Dear Colleagues,

It is my pleasure to present you the 142nd issue of the Magellanic Clouds Newsletter. There’s some interesting new work on the intriguing evolution of massive star clusters, and also the spectacular release of a sample of over 45,000 RR Lyrae across the Magellanic System — among other exciting things.

Many thanks to Ben Tatton, Tom Marsh and Karin Sandstrom for encouraging and explaining how to add hyperlinks to the PDF. It has been successfully implemented in another newsletter I run, but do let me know if you encounter any oddities or malfunctions.

There’s a great job opportunity in Melbourne — check it out!

Tired of too many launches of new journals? This one’s different — no page charges!

And if you’re dying to learn what Gaia is going to teach us about the Magellanic System and some of its inhabitants, why not attend the meeting in Nice (France) next year?

If you have any picture, spectrum or graph for the cover of the newsletter, just e-mail it and it will receive due consideration.

The next issue is planned to be distributed on the 1st of October 2016.

Editorially Yours,

Jacco van Loon
Planetary Nebulæ in the Small Magellanic Cloud

P. Ventura¹, L. Stanghellini², M. Di Criscienzo¹, A. García–Hernández³ and F. Dell’Aglì¹

¹INAF–Osservatorio Astronomico di Roma, Via Frascati 33, 00040, Monte Porzio Catone (RM), Italy
²National Optical Astronomy Observatory, 950 N. Cherry Avenue, Tucson (AZ) 85719, USA
³Departamento de Astrofísica, Universidad de La Laguna (ULL), E-38206 La Laguna, Tenerife, Spain

We analyse the planetary nebulae (PNe) population of the Small Magellanic Cloud (SMC), based on evolutionary models of stars with metallicities in the range $10^{-3} \leq Z \leq 4 \times 10^{-3}$ and mass $0.9 \, M_\odot < M < 8 \, M_\odot$, evolved through the asymptotic giant branch (AGB) phase. The models used account for dust formation in the circumstellar envelope. To characterise the PNe sample of the SMC, we compare the observed abundances of the various species with the final chemical composition of the AGB models: this study allows us to identify the progenitors of the PNe observed, in terms of mass and chemical composition. According to our interpretation, most of the PNe descend from low-mass ($M < 2 \, M_\odot$) stars, which become carbon rich, after experiencing repeated third dredge-up episodes, during the AGB phase. A fraction of the PNe showing the signature of advanced CNO processing are interpreted as the progeny of massive AGB stars, with mass above $\sim 6 \, M_\odot$, undergoing strong hot bottom burning. The differences with the chemical composition of the PNe population of the Large Magellanic Cloud (LMC) is explained on the basis of the diverse star formation history and age–metallicity relation of the two galaxies. The implications of the present study for some still highly debated points regarding the AGB evolution are also commented.

Accepted for publication in MNRAS

A dipole on the sky: predictions for hypervelocity stars from the Large Magellanic Cloud

Douglas Boubert¹

¹Cambridge University, UK

We predict the distribution of hypervelocity stars (HVSs) ejected from the Large Magellanic Cloud (LMC), under the assumption that the dwarf galaxy hosts a central massive black hole (MBH). For the majority of stars ejected from the LMC the orbital velocity of the LMC has contributed a significant fraction of their galactic rest frame velocity, leading to a dipole density distribution on the sky. We quantify the dipole using spherical harmonic analysis and contrast with the monopole expected for HVSs ejected from the Galactic Center (GC). There is a tendril in the density distribution that leads the LMC which is coincident with the well-known and unexplained clustering of HVSs in the constellations of Leo and Sextans. Our model is falsifiable, since it predicts that Gaia will reveal a large density of HVSs in the southern hemisphere.

Accepted for publication in ApJ Letters
Detection of a hot molecular core in the Large Magellanic Cloud with ALMA

Takashi Shimonishi1,2, Takashi Onaka3, Akiko Kawamura4 and Yuri Aikawa5

1Frontier Research Institute for Interdisciplinary Sciences, Tohoku University, Japan
2Astronomical Institute, Tohoku University, Japan
3Department of Astronomy, Graduate School of Science, The University of Tokyo, Japan
4National Astronomical Observatory of Japan, Japan
5Center for Computational Sciences, The University of Tsukuba, Japan

We report the first detection of a hot molecular core outside our Galaxy based on radio observations with ALMA toward a high-mass young stellar object (YSO) in a nearby low metallicity galaxy, the Large Magellanic Cloud (LMC). Molecular emission lines of CO, C^{17}O, HCO^+, H^{13}CO^+, H_2CO, NO, SiO, H_2CS, 34SO, 32SO_2, 33SO_2, and 33SO_2 are detected from a compact region (~ 0.1 pc) associated with a high-mass YSO, ST11. The temperature of molecular gas is estimated to be higher than 100 K based on rotation diagram analysis of SO_2 and 34SO_2 lines. The compact source size, warm gas temperature, high density, and rich molecular lines around a high-mass protostar suggest that ST11 is associated with a hot molecular core. We find that the molecular abundances of the LMC hot core are significantly different from those of Galactic hot cores. The abundances of CH_3OH, H_2CO, and HNCO are remarkably lower compared with Galactic hot cores by at least 1–3 orders of magnitude. We suggest that these abundances are characterized by the deficiency of molecules whose formation requires the hydrogenation of CO on grain surfaces. In contrast, NO shows a high abundance in ST11 despite the notably low abundance of nitrogen in the LMC. A multitude of SO_2 and its isotopologue line detections in ST11 imply that SO_2 can be a key molecular tracer of hot core chemistry in metal-poor environments. Furthermore, we find molecular outflows around the hot core, which is the second detection of an extragalactic protostellar outflow. In this paper, we discuss physical and chemical characteristics of a hot molecular core in the low metallicity environment.

Accepted for publication in The Astrophysical Journal

The tight subgiant branch of the intermediate-age star cluster NGC 411 implies a single-aged stellar population

Chengyuan Li1,2,3,4

1Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing 210008, China
2Kavli Institute for Astronomy & Astrophysics and Department of Astronomy, Peking University, Yi He Yuan Lu 5, Hai Dian District, Beijing 100871, China
3Key Laboratory for Optical Astronomy, National Astronomical Observatories, Chinese Academy of Sciences, 20A Datun Road, Chaoyang District, Beijing 100012, China
4Department of Physics and Astronomy, Macquarie University, Sydney, NSW 2109, Australia

The presence of extended main-sequence turn-off (eMSTO) regions in intermediate-age star clusters in the Large and Small Magellanic Clouds is often interpreted as resulting from extended star-formation histories (SFHs), lasting > 300 Myr. This strongly conflicts with the traditional view of the dominant star-formation mode in stellar clusters, which are thought of as single-aged stellar populations. Here we present a test of this interpretation by exploring the morphology of the subgiant branch (SGB) of NGC 411, which hosts possibly the most extended eMSTO among all known intermediate-age star clusters. We show that the width of the NGC 411 SGB favours the single-aged stellar population interpretation and rules out an extended SFH. In addition, when considering the red clump (RC) morphology and adopting the unproven premise that the widths of all features in the colour–magnitude diagram are determined by an underlying range in ages, we find that the SFH implied is still very close to that resulting from a single-aged stellar population, with a minor fraction of stars scattering to younger ages compared with the bulk of the population. The SFHs derived from the SGB and RC are both inconsistent with the SFH derived from the eMSTO region. NGC 411 has a very low escape velocity and it has unlikely undergone significant mass loss at an early stage, thus indicating that it may lack the capacity to capture most of its initial, expelled gas from stellar evolutionary processes, a condition often required for extended SFHs to take root.

Accepted for publication in MNRAS
Constraining dust properties in circumstellar envelopes of C-stars in the Small Magellanic Cloud: optical constants and grain size of carbon dust

Ambra Nanni1, Paola Marigo1, Martin A.T. Groenewegen2, Bernhard Aringer1, Léo Girardi3, Giada Pastorelli1, Alessandro Bressan4 and Sara Bladh1

1Dipartimento di Fisica e Astronomia Galileo Galilei, Università di Padova, Vicolo dell’Osservatorio 3, I-35122 Padova, Italy
2Royal Observatory of Belgium, Ringlaan 3, B-1180 Brussels, Belgium
3Osservatorio Astronomico di Padova, Vicolo dell’Osservatorio 5, I-35122 Padova, Italy
4SISSA, via Bonomea 265, I-34136 Trieste, Italy

We present a new approach aimed at constraining the typical size and optical properties of carbon dust grains in Circumstellar envelopes (CSEs) of carbon-rich stars (C-stars) in the Small Magellanic Cloud (SMC). To achieve this goal, we apply our recent dust growth description, coupled with a radiative transfer code to the CSEs of C-stars evolving along the TP-AGB, for which we compute spectra and colors. Then we compare our modeled colors in the near- and mid-infrared (NIR and MIR) bands with the observed ones, testing different assumptions in our dust scheme and employing several data sets of optical constants for carbon dust available in the literature. Different assumptions adopted in our dust scheme change the typical size of the carbon grains produced. We constrain carbon dust properties by selecting the combination of grain size and optical constants which best reproduces several colors in the NIR and MIR at the same time. The different choices of optical properties and grain size lead to differences in the NIR and MIR colors greater than two magnitudes in some cases. We conclude that the complete set of observed NIR and MIR colors are best reproduced by small grains, with sizes between $\sim 0.035$ and $\sim 0.12$ $\mu$m, rather than by large grains between $\sim 0.2$ and $0.7$ $\mu$m. The inability of large grains to reproduce NIR and MIR colors seems independent of the adopted optical data set. We also find a possible trend of the grain size with mass-loss and/or carbon excess in the CSEs of these stars.

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Inhomogeneous molecular ring around the B[e] supergiant LHA 120-S 73

M. Kraus1,2, L.S. Cidale3,4, M.L. Arias3,4, G. Maravelias1, D.H. Nickeler4, A.F. Torres5,4, M. Borges Fernandes5, A. Are6, M. Car7, R. Vallerd6,4 and R.H. Barbá7

1Astronomický ústav, Akademie věd České republiky, Přívoz 298, 25165 Ondřejov, Czech Republic
2Tartu Observatory, Tõravere, 61029 Tartumaa, Estonia
3Departamento de Espectroscopía Estelar, Facultad de Ciencias Astrónomicas y Geofísicas, Universidad Nacional de La Plata (UNLP), Paseo del Bosque s/n, B1900FWA, La Plata, Argentina
4Instituto de Astrofísica de La Plata, CCT La Plata, CONICET–UNLP, Paseo del Bosque s/n, B1900FWA, La Plata, Argentina
5Observatório Nacional, Rua General José Cristino 77, 20921-400 São Cristovão, Rio de Janeiro, Brazil
6Instituto de Física y Astronomía, Facultad de Ciencias, Universidad de Valparaíso, Av. Gran Bretaña 1111, Casilla 5030, Valparaíso, Chile
7Departamento de Física y Astronomía, Universidad de La Serena, Cisternas 1200 Norte, La Serena, Chile

Context: B[e] supergiants are evolved massive stars, enshrouded in a dense wind and surrounded by a molecular and dusty disk. The mechanisms that drive phases of enhanced mass loss and mass ejections, responsible for the shaping of the circumstellar material of these objects, are still unclear.

Aims: We aim to improve our knowledge on the structure and dynamics of the circumstellar disk of the Large Magellanic Cloud B[e] supergiant LHA 120-S 73.

Methods: High-resolution optical and near-infrared spectroscopic data were obtained over a period of 16 and 7 years, respectively. The spectra cover the diagnostic emission lines from [Ca ii] and [O i], as well as the CO bands. These features trace the disk at different distances from the star. We analyzed the kinematics of the individual emission
regions by modeling their emission profiles. A low-resolution mid-infrared spectrum was obtained as well, which provides information on the composition of the dusty disk.

**Results:** All diagnostic emission features display double-peaked line profiles, which we interpret as due to Keplerian rotation. We find that the profile of each forbidden line contains contributions from two spatially clearly distinct rings. In total, we find that LHA 120-S 73 is surrounded by at least four individual rings of material with alternating densities (or by a disk with strongly non-monotonic radial density distribution). Moreover, we find that the molecular ring must have gaps or at least strong density inhomogeneities, or in other words, a clumpy structure. The optical spectra additionally display a broad emission feature at 6160–6180 Å, which we interpret as molecular emission from TiO. The mid-infrared spectrum displays features of oxygen- and carbon-rich grain species, which indicates a long-lived, stable dusty disk. We cannot confirm the previously reported high value for the stellar rotation velocity. He I λ5876 is the only clearly detectable pure atmospheric absorption line in our data. Its line profile is strongly variable in both width and shape and resembles of those seen in non-radially pulsating stars. A proper determination of the real underlying stellar rotation velocity is hence not possible.

**Conclusions:** The existence of multiple stable and clumpy rings of alternating density recalls ring structures around planets. Although there is currently insufficient observational evidence, it is tempting to propose a scenario with one (or more) minor bodies or planets revolving around LHA 120-S 73 and stabilizing the ring system, in analogy to the shepherd moons in planetary systems.

**Accepted for publication in Astronomy and Astrophysics**


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**First observational signature of rotational deceleration in a massive, intermediate-age star cluster in the Magellanic Clouds**

**Xiaohan Wu**¹,², **Chengyuan Li**³,⁴,⁵, **Richard de Grijs**²,⁶ and **Licai Deng**³

¹School of Physics, Peking University, Yi He Yuan Lu 5, Hai Dian District, Beijing 100871, China
²Kavli Institute for Astronomy & Astrophysics and Department of Astronomy, Peking University, Yi He Yuan Lu 5, Hai Dian District, Beijing 100871, China
³Key Laboratory for Optical Astronomy, National Astronomical Observatories, Chinese Academy of Sciences, 20A Datun Road, Chaoyang District, Beijing 100012, China
⁴Department of Physics and Astronomy, Macquarie University, Sydney, NSW 2109, Australia
⁵Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing 210008, China
⁶International Space Science Institute–Beijing, 1 Nanertiao, Zhongguancun, Hai Dian District, Beijing 100190, China

While the extended main-sequence turn-offs (eMSTOs) found in almost all 1–2 Gyr-old star clusters in the Magellanic Clouds are often explained by postulating extended star-formation histories, the tight subgiant branches (SGBs) seen in some clusters challenge this popular scenario. Puzzlingly, the SGB of the eMSTO cluster NGC 419 is significantly broader at bluer than at redder colors. We carefully assess and confirm the reality of this observational trend. If we would assume that the widths of the features in color–magnitude space were entirely owing to a range in stellar ages, the star-formation histories of the eMSTO stars and the blue SGB region would be significantly more prolonged than that of the red part of the SGB. This cannot be explained by assuming an internal age spread. We show that rotational deceleration of a population of rapidly rotating stars, a currently hotly debated alternative scenario, naturally explains the observed trend along the SGB. Our analysis shows that a ‘converging’ SGB could be produced if the cluster is mostly composed of rapidly rotating stars that slow down over time owing to the conservation of angular momentum during their evolutionary expansion from main-sequence turn-off stars to red giants.

**Accepted for publication in The Astrophysical Journal Letters**

The tight subgiant branch of the intermediate-age star cluster NGC 411 implies a single-aged stellar population

Chengyuan Li1,2,3,4, Richard de Grijs2,5, Nathan Bastian6, Licai Deng3, Florian Niederhofer7,8,9 and Chaoli Zhang10

1Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing 210008, China
2Kavli Institute for Astronomy & Astrophysics and Department of Astronomy, Peking University, Yi He Yuan Lu 5, Hai Dian District, Beijing 100871, China
3Key Laboratory for Optical Astronomy, National Astronomical Observatories, Chinese Academy of Sciences, 20A Datun Road, Chaoyang District, Beijing 100102, China
4Department of Physics and Astronomy, Macquarie University, Sydney, NSW 2109, Australia
5International Space Science Institute–Beijing, 1 Nanetiaoo, Zhongguancun, Hai Dian District, Beijing 100190, China
6Astrophysics Research Institute, Liverpool John Moores University, 146 Brownlow Hill, Liverpool L3 5RF, UK
7Excellence Cluster "Origin and Structure of the Universe", Boltzmannstraße 2, D-85748 Garching bei München, Germany
8Universitäts-Sternwarte München, Scheinerstraße 1, D-81679 München, Germany
9Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
10Shanghai Astronomical Observatory, Chinese Academy of Sciences, Shanghai 200030, China

The presence of extended main-sequence turn-off (eMSTO) regions in intermediate-age star clusters in the Large and Small Magellanic Clouds is often interpreted as resulting from extended star-formation histories (SFHs), lasting \( \geq 300 \) Myr. This strongly conflicts with the traditional view of the dominant star-formation mode in stellar clusters, which are thought of as single-aged stellar populations. Here we present a test of this interpretation by exploring the morphology of the subgiant branch (SGB) of NGC 411, which hosts possibly the most extended eMSTO among all known intermediate-age star clusters. We show that the width of the NGC 411 SGB favours the single-aged stellar population interpretation and rules out an extended SFH. In addition, when considering the red clump (RC) morphology and adopting the unproven premise that the widths of all features in the colour–magnitude diagram are determined by an underlying range in ages, we find that the SFH implied is still very close to that resulting from a single-aged stellar population, with a minor fraction of stars scattering to younger ages compared with the bulk of the population. The SFHs derived from the SGB and RC are both consistent with the SFH derived from the eMSTO region. NGC 411 has a very low escape velocity and it has unlikely undergone significant mass loss at an early stage, thus indicating that it may lack the capacity to capture most of its initial, expelled gas from stellar evolutionary processes, a condition often required for extended SFHs to take root.

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The OGLE collection of variable stars. Over 45 000 RR Lyræ stars in the Magellanic System

I. Soszyński1, A. Udalski1, M.K. Szymański1, L. Wyrzykowski1, K. Ulaczyk1,2, R. Poleski1,3, P. Pietrukowicz1, S. Kozłowski1, D.M. Skowron1, J. Skowron1, P. Mróz1 and M. Pawlak1

1Warsaw University Observatory, Al. Ujazdowskie 4, 00-476Warszawa, Poland
2Department of Physics, University of Warwick, Gibbet Hill Road, Coventry, CV4 7AL, UK
3Department of Astronomy, Ohio State University, 140W. 18th Ave., Columbus, OH 43210, USA

We present the largest collection of RR Lyræ stars in the Magellanic System and in its foreground. The sample consists of 45 451 RR Lyr stars, of which 39 082 were detected toward the Large Magellanic Cloud and 6369 toward the Small Magellanic Cloud. We provide long-term time-series photometric measurements collected during the fourth phase of the Optical Gravitational Lensing Experiment (OGLE-IV).

We discuss several potential astrophysical applications of our collection: investigation of the structure of the Magellanic Clouds and the Galactic halo, studies of the globular clusters in the Magellanic System, analysis of double-mode RR Lyr stars, and search for RR Lyr stars in eclipsing binary systems.

Published in Acta Astronomica 66, 131 (2016)


Job Advert

Research Fellow in Statistical Inference for Astronomical Data

We seek to fill a 2.5 year post-doctoral fellowship dedicated to extensions and applications of the Minimum Message Length (MML) technique to the analysis of spectroscopic data from recent large surveys, such as GALAH. The position is based jointly within the Monash Centre for Astrophysics (MoCA, in the School of Physics and Astronomy) and the Faculty of Information Technology (FIT).

The successful applicant will develop and extend the MML method as needed, applying it to spectroscopic data from the GALAH project, with an aim to understanding nucleosynthesis in stars as well as the formation and evolution of our Galaxy (“galactic archaeology”).

The position is based at the main campus of Monash University which hosts approximately 56,000 equivalent full-time students and approximately 3500 academic staff spread across its Australian and off-shore campuses. Monash is committed to growing its already established excellence in astrophysics as well as machine learning and statistical inference. The successful applicant will work with world experts in both the Bayesian information-theoretic MML method as well as nuclear astrophysics. The immediate supervisors will be Professor John Lattanzio (MoCA), Associate Professor David Dowe (FIT) and Dr. Aldeida Aleti (FIT).

Salary will be in the range $86,209–$92,541 (which includes a 9.5% employer contribution to superannuation).

Monash University is based in Melbourne, named the World’s most livable city in each of the last 5 years. It is a highly multi-cultural cosmopolitan city providing extensive cultural and lifestyle opportunities, is situated on the coast with excellent beaches readily accessible, many fine restaurants and world-leading vineyards are less than 60 minutes away.

Applications due by 1 August 2016.

Further Information:
Position Description:
Monash University: http://www.monash.edu
Monash Centre for Astrophysics: http://moca.monash.edu
School of Physics and Astronomy: http://www.monash.edu/science/schools/physics
Faculty of Information Technology: http://www.infotech.monash.edu.au
City of Melbourne:
http://www.thatsmelbourne.com.au

See also http://www.jobs-monash.jxt.net.au/academic-jobs/research-fellow-in-statistics-and-astrophysics/706686
**Announcements**

**IAU symposium 330**

**Astrometry and Astrophysics in the Gaia sky**

We are pleased to announce the opening of the registration for the IAU symposium 330 – Astrometry and Astrophysics in the Gaia sky, to be held in Nice (France), from 24–28th April 2017.

The goal of this IAU symposium is to ensure the world-wide sharing of the Gaia mission results, foster international collaborations and discussions that will enhance the Gaia scientific return. This symposium will mark the first step of the Gaia revolution in astrometry, our understanding of the Milky Way galaxy, stellar physics and the Solar system bodies. The astrometry and reference frames science will be one of the conference highlights. The Gaia DR1 is indeed confirmed for the end of summer 2016. It will include the five-parameter astrometric solution – positions, parallaxes, and proper motions – for 2.5 million stars in common between the Tycho-2 Catalogue and Gaia (TGAS).

All these topics will be at the heart of the interdisciplinary scientific discussions of the symposium. We indeed hope to bring together the diverse scientific communities that will be impacted by the Gaia data. The conference will also be a tribute to François Mignard, expert in astrometry and reference frames, and chair of the Gaia Data Processing and Analysis Consortium since its formation and until the end of 2012.

Please visit the IAUS 330 website for more information: http://iaus330.sciencesconf.org/

The deadline for abstract submission and early registration are December 4, 2016 and January 10, 2017, respectively.

We are looking forward to seeing you in Nice in April 2017!

Alejandra Recio-Blanco, Anthony Brown and Timo Prusti (for the SOC)
Patrick de Laverny (for the LOC)

See also [http://iaus330.sciencesconf.org/](http://iaus330.sciencesconf.org/)

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**Nature Astronomy is now open for submissions**

Nature Astronomy is a truly multidisciplinary journal launching in January 2017. It will represent – and foster closer interaction between – all of the key astronomy-relevant disciplines. As a Nature Research journal, it will publish the most significant research, review and comment at the cutting edge of astronomy, astrophysics, cosmology and planetary science.

Nature Astronomy will offer a range of content types – including original research, Review Articles, Perspectives, Commentaries, News & Views and Research Highlights – to explore topical issues as well as showcasing significant advances in the field.

Publication in Nature Astronomy is free of charge, and its publication policy allows the posting of submitted manuscripts on preprint servers, and the self-archiving of the published versions of papers six months after publication.

Please visit the Nature Astronomy website for more information and to submit a manuscript.

See also [http://www.nature.com/natureastronomy](http://www.nature.com/natureastronomy)