Editorial

It is our pleasure to present the 83rd issue of the Magellanic Clouds Newsletter. It was great to see so many of you in Prague, and some of you in Vienna the week before.

This issue again reflects the enormous diversity in astronomical topics that can be studied in the Magellanic Clouds: massive stars and red giants, young stellar objects and planetary nebulae, supernova remnants and SN 1987A, dark matter, et cetera. The S3MC team have just published the first results of their Spitzer Space Telescope survey of the SMC, and a paper from the SAGE team describes more results from their Spitzer survey in the LMC.

Congratulations to Christophe Martayan, for his thesis on B and Be stars in the Magellanic Clouds.

The next issue will be distributed on the 1st of December; the deadline for contributions is the 30th of November.

Editorially Yours,

Jacco van Loon and Snežana Stanimirović
Chemically peculiar stars in the Large Magellanic Cloud

E. Paunzen¹, H.M. Maitzen¹, O.I. Pintado², A. Claret³, I.Kh. Iliev⁴ and M. Netopil¹

¹Institut für Astronomie der Universität Wien, Türkenschanzstr. 17, A-1180 Wien, Austria
²Departamento de Física, Facultad de Ciencias Exactas, y Tecnología, Universidad Nacional de Tucumán, Argentina - Consejo Nacional, de Investigaciones Científicas y Técnicas de la República Argentina
³Instituto de Astrofísica de Andalucía, CSIC, Apartado 3004, 18080 Granada, Spain
⁴Institute of Astronomy, National Astronomical Observatory, P.O. Box 136, BG-4700 Smolyan, Bulgaria

The detection of magnetic chemically peculiar (CP2) stars in open clusters of extragalactic systems can give observational answers to many unsolved questions. The mean percentage of CP2 stars in the Milky Way is of the order of 5% for the spectral range from early B- to F-type, luminosity class V objects. The origin of the CP2 phenomenon seems to be closely connected to the overall metallicity and global magnetic field environment. The theoretical models are still only tested by observations in the Milky Way. It is therefore essential to provide high quality observations in rather different global environments. The young clusters NGC 2136/7 were observed in the Delta a photometric system. This intermediate band photometric system samples the depth of the 520nm flux depression by comparing the flux at the center with the adjacent regions with bandwidths of 11nm to 23nm. The Delta a photometric system is most suitable for detecting CP2 stars with high efficiency, but is also capable of detecting a small percentage of non-magnetic CP objects. We present high precision photometric Delta a observations of 417 objects in NGC 2136/7 and its surrounding field, of which five turned out to be bona fide magnetic CP stars. In addition, we discovered two Be/Ae stars. From our investigations of NGC 1711, NGC 1866, NGC 2136/7, their surroundings, and one independent field of the LMC population, we derive an occurrence of classical chemically peculiar stars of 2.2(6)% in the LMC, which is only half the value found in the Milky Way. The mass and age distribution of the photometrically detected CP stars is not different from that of similar objects in galactic open clusters.

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Spitzer SAGE survey of the Large Magellanic Cloud II: Evolved Stars and Infrared Color Magnitude Diagrams

R.D. Blum et al. ¹

¹NOAO, USA

Color-magnitude diagrams (CMDs) are presented for the Spitzer SAGE (Surveying the Agents of a Galaxy’s Evolution) survey of the Large Magellanic Cloud (LMC). IRAC and MIPS 24 μm epoch one data are presented. These data represent the deepest, widest mid-infrared CMDs of their kind ever produced in the LMC. Combined with the 2MASS survey, the diagrams are used to delineate the evolved stellar populations in the Large Magellanic Cloud as well as Galactic foreground and extragalactic background populations. Some 32000 evolved stars brighter than the tip of the red giant branch are identified. Of these, approximately 17500 are classified as oxygen-rich, 7000 carbon-rich, and another 1200 as “extreme” asymptotic giant branch (AGB) stars. Brighter members of the latter group have been called “obscured” AGB stars in the literature owing to their dusty circumstellar envelopes. A large number (1200) of luminous oxygen-rich AGB stars/M supergiants are also identified. Finally, there is strong evidence from the 24 μm MIPS channel that previously unexplored, lower luminosity oxygen-rich AGB stars contribute significantly to the mass loss budget of the LMC (1200 such sources are identified).

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Hubble Space Telescope Images of Magellanic Cloud Planetary Nebulae

Richard A. Shaw1, Letizia Stanghellini1, Eva Villaver2 and Max Mutchler2

1NOAO, USA
2STScI, USA

We present images and slitless spectra which were obtained in HST surveys of Planetary Nebulae (PNe) in both the Large and Small Magellanic Clouds, using the Space Telescope Imaging Spectrograph. These new data on 59 PNe (54 in the LMC and five in the SMC) permit us to determine the nebular dimensions and morphology in the monochromatic light of several emission lines: Hα, [N ii] λ6583 and [O iii] λ5007, plus others of varying ionization, including [O i], He i, and [S ii]. We describe the nebular morphology and related features in detail. This survey, when combined with similar data from our prior HST programs and other archived PN images, brings the total of nebulae imaged with HST to 114 in the LMC and 35 in the SMC. We describe various basic properties for the sample, including sizes, morphologies, densities, and completeness. Trends in [O iii] λ5007 flux, surface brightness, and electron density with physical radius suggest that many nebulae, particularly those with bipolar morphology, may be optically thick even at large size. Bipolars also show the most extreme values of [N ii]/Hα flux ratios, which is a rough indicator N enrichment.

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The RR Lyrae Period - K Luminosity relation for Globular Clusters: an observational approach

A. Sollima1, C. Cacciari2 and E. Valenti2

1Dipartimento di Astronomia, Università di Bologna, Italy
2INAF - Osservatorio Astronomico di Bologna, Italy

The Period - metallicity - K band luminosity (PLK) relation for RR Lyrae stars in 15 Galactic globular clusters and in the LMC globular cluster Reticulum has been derived. It is based on accurate near infrared (K) photometry combined with 2MASS and other literature data. The PLK relation has been calibrated and compared with the previous empirical and theoretical determinations in literature. The zero point of the absolute calibration has been obtained from the K magnitude of RR Lyr whose distance modulus has been measured via trigonometric parallax with HST. Using this relation we obtain a distance modulus to the LMC of (m − M)0 = 18.54 ± 0.15 mag, in good agreement with recent determinations based on the analysis of Cepheid variable stars.

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Discovery of a compact X-ray source in the LMC supernova remnant N23 with Chandra

Asami Hayato1,2, Aya Bamba1, Toru Tamagawa1,2 and Kiyoshi Kawabata2

1RIKEN, Japan
2Tokyo University of Science, Japan

An X-ray compact source was discovered with Chandra in a supernova remnant (SNR) N23, located in the Large Magellanic Cloud. The compact source (CXOU J050552.3−680141) is seen in only the hard band (> 2 keV) image of N23, while the soft band image (< 2 keV) shows diffuse emission of the SNR, with an extent of ∼ 60″ × ∼ 80″. The compact source is located at almost the center of N23, and there is no identifiable object for the source from previous observations at any other wavelength. The source spectrum is best explained by a power-law model with a photon index of 2.2 (1.9–2.7) and an absorption-corrected luminosity of $1.0 \times 10^{34}$ ergs s⁻¹ in the 0.5–10 keV band for a distance of 50 kpc. Neither pulsation nor time variability of the source was detected with this observation with
a time resolution of 3.2 sec. These results correspond with those of Hughes et al. (2006) who carried out analysis independently around the same time as our work. Based on information from the best-fit power-law model, we suggest that the source emission is most likely from a rotation-powered pulsar and/or a pulsar wind nebula. It is generally inferred that the progenitor of N23 is a core-collapsed massive star. Based on information from the best-fit power-law model, we suggest that the source emission is most likely from a rotation-powered pulsar and/or a pulsar wind nebula. It is generally inferred that the progenitor of N23 is a core-collapsed massive star.

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Is the dark matter halo of the Milky Way flattened?

Adam Růžička¹,², Jan Palouš¹ and Christian Theis³

¹Astronomical Institute, Academy of Sciences of the Czech Republic
²Faculty of Mathematics and Physics of the Charles University in Prague, Czech Republic
³Institut für Astronomie der Universität Wien, Austria

We performed an extended analysis of the parameter space for the interaction of the Magellanic System with the Milky Way (MW). The varied parameters cover the phase space parameters, the masses, the structure, and the orientation of both Magellanic Clouds, as well as the flattening of the dark matter halo of the MW. The analysis was done by a specially adopted optimization code searching for the best match between numerical models and the detailed H₁ map of the Magellanic System by Brüns et al. (2005). The applied search algorithm is a genetic algorithm combined with a code based on the fast, but approximative restricted N-body method. By this, we were able to analyze more than 10⁶ models, which makes this study one of the most extended ones for the Magellanic System. Here we focus on the flattening q of the axially symmetric MW dark matter halo potential, that is studied within the range 0.74 ≤ q ≤ 1.20. We show that creation of a trailing tail (Magellanic Stream) and a leading stream (Leading Arm) is quite a common feature of the Magellanic System-MW interaction, and such structures were modeled across the entire range of halo flattening values. However, important differences exist between the models, concerning density distribution and kinematics of H₁, and also the dynamical evolution of the Magellanic System. Detailed analysis of the overall agreement between modeled and observed distribution of neutral hydrogen shows that the models assuming an oblate (q < 1.0) dark matter halo of the Galaxy allow for better satisfaction of H₁ observations than models with other halo configurations.

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Ellipsoidal Variability and Long Secondary Periods in MACHO Red Giant Stars

A. Derekas¹, L. L. Kiss¹, T. R. Bedding¹, H. Kjeldsen², P. Lah³ and Gy. M. Szabó⁴,⁵

¹School of Physics, University of Sydney, NSW 2006, Australia
²Department of Physics and Astronomy, University of Aarhus, DK-8000 Aarhus C, Denmark
³Research School of Astronomy & Astrophysics, Australian National University, Canberra, Australia
⁴Department of Experimental Physics, University of Szeged, Dóm tér 9. Szeged 6720, Hungary
⁵Magyary Zoltán Postdoctoral Research Fellow

We present a period-luminosity-amplitude analysis of 5899 red giant and binary stars in the Large Magellanic Cloud, using publicly available observations of the MACHO project. For each star, we determined new periods, which were double-checked in order to exclude aliases and false periods. The period-luminosity relations confirm the existence of a short-period, small-amplitude P-L sequence at periods shortward of Seq. A. We point out that the widely accepted sequence of eclipsing binaries between Seqs. C and D, known as Seq. E, does not exist. The correct position for Seq. E is at periods a factor of two greater, and the few stars genuinely lying between Seq. C and D are under-luminous Mira variables, presumably enshrouded in dust. The true Seq. E overlaps with the sequence of Long Secondary Periods...
(Seq. D) and their P-L relation is well described by a simple model assuming Roche geometry. The amplitudes of LSPs have properties that are different from both the pulsations and the ellipsoidal variations, but they are more similar to the former than the latter, arguing for pulsation rather than binarity as the origin of the LSP phenomenon.

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Massive Young Stellar Objects in the Large Magellanic Cloud: water masers and ESO-VLT 3–4 μm spectroscopy

J.M. Oliveira¹, J.Th. van Loon¹, S. Stanimirović² and A.A. Zijlstra³

¹School of Physical and Geographical Sciences, Lennard-Jones Laboratories, Keele University, Staffordshire ST5 5BG, UK
²Radio Astronomy Lab., University of California at Berkeley, 601 Campbell Hall, Berkeley CA 94720, USA
³Department of Physics and Astronomy, University of Manchester, Sackville, P.O. Box 88, Manchester M60 1QD, UK

We investigate the conditions of star formation in the Large Magellanic Cloud. We have conducted a survey for water maser emission arising from massive young stellar objects in the 30 Doradus region (N 157) and several other H II regions in the Large Magellanic Cloud (N 105A, N 113 and N 160A). We have identified a new maser source in 30 Dor at the systemic velocity of the LMC. We have obtained 3–4 μm spectra, with the ESO Very Large Telescope, of two candidate young stellar objects. N 105A IRS1 shows H recombination line emission and its Spectral Energy Distribution (SED) and mid-infrared colours are consistent with a massive young star ionising the molecular cloud. N 157B IRS1 is identified as an embedded young object, based on its SED and a tentative detection of water ice. The data on these four H II regions are combined with mid-infrared archival images from the Spitzer Space Telescope to study the location and nature of the embedded massive young stellar objects and signatures of stellar feedback. Our analysis of 30 Dor, N 113 and N 160A confirms the picture that the feedback from the massive O and B-type stars, which creates the H II regions, also triggers further star formation on the interfaces of the ionised gas and the surrounding molecular cloud. Although in the dense cloud N 105A star formation seems to occur without evidence of massive star feedback, the general conditions in the LMC seem favourable for sequential star formation as a result of feedback. In an appendix we present water maser observations of the galactic red giants R Doradus and W Hydrae.

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The Spitzer Survey of the Small Magellanic Cloud: S³MC Imaging and Photometry in the Mid- and Far-Infrared Wavebands

Alberto D. Bolatto¹, Joshua D. Simon², Snežana Stanimirović³, Jacco Th. van Loon³, Ronak Y. Shah³, Kim Venn⁵, Adam K. Leroy³, Karin Sandstrom¹, James M. Jackson⁴, Frank P. Israel⁶, Aigen Li⁷, Lister Staveley-Smith⁸, Caroline Bot², François Boulanger⁹ and Mónica Rubio¹⁰

¹Department of Astronomy and Radio Astronomy Laboratory, UC Berkeley, USA
²Department of Astronomy, Caltech, USA
³Astrophysics Group, Lennard Jones Laboratories, Keele University, UK
⁴Department of Astronomy and Center for Astrophysical Research, Boston University, USA
⁵Department of Astronomy, University of Victoria, Canada
⁶Leiden Observatory, Leiden, The Netherlands
⁷Department of Physics and Astronomy, University of Missouri-Columbia, USA
⁸Australia Telescope National Facility, Australia
⁹Institut d’Astrophysique Spatiale, Université Paris-Sud, France
¹⁰Departamento de Astronomía, Universidad de Chile, Chile

We present the initial results from the Spitzer Survey of the Small Magellanic Cloud (S³MC), which imaged the star-forming body of the Small Magellanic Cloud (SMC) in all seven MIPS and IRAC wavebands. We find that the F⁸/F₂₄
ratio (an estimate of PAH abundance) has large spatial variations and takes a wide range of values that are unrelated to metallicity but anticorrelated with 24 μm brightness and $F_{24}/F_{70}$ ratio. This suggests that photodestruction is primarily responsible for the low abundance of PAHs observed in star-forming low-metallicity galaxies. We use the S3MC images to compile a photometric catalog of ~ 400,000 mid- and far-infrared point sources in the SMC. The sources detected at the longest wavelengths fall into four main categories: 1) bright 5.8 μm sources with very faint optical counterparts and very red mid-infrared colors ($[5.8] - [8.0] > 1.2$), which we identify as YSOs. 2) Bright mid-infrared sources with mildly red colors ($0.16 < [5.8] - [8.0] < 0.6$), identified as carbon stars. 3) Bright mid-infrared sources with neutral colors and bright optical counterparts, corresponding to oxygen-rich evolved stars. And, 4) unreddened early B stars (B3 to O9) with a large 24 μm excess. This excess is reminiscent of debris disks, and is detected in only a small fraction of these stars (≤5%). The majority of the brightest infrared point sources in the SMC fall into groups one to three. We use this photometric information to produce a catalog of 282 bright YSOs in the SMC with a very low level of contamination (~7%).

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**Shock processing of interstellar dust and polycyclic aromatic hydrocarbons in the supernova remnant N132D**

A. Tappe¹, J. Rho¹ and W.T. Reach¹

¹Spitzer Science Center, California Institute of Technology, USA

We observed the oxygen-rich Large Magellanic Cloud (LMC) supernova remnant N132D (SNR 0525–69.6), using all instruments onboard the Spitzer Space Telescope, IRS, IRAC, and MIPS (Infrared Spectrograph, Infrared Array Camera, Multiband Imaging Photometer for Spitzer). The 5-40 μm IRS spectra toward the southeastern shell of the remnant show a steeply rising continuum with [NeIII] and [OIV] as well as PAH emission. We also present the spectrum of a fast moving ejecta knot, previously detected at optical wavelengths, which is dominated by strong [NeIII] and [OIV] emission lines. We interpret the continuum as thermal emission from swept-up, shock-heated dust grains in the expanding shell of N132D, which is clearly visible in the MIPS 24 μm image. A 15-20 μm emission hump appears superposed on the dust continuum, and we attribute this to PAH C-C-C bending modes. We also detect the well-known 11.3 μm PAH C-H bending feature, and find the integrated strength of the 15-20 μm hump about a factor of seven stronger than the 11.3 μm band in the shell of the remnant. IRAC 3-9 μm images do not show clear evidence of large-scale, shell-like emission from the remnant, partly due to confusion with the ambient ISM material. However, we identified several knots of shocked interstellar gas based on their distinct infrared colors. We discuss the bright infrared continuum and the polycyclic aromatic hydrocarbon features with respect to dust processing in young supernova remnants.

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**Is there a problem with low energy SN1987A neutrinos?**

M.L. Costantini¹,², A. Ianni³, G. Pagliaroli¹,² and F. Vissani³

¹INFN, Lab. Naz. Gran Sasso, Italy
²University of L’Aquila, L’Aquila, Italy

The observation of several low energy events during the SN1987A burst made by Kamiokande-II is somewhat embarrassing when compared with the theoretical expectations and with the observations of IMB, and has a certain weight in the attempts to use these data to learn on the properties of the supernova neutrinos.
We show however that the distributions in space and in energy suggest the presence of a few events due to background, and this makes the comparison with theory and with IMB less problematic. More specifically, we note that: (1) in the period of time between the first and the last candidate events, 2.3 background events are expected on average; (2) 5 candidate events are in the outermost 4 percent volume of the detector; (3) the theoretical energy distribution suggests that some events are not due to supernova neutrinos, when we assume conventional values for the energy emitted in the collapse $2.4 \times 10^{53}$ erg and for electron antineutrinos energy–14 MeV–as described in Phys. Rev. D 70 (2004) 043006. Assuming that 3 – 4 events (out of 12) are due to background, the observed and expected visible energy agree within one standard deviation.

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The Spitzer-IRS spectrum of SMP LMC 11
J. Bernard-Salas, E. Peeters, G.C. Sloan, J. Cami, S. Guiles and J.R. Houck

1Cornell University, USA
2SETI Institute, USA

We present the first mid-infrared spectra of SMP LMC 11 in the Large Magellanic Cloud. While this object resembles a planetary nebula in the optical, its infrared properties are more similar to an object in transition from the asymptotic giant branch to the planetary nebula phase. A warm dust continuum dominates the infrared spectrum. The peak emission corresponds to a mean dust temperature of 330 K. The spectrum shows overlapping molecular absorption bands from 12 to 17 μm corresponding to acetylene and polycyclicenic chains and benzene. This is the first detection of C₄H₂, C₆H₂, C₆H₆ and other molecules in an extragalactic object. The infrared spectrum of SMP LMC 11 is similar in many ways to that of the pre-planetary nebula AFGL 618. The IRS spectrum shows little evidence of nitrogen-based molecules which are commonly seen in Galactic AGB stars. Polycyclic aromatic hydrocarbons are also absent from the spectrum. The detection of the [Ne II] 12.8 μm line in the infrared and other forbidden emission lines in the optical indicates that an ionized region is present.

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Past and present star formation in the SMC: NGC 346 and its neighborhood

1Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD, USA
2ESA, Space Telescope Operations Division
3INAF-Osservatorio Astronomico di Bologna, Italy
4University of Wisconsin, USA
5University of Michigan, USA
6University of New Mexico State, USA
7MPIA, Germany
8University College London, UK

In the quest of understanding how star formation occurs and propagates in the low metallicity environment of the Small Magellanic Cloud (SMC), we acquired deep F555W (~V), and F814W (~I) HST/ACS images of the young and massive star forming region NGC 346. These images and their photometric analysis provide us with a snapshot of the star formation history of the region. We find evidence for star formation extending from ~10 Gyr in the
past until \( \sim 150 \) Myr in the field of the SMC. The youngest stellar population (\( \sim 3 \pm 1 \) Myr) is associated with the NGC 346 cluster. It includes a rich component of low mass pre-main sequence stars mainly concentrated in a number of sub-clusters, spatially co-located with CO clumps previously detected by Rubio et al. (2000). Within our analysis uncertainties, these sub-clusters appear coeval with each other. The most massive stars appear concentrated in the central sub-clusters, indicating possible mass segregation. A number of embedded clusters are also observed. This finding, combined with the overall wealth of dust and gas, could imply that star formation is still active. An intermediate age star cluster, BS90, formed \( \sim 4.3 \pm 0.1 \) Gyr ago, is also present in the region. Thus, this region of the SMC has supported star formation with varying levels of intensity over much of the cosmic time.

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**XMM-Newton observations of SN1987A**

_F. Haberl¹, U. Geppert¹, B. Aschenbach¹ and G. Hasinger¹_

¹MPE, Garching bei München, Germany

We report on XMM-Newton observations of SN1987A in the Large Magellanic Cloud. The large collecting area telescopes together with the European Photon Imaging Cameras (EPIC) provide X-ray spectra with unprecedented statistical quality and make it possible to investigate the spectral evolution during the brightening observed since the discovery in X-rays. High resolution spectra from the Reflection Grating Spectrometers yield a complementary view and allow us to perform more detailed investigations of prominent emission lines. The X-ray spectra were modeled with two-temperature emission components from a hot plasma in collisional ionization equilibrium and in non-equilibrium (NEI). We find a temperature for the equilibrium component of 0.24 \( \pm 0.02 \) keV in January 2000 and April 2001 which increased to 0.30 \( \pm 0.02 \) keV in May 2003 and also an indication for a temperature increase in the hot NEI component from \( \sim 2 \) keV to \( \sim 3 \) keV. Emission line ratios inferred from the RGS spectra suggest temperatures as low as 100 eV and an increase in the ionization state of oxygen and neon consistent with the observed temperature increases. The fast readout of the EPIC-pn instrument yields X-ray fluxes free of CCD pile-up effects which we used to normalize pile-up corrections for the published Chandra fluxes. The corrected X-ray light curve of SN1987A in the 0.5-2.0 keV energy band is best represented by a linear increase up to about day 4000 after the explosion and an exponential rise afterwards until the last published Chandra observation on day 6716. Modeling the light curve by emission from the inner ring which is approximated by a circular torus a central density \( n_H = 1.15 \times 10^4 \text{ cm}^{-3} \) is found. In this model the forward shock has just passed the center of the torus. SN1987A continues to brighten exponentially in soft X-rays. The X-ray spectra can be represented by pure thermal emission without significant contribution from a compact object yet.

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**Properties of RR Lyrae stars in the inner regions of the Large Magellanic Cloud. II. The extended sample.**

_J. Borissova¹, D. Minniti², M. Rejkuba³ and D. Alves⁴_

¹Universidad de Valparaíso, Chile
²Pontificia Universidad Católica, Chile
³European Southern Observatory, Germany
⁴3549 Lynne Way, Sacramento, USA

All galaxies that have been adequately examined so far have shown an extended stellar halo. To search for such a halo
in the LMC we have obtained low-resolution spectra for 100 LMC RR Lyrae stars, of which 87 are in the field and 13 in the clusters NGC1835 and NGC2019. We measured radial velocities for 87 LMC RR Lyrae stars, and metallicities for 78 RR Lyrae stars, nearly tripling the previous sample. These targets are located in 10 fields covering a wide range of distances, out to 2.5 degrees from the center of the LMC. Our main result is that the mean velocity dispersion for the LMC RR Lyrae stars is $\sigma_{RV} = 50 \pm 2 \text{ km/s}$. This quantity does not appear to vary with distance from the LMC center. The metallicity shows a Gaussian distribution, with mean $[\text{Fe/H}] = -1.53 \pm 0.02 \text{ dex}$, and dispersion $\sigma_{[\text{Fe/H}]} = 0.20 \pm 0.02 \text{ dex}$ in the Harris metallicity scale, confirming that they represent a very homogeneous metal-poor population. There is no dependence between the kinematics and metallicity of the field RR Lyrae star population. Using good quality low-resolution spectra from FORS1, FORS2 and GEMINI-GMOS we have found that field RR Lyrae stars in the LMC show a large velocity dispersion and that this indicate the presence of old and metal-poor stellar halo. All the evidence so far for the halo, however, is from the spectroscopy of the inner LMC regions, similar to the inner flattened halo in our Galaxy. Further study is necessary to confirm this important result.

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The VLT-FLAMES survey of massive stars: Surface chemical compositions of B-type stars in the Magellanic Clouds
I. Hunter$^1$, P.L. Dufton$^1$, S.J. Smartt$^1$, R.S.I. Ryans$^1$, C.J. Evans$^2$, D.J. Lennon$^{3,4}$, C. Trundle$^{1,4}$, I. Hubeny$^5$ and T. Lanz$^6$

$^1$Department of Physics and Astronomy, The Queen’s University of Belfast, BT7 1NN, Northern Ireland, UK
$^2$UK Astronomy Technology Centre, Royal Observatory, Blackford Hill, Edinburgh, EH9 3HJ, Scotland, UK
$^3$The Isaac Newton Group of Telescopes, Apartado de Correos 321, E-38700, Santa Cruz de La Palma, Canary Islands, Spain
$^4$Instituto de Astrofísica de Canarias, 38200 La Laguna, Tenerife, Spain
$^5$Steward Observatory, University of Arizona, Tucson, AZ 85712, USA
$^6$Department of Astronomy, University of Maryland, College Park, MD 20742, USA

We present an analysis of high-resolution FLAMES spectra of approximately 50 early B-type stars in three young clusters at different metallicities, NGC6611 in the Galaxy, N11 in the Large Magellanic Cloud (LMC) and NGC346 in the Small Magellanic Cloud (SMC). Using the TLUSTY non-LTE model atmospheres code, atmospheric parameters and photospheric abundances (C, N, O, Mg and Si) of each star have been determined. These results represent a significant improvement on the number of Magellanic Cloud B-type stars with detailed and homogeneous estimates of their atmospheric parameters and chemical compositions. The relationships between effective temperature and spectral type are discussed for all three metallicity regimes, with the effective temperature for a given spectral type increasing as one moves to a lower metallicity regime. Additionally the difficulties in estimating the microturbulent velocity and the anomalous values obtained, particularly in the lowest metallicity regime, are discussed. Our chemical composition estimates are compared with previous studies, both stellar and interstellar with, in general, encouraging agreement being found. Abundances in the Magellanic Clouds relative to the Galaxy are discussed and we also present our best estimates of the base-line chemical composition of the LMC and SMC as derived from B-type stars. Additionally we discuss the use of nitrogen as a probe of the evolutionary history of stars, investigating the roles of rotational mixing, mass-loss, blue loops and binarity on the observed nitrogen abundances and making comparisons with stellar evolutionary models where possible.

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The TP-AGB phase. Lifetimes from C and M star counts in Magellanic Cloud clusters

Léo Girardi\(^1\) and Paola Marigo\(^2\)

\(^1\)Oss.Ast.Padova-INAF, Italy
\(^2\)Dip.Astron.Padova, Italy

Using available data for C and M giants with \(M_{\text{bol}} < -3.6\) in Magellanic Cloud clusters, we derive limits to the lifetimes of the corresponding evolutionary phases, as a function of stellar mass. The C-star phase is found to have a duration between 2 and 3 Myr for stars in the mass range from 1.5 to 2.8 \(M_\odot\). There is also an indication that the peak of C-star lifetime shifts to lower masses (from slightly above to slightly below 2 \(M_\odot\)) as we move from LMC to SMC metallicities. The M-giant lifetimes also peak at 2 \(M_\odot\) in the LMC, with a maximum value of about 4 Myr, whereas in the SMC their lifetimes appear much shorter but, actually, they are poorly constrained by the data. These numbers constitute useful constraints to theoretical models of the TP-AGB phase. We show that several models in the literature underestimate the duration of the C-star phase at LMC metallicities.

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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. Martayan\(^1\), Y. Frémat\(^2\), A.-M. Hubert\(^1\), M. Floquet\(^1\), J. Zorec\(^3\) and C. Neiner\(^1\)

\(^1\)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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Influence of the frictional heating on the wind line-profiles of SMC stars

Jiří Krtička¹, Daniela Korčáková² and Jiří Kubát²

¹Ústav teoretické fyziky a astrofyziky, Přírodovědecká fakulta Masarykovy univerzity, Kotlářská 2, CZ-611 37 Brno, Czech Republic
²Astronomický ústav, Akademie věd České republiky, CZ-251 65 Ondřejov, Czech Republic

We study the influence of the frictional heating on the wind line-profiles of SMC stars. For this purpose we use our NLTE wind code to obtain consistent occupation numbers of studied levels and our radiative transfer code to solve the radiative transfer equation in moving media. We compare predicted wind line profiles calculated with and without frictional heating for a low-luminosity SMC star with a weak wind and discuss the relevance of frictional heating as a solution of a "weak-wind problem" for this star.

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Triggered star formation in the Magellanic Clouds

Kenji Bekki¹

¹University of New South Wales, Australia

We discuss how tidal interaction between the Large Magellanic Cloud (LMC), the Small Magellanic Cloud (SMC), and the Galaxy triggers galaxy-wide star formation in the Clouds for the last 0.2 Gyr based on our chemodynamical simulations on the Clouds. Our simulations demonstrate that the tidal interaction induces the formation of asymmetric spiral arms with high gas densities and consequently triggers star formation within the arms in the LMC. Star formation rate in the present LMC is significantly enhanced just above the eastern edge of the LMC’s stellar bar owing to the tidal interaction. The location of the enhanced star formation is very similar to the observed location of 30 Doradus, which suggests that the formation of 30 Doradus is closely associated with the last Magellanic collision about 0.2 Gyr ago. The tidal interaction can dramatically compress gas initially within the outer part of the SMC so that new stars can be formed from the gas to become intergalactic young stars in the inter-Cloud region (e.g., the Magellanic Bridge). The metallicity distribution function of the newly formed stars in the Magellanic Bridge has a peak of [Fe/H] ~ −0.8, which is significantly lower than the stellar metallicity of the SMC.

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Effects of metallicity, star formation conditions and evolution of B & Be stars

Christophe Martayan¹, Anne-Marie Hubert¹, Michele Floquet¹, Coralie Neiner¹, Yves Frémat² and Jean Zorec³

¹Observatoire de Paris-Meudon, GEPI, France
²Royal Observatory of Belgium, Belgium
³Institut d’Astrophysique de Paris, France

To study the effects of metallicity and evolution on the appearance of the Be phenomenon in the B stars population, we
observed several fields in the Large and Small Magellanic Clouds (LMC and SMC, respectively) which have different metallicities. Thanks to the FLAMES-GIRAFFE multi-fibres spectrograph on the VLT-UT2, we obtained spectra of 520 stars in the LMC-NGC2004 and SMC-NGC330 regions. We used 2 settings at medium resolution: R=8600 for the red setting which contains H\textsubscript{$\gamma$}, H\textsubscript{$\delta$}, He\textsubscript{i} 4026, 4388, 4471 Å. The latter setting was used to obtain fundamental parameters of the stars by fitting the observed spectrum with theoretical spectra. We used TLUSTY (Hubeny & Lanz 1995) to compute a grid of model atmospheres with abundance adopted from Korn et al. (2002) for the LMC and from Jasniwicz & Thévenin (1994) for the SMC. Thanks to the GIRFIT code (Frémat et al. 2005a), we obtained the fundamental parameters $T_{\text{eff}}$, log $g$, $v\sin i$ and radial velocity (RV) for each star of the samples. We took into account the effects of fast rotation (stellar flattening and gravitational darkening) for Be stars to correct their apparent fundamental parameters. Then we compared the rotational velocities between fields and clusters in the SMC and in the LMC respectively, between the LMC and the SMC, and between the MC and the Milky Way (MW). The results show an increase in $v\sin i$ with decreasing metallicity in B and Be stars populations. The evolutionary status and ages of Be stars were also investigated.

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**Short term variability in Be stars and binaries in the Magellanic Clouds**

*Christophe Martayan\textsuperscript{1}, Michele Floquet\textsuperscript{1}, Anne-Marie Hubert\textsuperscript{1} and Malek Mekkas\textsuperscript{1}*

\textsuperscript{1}Observatoire de Paris-Meudon, GEPI, France

We observed a large sample of B & Be stars in the Magellanic Clouds, respectively 176 and 344 stars, with the multi-object spectrograph GIRAFFE at ESO/VLT. We obtained spectra at different settings at various epochs. It allowed us to discover several spectroscopic binaries with short and intermediate periods. By cross-correlation in coordinates with the MACHO database, we found the light-curves for 350 stars in our samples. Among them, 19 (14 new) are photometric binaries (5 in the LMC, 14 in the SMC). Among these 19 photometric binaries 6 are also spectroscopic binaries (5 in the LMC, 1 in the SMC) and 2 others are Be stars (2 in the SMC). For all these binaries the orbital period was determined. Among our sample, 134 Be stars were observed by MACHO and, for these stars, we searched for short-term photometric variability. We have found 13 objects among Be stars in the SMC which present short-term photometric variability (P<2.5d) with amplitude lower than 0.1 magnitude. This short-term variability is often superimposed to a long-term variation.

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**Asymptotic giant branch evolution and its impact on the chemical evolution of the Milky Way and the Magellanic Clouds**

*Letizia Stanghellini\textsuperscript{1}*

\textsuperscript{1}NOAO, USA

The asymptotic giant branch (AGB) phase of stellar evolution is common to most stars of low and intermediate mass. Most of the carbon and nitrogen in the Universe is produced by AGB stars. The final fate of the AGB envelopes are represented by planetary nebulae (PN). By studying PN abundances and compare them with the yields of stellar evolution is possible to quantify carbon and nitrogen production, and to study cosmic recycling in galactic and Magellanic Cloud populations. In this paper we present the latest results in PN chemical abundance analysis.
and their implication to the chemical evolution of the galaxy and the Magellanic Clouds, with particular attention to carbon abundance, available only thanks to ultraviolet spectroscopy.

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Be stars in open clusters in the Small Magellanic Cloud

C. Martayan¹,², D. Baade¹, A.-M. Hubert², M. Floquet², J. Fabregat³, E. Bertin⁴ and C. Neiner²

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

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 Hα. 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 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.

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The Conditions for Star Formation at Low Metallicity: Results from the LMC

J.M. Oliveira¹, J.Th. van Loon¹ and S. Stanimirović²

¹Astrophysics Group, Keele University, UK
²Radio Astronomy Lab, UC Berkeley, USA

We present our recent work on the conditions under which star formation occurs in a metal-poor environment, the Large Magellanic Cloud ([Fe/H] ~ −0.4). Water masers are used as beacons of the current star formation in H II regions. Comparing their location with the dust morphology imaged with the Spitzer Space Telescope, and additional Hα imaging and groundbased near-infrared observations, we conclude that the LMC environment seems favourable to sequential star formation triggered by massive star feedback (Oliveira et al. 2006). Good examples of this are 30 Doradus and N 113. There are also H II regions, such as N 105A, where feedback may not be responsible for the current star formation although the nature of one young stellar object (YSO) suggests that feedback may soon start making an impact. The chemistry in one YSO hints at a stronger influence from irradiation effects in a metal-poor environment where shielding by dust is suppressed (van Loon et al. 2005).

Poster contribution, published in IAU Symposium No. 237, "Triggered Star Formation in a Turbulent ISM"
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and from http://www.astro.keele.ac.uk/~jacco/papers/proc.ps (proceedings paper)
Effects of metallicity, star-formation conditions, and evolution on the B and Be stars populations in the Magellanic Clouds

Christophe Martayan\textsuperscript{1,2}

\textsuperscript{1}Observatoire de Paris-Meudon, GEPI, France
\textsuperscript{2}Université Paris XI Orsay, France

If in the Milky Way, the B & Be star populations are relatively well known, this is not the same case in the Magellanic Clouds. The Large and Small Magellanic Clouds are galaxies, satellites of our proper Galaxy and they are known for having a low metallicity. In order to study the effects of metal under abundances in the hot stars, we have observed large samples of stars in the Magellanic Clouds with the multifiber spectrograph GIRAFFE at the VLT. In this thesis, we present the creation of astrometric and photometric catalogues and the process of B & Be stars selection. Then, we present the fundamental parameters determination and we examine the consequences of the metallicity on the rotational velocities. For the first time, we show the ZAMS rotational velocities distributions of Be stars and their implications on their behaviour. Afterwards, we compare the evolutionary status of Be stars in the Magellanic Clouds with the Milky Way and we give answers to understand the differences seen. Finally, we give an estimate of the surface carbon abundances and we show differences between the fast rotators like the Be stars and the slow rotators like B stars. In the second part of this manuscript, we expose some complementary studies like: the mapping of emission line objects in the Magellanic clouds with the ESO WFI in spectrographic mode; the study of hot stars in young open clusters of the Milky Way. The discovery of short-term photometric variability in Be stars and binaries in the Magellanic clouds and a study of nebular lines are also shown in this latter part.

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