Spectroscopic observations of hot stars belonging to the young cluster LMC-NGC 2004 and its surrounding region were carried out with the VLT-GIRAFFE facilities in MEDUSA mode. We determined the fundamental parameters (teff, logg, vsini, and radial velocity) for all B and Be stars in the sample thanks to a code developed in our group. The effect of fast rotation (stellar flattening and gravitational darkening) are taken into account in this study. We also determined the age of observed clusters. We then compared the mean vsini obtained for field and cluster B and Be stars in the Large Magellanic Cloud (LMC) with the ones in the Milky Way (MW). We find, in particular, that Be stars rotate faster in the LMC than in the MW, in the field as well as in clusters. We discuss the relations between vsini, metallicity, star-formation conditions, and stellar evolution by comparing the LMC with the MW. We conclude that Be stars began their main sequence life with an initial rotational velocity higher than the one for B stars. It is probable that only part of the B stars, those with a sufficient initial rotational velocity, can become Be stars. This result may explain the differences in the proportion of Be stars in clusters with similar ages.

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Effects of metallicity, star-formation conditions, and evolution in B and Be stars. II: Small Magellanic Cloud, field of NGC 330.

C. Martayan¹, Y. Frémat², A.-M. Hubert¹, M. Floquet¹, J. Zorec³ and C. Neiner¹

¹ GEPI, UMR 8111 du CNRS, Observatoire de Paris-Meudon, 92195 Meudon Cedex, France ² Royal Observatory of Belgium, 3 avenue circulaire, 1180 Brussels, Belgium ³ Institut d'Astrophysique de Paris (IAP), 98bis boulevard Arago, 75014 Paris, France

We search for effects of metallicity on B and Be stars in the Small and Large Magellanic Clouds (SMC and LMC) and in the Milky Way (MW). We extend our previous analysis of B and Be stars populations in the LMC to the SMC. The rotational velocities of massive stars and the evolutionary status of Be stars are examined with respect to their environments. Spectroscopic observations of hot stars belonging to the young cluster SMC-NGC 330 and its surrounding region have been obtained with the VLT-GIRAFFE facilities in MEDUSA mode. We determine fundamental parameters for B and Be stars with the GIRFIT code, taking into account the effect of fast rotation, and the age of observed clusters. We compare the mean $v \sin i$ obtained by spectral type- and mass-selection for field and cluster B and Be stars in the SMC with the one in the LMC and MW. We find that (i) B and Be stars rotate faster in the SMC than in the LMC, and in the LMC than in the MW; (ii) at a given metallicity, Be stars begin their main sequence life with a higher initial rotational velocity than B stars. Consequently, only a fraction of B stars that reach the ZAMS with a sufficiently high initial rotational velocity can become Be stars; (iii) the distributions of initial rotational velocities at the ZAMS for Be stars in the SMC, LMC and MW are mass- and metallicity-dependent; (iv) the angular velocities of B and Be stars are higher in the SMC than in the LMC and MW; (v) in the SMC and LMC, massive Be stars appear in the second part of the main sequence, contrary to massive Be stars in the MW.

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For preprints, contact christophe.martayan@obspm.fr

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6. Dynamical simulations - Theory**Monte Carlo Simulations of Globular Cluster Evolution. IV. Direct Integration of Strong Interactions****John M. Fregeau & Frederic A. Rasio**

Department of Physics and Astronomy, Northwestern University

We study the dynamical evolution of globular clusters containing populations of primordial binaries, using our newly updated Monte Carlo cluster evolution code with the inclusion of direct integration of binary scattering interactions. We describe the modifications we have made to the code, as well as improvements we have made to the core Monte Carlo method. We present several test calculations to verify the validity of the new code, and perform many comparisons with previous analytical and numerical work in the literature. We simulate the evolution of a large grid of models, with a wide range of initial cluster profiles, and with binary fractions ranging from 0 to 1, and compare with observations of Galactic globular clusters. We find that our code yields excellent agreement with direct N -body simulations of clusters with primordial binaries, but yields some results that differ significantly from other approximate methods. Our results for the structural parameters of clusters during the binary-burning phase are outside the range of parameters for observed clusters, implying that either clusters are born significantly more or less centrally concentrated than has been previously considered, or that there are additional physical processes beyond two-body relaxation and binary interactions that affect the structural characteristics of clusters.

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A highly abnormal massive star mass function in the Orion Nebula cluster and the dynamical decay of trapezia systems

Jan Pflamm-Altenburg ⁽¹⁾⁽²⁾ Pavel Kroupa ⁽¹⁾⁽²⁾

⁽¹⁾ Argelander-Institut für Astronomie Universität Bonn ⁽²⁾ Rhine Stellar Dynamics Network (RSDN)

The ONC appears to be unusual on two grounds: The observed constellation of the OB-stars of the entire Orion Nebula cluster and its Trapezium at its centre implies a time-scale problem given the age of the Trapezium, and an IMF problem for the whole OB-star population in the ONC. Given the estimated crossing time of the Trapezium, it ought to have totally dynamically decayed by now. Furthermore, by combining the lower limit of the ONC mass with a standard IMF it emerges that the ONC should have formed at least about 40 stars heavier than $5 M_{\odot}$ while only ten are observed. Using N -body experiments we (i) confirm the expected instability of the trapezium and (ii) show that beginning with a compact OB-star configuration of about 40 stars the number of observed OB stars after 1 Myr within 1 pc radius and a compact trapezium configuration can both be reproduced. These two empirical constraints thus support our estimate of 40 initial OB stars in the cluster. Interestingly a more-evolved version of the ONC resembles the Upper Scorpius OB association. The N -body experiments are performed with the new C-code CATENA by integrating the equations of motion using the chain-multiple-regularization method. In addition we present a new numerical formulation of the initial mass function.

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For preprints, contact `jpflamm@astro.uni-bonn.de`, `pavel@astro.uni-bonn.de`

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A dynamical origin for early mass segregation in young star clusters

S. McMillan ⁽¹⁾, E. Vesperini ⁽¹⁾, and S. Portegies Zwart ⁽²⁾

⁽¹⁾ Department of Physics, Drexel University, Philadelphia, PA 19104, USA ⁽²⁾ Astronomical Institute ‘Anton Pannekoek’ and Section Computational Science, University of Amsterdam, Kruislaan 403, 1098SJ Amsterdam, the Netherlands

Some young star clusters show a degree of mass segregation that is inconsistent with the effects of standard two-body relaxation from an initially unsegregated system without substructure, in virial equilibrium, and it is unclear whether current cluster formation models can account for this degree of initial segregation in clusters of significant mass. In this Letter we demonstrate that mergers of small clumps that are either initially mass segregated, or in which mass segregation can be produced by two-body relaxation before they merge, generically lead to larger systems which inherit the progenitor clumps’ segregation. We conclude that clusters formed in this way are naturally mass segregated, accounting for the anomalous observations and suggesting that this process of prompt mass segregation due to initial clumping should be taken fully into account in constructing cluster dynamical models.

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Star Clusters with Primordial Binaries: III. Dynamical Interaction between Binaries and an Intermediate Mass Black Hole

Michele Trenti^(1,2), Eliani Ardi⁽¹⁾, Shin Mineshige⁽¹⁾, Piet Hut⁽³⁾

⁽¹⁾ Yukawa Institute for Theoretical Physics, Kyoto, J ⁽²⁾ Space Telescope Science Institute, Baltimore, MD ⁽³⁾ Institute for Advanced Study, Princeton, NJ

We present the first study of the dynamical evolution of an isolated star cluster that combines a significant population of primordial binaries with the presence of a central black hole. We use equal-mass direct N-body simulations, with N ranging from 4096 to 16384 and a primordial binary ratio of 0-10new features with respect to the scenarios investigated so far, where the influence of the black hole and of the binaries have been considered separately. A large core to half mass radius ratio appears to be a promising indirect evidence for the presence of a intermediate-mass black hole in old globular clusters.

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Collisional Hardening of Compact Binaries in Globular Clusters

S. Banerjee, P. Ghosh

Tata Institute of Fundamental Research, Mumbai

We consider essential mechanisms for orbit-shrinkage or "hardening" of compact binaries in globular clusters to the point of Roche-lobe contact and X-ray emission phase, focussing on the process of collisional hardening due to encounters between binaries and single stars in the cluster core. The interplay between this kind of hardening and that due to emission of gravitational radiation produces a characteristic scaling of the orbit-shrinkage time with the single-star binary encounter rate γ in the cluster which we introduce, clarify, and explore. We investigate possible effects of this scaling on populations of X-ray binaries in globular clusters within the framework of a simple "toy" scheme for describing the evolution of pre-X-ray binaries in globular clusters. We find the expected qualitative trends sufficiently supported by data on X-ray binaries in galactic globular clusters to encourage us toward a more quantitative study.

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6. Miscellaneous**A maximum likelihood method for fitting colour-magnitude diagrams****Tim Naylor R.D. Jeffries**

University of Exeter Keele University

We present a maximum likelihood method for fitting two-dimensional model distributions to stellar data in colour-magnitude space. This allows one to include (for example) binary stars in an isochronal population. The method also allows one to derive formal uncertainties for fitted parameters, and assess the likelihood that a good fit has been found. We use the method to derive an age of $38.5 \pm 3.5/-6.5$ Myrs and a true distance modulus of $7.79 \pm 0.11/-0.05$ mags from the V vs V-I diagram of NGC2547 (the uncertainties are 67 percent confidence limits, and the parameters are insensitive to the assumed binary fraction). These values are consistent with those previously determined from low-mass isochronal fitting, and are the first measurements to have statistically meaningful uncertainties. The age is also consistent with the lithium depletion age of NGC2547, and the HIPPARCOS distance to the cluster is consistent with our value. The method appears to be quite general and could be applied to any N-dimensional dataset, with uncertainties in each dimension. However, it is particularly useful when the data are sparse, in the sense that both the typical uncertainties for a datapoint and the size of structure in the function being fitted are small compared with the typical distance between datapoints. In this case binning the data will lose resolution, whilst the method presented here preserves it. Software implementing the methods described in this paper is available from <http://www.astro.ex.ac.uk/people/timn/tau-squared/>.

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Star Formation in the Eagle Nebula and NGC 6611

J.M. Oliveira, R.D. Jeffries, J.Th van Loon

Astrophysics Group, Lennard-Jones Laboratories, Keele University, UK

We present IZJHKL' photometry of the core of the cluster NGC 6611 in the Eagle Nebula. This photometry is used to constrain the Initial Mass Function (IMF) and the circumstellar disk frequency of the young stellar objects. Optical spectroscopy of 258 objects is used to confirm membership and constrain contamination as well as individual reddening estimates. Our overall aim is to assess the influence of the ionizing radiation from the massive stars on the formation and evolution of young low-mass stars and their disks. The disk frequency determined from the JHKL' colour-colour diagram suggests that the ionizing radiation from the massive stars has little effect on disk evolution (Oliveira et al. 2005). The cluster IMF seems indistinguishable from those of quieter environments; however towards lower masses the tell-tale signs of an environmental influence are expected to become more noticeable, a question we are currently addressing with our recently acquired ultra-deep (ACS and NICMOS) HST images.

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Statistics of initial velocities of open clusters

J.R.D. Lépine¹, W. S. Dias², Yu. Mishurov³

¹ IAG, Universidade de São Paulo, Brazil;

² UNIFEI - Universidade Federal de Itajuba, MG, Brazil

³ Rostov State University, Russia

We made use of our large database of galactic clusters, which contains distances, proper motions and radial velocities, to determine the initial velocities of these objects (direction in the galactic plane, and amplitude).

In a previous work (Dias et al. 2005) we showed that the birth of open clusters occurs in the spiral arms. By integrating backwards the galactic orbits of the clusters for a time equal to their age, we retrieved the birthplaces as a function of time and we determined the rotation speed of the spiral pattern.

Now we use the same method to retrieve the initial velocities, and we measure the angle of the initial velocity perturbation with respect to the direction of circular motion. We find that the clusters are not born with random velocities, but with velocities that are organized in a few preferential directions with respect to the spiral arms. The existence of preferential initial directions allows us to directly observe the epicycle frequency, by plotting the orientation angle of the residual velocity (after the removal of the normal circular velocity) as a function of age.

Our results show that a preferential direction of birth velocity can survive for times longer than 100 Myr. This can be explained by star-formation in spiral shock waves, but excludes some other star formation mechanisms such as star formation induced by supernovae.

To appear in the proceedings of the IAU Symposium No. 237, 2006, held in Prague 14/08 – 18/08/2006, ed. B. G. Elmegreen & J. Palous

For preprints, contact jacques@iagusp.usp.br

Also available from the URL <http://>

or by anonymous ftp at <ftp://>

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Cluster Disruption: Combining Theory and Observations

Nate Bastian Mark Gieles

University College London Utrecht University

We review the theory and observations of star cluster disruption. The three main phases and corresponding typical timescales of cluster disruption are: I) Infant Mortality (10^7 yr), II) Stellar Evolution (10^8 yr) and III) Tidal relaxation (10^9 yr). During all three phases there are additional tidal external perturbations from the host galaxy. In this review we focus on the physics and observations of Phase I and on population studies of Phases II & III and external perturbations concentrating on cluster-GMC interactions. Particular attention is given to the successes and short-comings of the Lamers cluster disruption law, which has recently been shown to stand on a firm physical footing.

To appear in : "Mass loss from stars and the evolution of stellar clusters" conference, Eds. A. de Koter, L. Smith and R. Waters (San Francisco: ASP)

For preprints, contact `bastian@star.ucl.ac.uk`

Also available from the URL <http://de.arxiv.org/abs/astro-ph/0609669>

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Optical and Infrared Observations of Stellar Mass Loss in Globular Cluster Red Giants

Iain McDonald, Jacco Th. van Loon

School of Physical and Geographical Sciences, Lennard-Jones Laboratories, Keele University, Staffordshire ST5 5BG,
United Kingdom

We are examining mass loss from globular clusters giant stars, focussing on metallicity dependance. We present three sets of observations: TIMMI-2 mid-IR spectra of 47 Tuc, UVES high-resolution optical spectra of several clusters, and an infrared atlas of ω Cen using the Spitzer Space Telescope.

To appear in : "Mass loss from stars and the evolution of stellar clusters", Lunteren (NL), May 29-June 1, 2006

For preprints, contact iain@astro.keele.ac.uk

Also available from the URL <http://it.arxiv.org/abs/astro-ph/0609446>

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Kinematics of Globular Cluster Systems

Aaron J. Romanowsky

Universidad de Concepcion

I review the field of globular cluster system (GCS) kinematics, including a brief primer on observational methods. The kinematical structures of spiral galaxy GCSs so far appear to be broadly similar. The inferred rotation and mass profiles of elliptical galaxy halos exhibit a diversity of behaviors, requiring more systematic observational and theoretical studies.

To appear in : Globular Clusters - Guides to Galaxies, eds. T. Richter & S.S. Larsen, Springer-Verlag, in press

For preprints, contact `romanow@astro-udec.cl`

Also available from the URL `http://`

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Be stars in open clusters in the Small Magellanic Cloud.

Martayan, C.^{1,2}, Baade, D.¹, Hubert, A.-M.², Floquet, M.², Fabregat, J.³, Bertin, E.⁴,
Neiner, C.²

¹: European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching b. Muenchen, Germany ²: GEPI, UMR8111 du CNRS, Observatoire de Paris-Meudon, 92195 Meudon Cedex, France ³: Observatorio Astronómico de Valencia, edifici Instituts d'investigació, Poligon la Coma, 46980 Paterna Valencia, Spain ⁴: Institut d'Astrophysique de Paris (IAP), 98bis boulevard Arago, 75014 Paris

We report on the study of the population of B and Be stars in SMC young clusters, performed with the Wide Field Imager in slitless spectroscopic mode at ESO/T2.2m with a filter centered at H α . First, we explain the reduction methods we used and our selection of different types of objects. Second, we present results on the proportion of Be stars in 85 SMC clusters, and we compare this proportion to the one observed in the Milky Way. Finally, we also present results on a statistical study of variability of Be stars with OGLE.

To appear in : SF2A2006

For preprints, contact christophe.martayan@obspm.fr

Also available from the URL <http://arxiv.org/abs/astro-ph/0609678>

or by anonymous ftp at ftp://

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The impact of red giant mass loss on star cluster evolution

Jacco Th. van Loon Iain McDonald

Astrophysics Group, Lennard-Jones Laboratories, Keele University, Staffordshire ST5 5BG, United Kingdom

We discuss the importance for the long-term cluster evolution of the mass loss from intermediate-mass stars ($0.8\text{--}8 M_{\odot}$). We present constraints on the mass loss from red giants in clusters in the Magellanic Clouds, a search for the intra-cluster medium in galactic globular clusters, and a simple estimate for the cluster evolution due to red giant mass loss compared to stellar escape.

To appear in : "Mass loss from stars and the evolution of stellar clusters", a conference in honour of Henny Lamers, eds. A. de Koter, L. Smith and L.B.F.M. Waters, ASP Conf.Ser

For preprints, contact jacco@astro.keele.ac.uk

Also available from the URL <http://it.arxiv.org/abs/astro-ph/0609445>

or by anonymous ftp at

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The primordial binary population in the association Sco OB2

Thijs Kouwenhoven^{1,2}

¹Astronomical Institute, University of Amsterdam, Kruislaan 403, 1098 SJ, Amsterdam, The Netherlands

²Currently at the Dept. of Physics & Astronomy, University of Sheffield, S3 7RH, Sheffield, UK

Thesis work conducted at: Astronomical Institute, University of Amsterdam, The Netherlands
 Ph.D directed by: Lex Kaper, Ed van den Heuvel, Anthony Brown, and Simon Portegies Zwart
 Ph.D degree awarded on 28 September 2006

Observations over the last decade have indicated that a large fraction of the stars are part of a binary or multiple system. For our understanding of star formation it is therefore of crucial importance to characterise the outcome of the star forming process in terms of binary parameters. In this thesis we aim to recover the primordial binary population, which is defined as *the population of binaries as established just after the gas has been removed from the forming system, i.e., when the stars can no longer accrete gas from their surroundings*. OB associations are the prime targets for finding the primordial binary population. Due to their youth (5–50 Myr) and low stellar density ($< 0.1 M_{\odot} \text{pc}^{-3}$), the effects of stellar evolution and dynamical interactions have only modestly effected the binary population since the moment of gas expulsion.

In this thesis we study the nearest (118–145 pc) young (5–20 Myr) association Sco OB2. We first recover the *current* binary population in Sco OB2 using a literature study, and extend the dataset with two (ADONIS and NAOS-CONICA) adaptive optics binarity surveys. By modeling the selection effects of visual, eclipsing, spectroscopic, and astrometric binary surveys in the available dataset, and comparing the simulated observations of model associations to the real observations, we recover the current binary population of Sco OB2.

Our results indicate that simulated observations of models with a binary fraction of 100% are most consistent with the observations ($> 70\%$ at the 3σ confidence level). The observed mass ratio distribution among binaries with primary spectral type A and B is consistent with an intrinsic distribution $f_q(q) \propto q^{-0.4 \pm 0.2}$, while random pairing between binary components is excluded. The semi-major axis distribution has the form $f_a(a) \propto a^{-1.0 \pm 0.15}$, while the log-normal period distribution of Duquennoy & Mayor (1991) is inconsistent with the observations. The observed eccentricity distribution, although poorly constrained by observations, is consistent with a flat distribution.

Our study further indicates a very small brown dwarf companion frequency, as well as a small substellar-to-stellar companion frequency among A and B type stars. These properties, often referred to as the *brown dwarf desert*, are a natural result of the mass ratio distribution in Sco OB2. If star formation results in a mass ratio distribution of the above form, the embryo ejection scenario is not necessary to explain the small number of brown dwarf companions. Our results suggest that brown dwarfs form like stars, and that the brown dwarf desert can be ascribed to an excess of planetary companions, rather than by a lack of brown dwarf companions.

Due to the youth and low stellar density of Sco OB2, one expects that stellar and dynamical evolution have only mildly affected its binary population since the moment of gas removal. The current binary population of Sco OB2 is thus very similar to its primordial binary population. The major result presented in this thesis, i.e. that practically all intermediate mass stars have formed in a binary or multiple system, provides fundamental information to our understanding of the star forming process.

For preprints, contact t.kouwenhoven@sheffield.ac.uk

Also available from the URL <http://dare.uva.nl/en/record/195643>

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Structure Formation in the Universe: Galaxies, Stars, Planets

Chamonix, France

27 May - 1 June 2007

G. Chabrier¹

¹Ecole Normale Supérieure de Lyon, France

This is the **second announcement** of the conference "*Structure formation in the universe*", to be held in Chamonix, France from 27 May through 1 June 2007. The aim of the conference is to bring together researchers working in the fields of planet, star and galaxy formation in order to share their expertise and to address common physical and numerical issues in the understanding of structure formation in astrophysics.

The **registration**, with the possibility to submit a poster presentation, is **now open**, with the hotel reservation. Chamonix is a very touristic location so booking as early as possibly is recommended. All information on the conference website.

Scientific rationale, final program and list of speakers on: <http://chamonix2007.ens-lyon.fr/>

Organizer and contact: **G. Chabrier (ENS-Lyon; chabrier@ens-lyon.fr)**

**The Dynamics of Star Clusters and Star Cluster Systems
(MODEST-7d)**

Sheffield, UK

Monday 6 - Wednesday 8 2006

Richard de Grijs, Simon Goodwin, Mark Wilkinson

We will hold a 2.5-day meeting on the evolution of star clusters and star cluster systems at this opportune time, when various fields related to star cluster formation and evolution are witnessing significant progress from both an observational point of view as well as in the field of numerical simulations, facilitated by the development of faster and more powerful parallel and dedicated supercomputers (e.g., GRAPEs) and sophisticated modeling techniques (e.g., the MODEST collaboration, <http://www.manybody.org/modest/>).

Dates: Monday 6 - Wednesday 8 November 2006

Venue: The University of Sheffield

Registration and more information can be found at the following website:

<http://www.shef.ac.uk/physics/people/grijs/RSmeeting/>

PhD and Postdoc positions in Research on Extragalactic Star Clusters (Utrecht)

A postdoc and two PhD positions in the field of extragalactic star clusters will become available at the Astronomical Institute of Utrecht University after Jan 1, 2007. The successful candidates will be part of S. Larsen's research project "Star Clusters: Tracing the Origin and Composition of Stellar Populations", which is funded by the Netherlands Organization for Scientific Research (NWO) as part of its Innovational Research Incentives (VIDI) Program.

The main goals of the project are to achieve a better understanding of the relation between the general process of star formation in galaxies and star formation in clusters specifically, and explore the use of star clusters to constrain the star formation histories of their parent galaxies. This is done using a combination of space- and ground-based data, including images from the Hubble Space Telescope and a variety of imaging and spectroscopic data from ground-based facilities (mainly ESO, La Palma).

More information about these positions and the application procedure can be obtained from **Soeren S. Larsen**, email: larsen@astro.uu.nl, web: <http://www.astro.uu.nl/~larsen/jobs>. The deadline for the PhD positions is December 1, 2006, and for the postdoc position it is December 15, 2006.

About Utrecht

Utrecht University was founded in 1636 and is the largest university in the Netherlands. Several Nobel prize winners studied or worked here, the most recent being Gerardus 't Hooft and Martinus Veltman (Nobel prize in Physics 1999). The astronomy department has a long tradition, having been founded in 1643. It is now part of the Faculty of Science and has about 10 full-time faculty members and 20 PhD students. The department has strong ties with the neighbouring Netherlands Institute for Space Research (SRON) and has access to the telescopes at ESO, La Palma, JCMT, and the Westerbork radio telescopes. The Astronomical Institute is part of the Dutch Research School for Astronomy (NOVA). Utrecht itself is a lively city with a historical centre, situated in the centre of the Netherlands and about 30 min by train from Schiphol International Airport and Amsterdam.

More information about requirements, how to apply, etc

Please go to: <http://www.astro.uu.nl/~larsen/jobs>

Information about the department of Physics and Astronomy can be found at <http://www.phys.uu.nl> and <http://www.astro.uu.nl>.

Lindheimer Postdoctoral Fellowship-NORTHWESTERN UNIVERSITY

Lindheimer Postdoctoral Fellowship
NORTHWESTERN UNIVERSITY
Department of Physics and Astronomy
2145 Sheridan Road
Evanston, IL 60208
USA
Tel: 847-491-4516
URL1:<http://www.astro.northwestern.edu>
Email Inquiries: davemeyer@northwestern.edu
The closing date for receipt of applications: 12/01/2006

Attention: Prof. David M. Meyer, Director of Astrophysical Studies

The Northwestern University astrophysics group invites applications for the 2007 Lindheimer Postdoctoral Fellowship. The Lindheimer Fellow is expected to pursue a creative research program in any area of astrophysics working independently and/or in collaboration with the NU faculty. Current astrophysical research at Northwestern includes: theoretical work on the dynamics of dense stellar systems and extrasolar planets, binary star evolution, the physics of neutron stars and black holes, and gravitational-wave astrophysics; multi-wavelength observations of supernova remnants, star formation regions, and the Galactic Center region; sub-mm studies of interstellar magnetic fields; optical/UV absorption-line observations of interstellar and extragalactic gas clouds; optical/X-ray studies of clusters of galaxies; and instrumental work on X-ray mirror fabrication, UV detector development, and sub-mm polarimetry. The Fellowship will be awarded for a two-year term (with the possibility of a third-year extension) that must commence no later than September 2007. It carries an annual stipend of \$54,000, a competitive benefit package, and a research budget of \$15,000 per year.

Applicants should send a complete curriculum vitae including a list of publications, a brief statement of research accomplishments, interests, and plans, and arrange for 3 letters of recommendation to be sent to the above address. Neither FAXed nor electronic applications will be accepted. Applicants must receive their Ph.D. prior to appointment. EOE/AAE.
