Dear Colleagues,

It is our pleasure to present the 89th issue of the Magellanic Clouds Newsletter. Kudos to all authors for the very interesting articles, both in refereed journals as well as conference proceedings; in this issue there is an unusually large number of articles on X-ray sources, and Planetary Nebulae and the properties of the interstellar medium are also very well represented. We wish to draw particular attention to the 20cm continuum survey of the LMC (Hughes et al.), and look forward to all the discoveries that will follow from it.

If you know of any good candidates for postgraduate study, then John Lattanzio would be grateful if you send them his way, to Monash University where the Magellanic Clouds rise high in the sky.

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
The Spitzer Survey of the Small Magellanic Cloud: Discovery of Embedded Protostars in the H\textsc{ii} Region NGC 346

Joshua D. Simon\textsuperscript{1}, Alberto D. Bolatto\textsuperscript{2}, Barbara A. Whitney\textsuperscript{3}, Thomas P. Robitaille\textsuperscript{4}, Ronak Y. Shah\textsuperscript{5}, David Makovoz\textsuperscript{6}, Snežana Stanimirović\textsuperscript{7}, Rodolfo H. Barba\textsuperscript{8} and Mónica Rubio\textsuperscript{9}

\textsuperscript{1}Caltech, USA
\textsuperscript{2}UC Berkeley, USA
\textsuperscript{3}Space Science Institute, USA
\textsuperscript{4}SUPA, St. Andrews, UK
\textsuperscript{5}Boston University, USA
\textsuperscript{6}Spitzer Science Center, USA
\textsuperscript{7}Wisconsin, USA
\textsuperscript{8}Universidad de La Serena, Chile
\textsuperscript{9}Universidad de Chile, Chile

We use Spitzer Space Telescope observations from the Spitzer Survey of the Small Magellanic Cloud (S\textsuperscript{3}MC) to study the young stellar content of N66, the largest and brightest H\textsc{ii} region in the SMC. In addition to large numbers of normal stars, we detect a significant population of bright, red infrared sources that we identify as likely to be young stellar objects (YSOs). We use spectral energy distribution (SED) fits to classify objects as ordinary (main sequence or red giant) stars, asymptotic giant branch stars, background galaxies, and YSOs. This represents the first large-scale attempt at blind source classification based on Spitzer SEDs in another galaxy. We firmly identify at least 61 YSOs, with another 50 probable YSOs; only one embedded protostar in the SMC was reported in the literature prior to the S\textsuperscript{3}MC. We present color selection criteria that can be used to identify a relatively clean sample of YSOs with IRAC photometry. Our fitted SEDs indicate that the infrared-bright YSOs in N66 have stellar masses ranging from 2 M\textsubscript{\odot} to 17 M\textsubscript{\odot}, and that approximately half of the objects are Stage II protostars, with the remaining YSOs roughly evenly divided between Stage I and Stage III sources. We find evidence for primordial mass segregation in the H\textsc{ii} region, with the most massive YSOs being preferentially closer to the center than lower-mass objects. Despite the low metallicity and dust content of the SMC, the observable properties of the YSOs appear consistent with those in the Milky Way. Although the YSOs are heavily concentrated within the optically bright central region of N66, there is ongoing star formation throughout the complex and we place a lower limit on the star formation rate of $3.2 \times 10^{-3}$ M\textsubscript{\odot} yr\textsuperscript{-1} over the last $\sim 1$ Myr.

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The intermediate-age globular cluster NGC 1783 in the Large Magellanic Cloud

A. Mucciarelli\textsuperscript{1}, L. Origlia\textsuperscript{2} and F. R. Ferraro\textsuperscript{1}

\textsuperscript{1}Dipartimento di Astronomia, Bologna, Italy
\textsuperscript{2}INAF - Osservatorio Astronomico di Bologna, Italy

We present Hubble Space Telescope ACS deep photometry of the intermediate-age globular cluster NGC 1783 in the Large Magellanic Cloud. By using this photometric dataset, we have determined the degree of ellipticity of the cluster ($\epsilon = 0.14 \pm 0.03$) and the radial density profile. This profile is well reproduced by a standard King model with an extended core ($r_c = 24.5''$) and a low concentration ($\epsilon = 1.16$), indicating that the cluster has not experienced the collapse of the core.

We also derived the cluster age, by using the Pisa Evolutionary Library (PEL) isochrones, with three different amount
of overshooting (namely, $\Delta_{\text{os}}=0.0$, 0.10 and 0.25). From the comparison of the observed Color-Magnitude Diagram (CMD) and Main Sequence (MS) Luminosity Function (LF) with the theoretical isochrones and LFs, we find that only models with the inclusion of some overshooting ($\Delta_{\text{os}}=0.10-0.25$) are able to reproduce the observables. By using the magnitude difference $\delta V_{\text{SGB}}^{\text{He}-\text{Cl}}=0.90$ between the mean level of the He-clump and the flat region of the SGB, we derive an age $\tau=1.4 \pm 0.2$ Gyr.

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Hysteresis of spectral evolution in the soft state of black-hole binary LMC X-3

David M. Smith¹, David M. Dawson¹ and Jean H. Swank²

¹Department of Physics and Santa Cruz Institute for Particle Physics, University of California, Santa Cruz, USA
²NASA’s Goddard Space Flight Center, USA

We report the discovery of hysteresis between the x-ray spectrum and luminosity of black-hole binary LMC X-3. Our observations, with the Proportional Counter Array on the Rossi X-ray Timing Explorer, took place entirely within the soft spectral state, dominated by a spectral component that was fitted well with a multicolor disk blackbody. A power-law component was seen only during times when the luminosity of the disk blackbody was declining. The x-ray luminosity at these times was comparable to that seen in transient systems (x-ray novae) when they return to the hard state at the end of an outburst. Our observations may represent partial transitions to the hard state; complete transitions have been seen in this system by Wilms et al. (2001). If they are related to the soft-to-hard transition in transients, then they demonstrate that hysteresis effects can appear without a full state transition. We discuss these observations in the context of earlier observations of hysteresis within the hard state of binaries 1E 1740.7−2942 and GRS 1758−258 and in relation to published explanations of hysteresis in transients.

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The Role of Evolutionary Age and Metallicity in the Formation of Classical Be Circumstellar Disks II. Assessing the Evolutionary Nature of Candidate Disk Systems

John P. Wisniewski¹, Karen S. Bjorkman², Antonio M. Magalhães³, Jon E. Bjorkman², Marilyn R. Meade¹ and Antonio Pereyra³

¹NASA GSFC, USA
²University of Toledo, USA
³University of São Paulo, Brazil
⁴University of Wisconsin, USA

We present the first detailed imaging polarization observations of six SMC and six LMC clusters, known to have large populations of B-type stars which exhibit excess Hα emission, to constrain the evolutionary status of these stars and hence better establish links between the onset of disk formation in classical Be stars and cluster age and/or metallicity. We parameterize the interstellar polarization (ISP) along the lines of sight to these twelve clusters, thereby providing a diagnostic of the fundamental properties of the dust which characterizes their localized interstellar medium. We determine that the ISP associated with the SMC cluster NGC 330 is characterized by a modified Serkowski law with $\lambda_{\text{max}} \sim 4500$ Å, indicating the presence of smaller than average dust grains. Furthermore, the morphology of the ISP associated with the LMC cluster NGC 2100 suggests that its interstellar environment is characterized by a complex magnetic field.

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Removing this interstellar polarization component from our data isolates the presence of any intrinsic polarization; the wavelength dependence of this intrinsic polarization provides a diagnostic of the dominant and any secondary polarigenic agents present, enabling us to discriminate pure gas disk systems, i.e. classical Be stars, from composite gas plus dust disk systems, i.e. Herbig Ae/Be or B[e] stars. Our intrinsic polarization results, along with available near-IR color information, strongly supports the suggestion of Wisniewski et al. that classical Be stars are present in clusters of age 5-8 Myr, and contradict assertions that the Be phenomenon only develops in the second half of a B star’s main sequence lifetime, i.e. no earlier than 10 Myr. Our data imply that a significant number of B-type stars must emerge onto the zero-age-main-sequence rotating at near-critical rotation rates, although we can not rule out the possibility that these data instead reveal the presence of a sub-group of the Be phenomenon characterized by sub-critically rotating objects.

Comparing the polarimetric properties of our dataset to a similar survey of Galactic classical Be stars, we find that the prevalence of polarimetric Balmer jump signatures decreases with metallicity. We speculate that these results might indicate that either it is more difficult to form large disk systems in low metallicity environments, or that the average disk temperature is higher in these low metallicity environments. We have characterized the polarimetric signatures of all candidate Be stars in our data sample and find ~25% are unlikely to arise from true classical Be star-disk systems. This detection of such a substantial number “contaminants” suggests one should proceed with caution when attempting to determine the role of evolutionary age and/or metallicity in the Be phenomenon purely via 2-CD results.

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**Discovery of a New Dusty B[e] Star in the Small Magellanic Cloud**

*John P. Wisniewski¹, Karen S. Bjorkman², Jon E. Bjorkman² and Mark Clampin¹*

¹NASA GSFC, USA
²University of Toledo, USA

We present new optical spectroscopic and archival Spitzer IRAC photometric observations of a B-type star in the SMC cluster NGC 346, NGC 346:KWBBe 200. We detect numerous Fe II, [O I], and [Fe II] lines, as well as strong P-Cygni profile H I emission lines in its optical spectrum. The star’s near-IR color and optical to IR SED clearly indicate the presence of an infrared excess, consistent with the presence of gas and warm, T ∼800 K, circumstellar dust. Based on a crude estimate of the star’s luminosity and the observed spectroscopic line profile morphologies, we find that the star is likely to be a B-type supergiant. We suggest that NGC 346:KWBBe 200 is a newly discovered B[e] supergiant star, and represents the fifth such object to be identified in the SMC.

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**CAL 87 - an evolved wind-driven supersoft X-ray binary**

*A. S. Oliveira¹,² and J. E. Steiner³*

¹IP&D, Univap, Brazil
²SOAR Telescope, Chile
³IAG-USP, Brazil

Compact binary supersoft X-ray sources (CBSS) are explained as being associated with hydrostatic nuclear burning on the surface of a white dwarf with high accretion rate. This high mass transfer rate has been suggested to be caused by dynamical instability, expected when the donor star is more massive than the accreting object. When the orbital period is smaller than ~6 hours, this mechanism does not work and the CBSS with such periods are believed to be fed by a distinct mechanism: the wind-driven accretion. Such a mechanism has been proposed to explain the properties
of objects like SMC13, TPyx and V617Sgr. One observational property that offers a critical test for discriminating between the above two possibilities is the orbital period change. As systems with wind-driven accretion evolve with increasing periods, some of them may reach quite long orbital periods. The above critical test may, therefore, also be applied to orbital periods longer than 6 hours. CAL87 is an eclipsing system in the LMC with an orbital period of 10.6 hours that could provide the opportunity for testing the hypothesis of the system being powered by wind-driven accretion. We obtained eclipse timings for this system and show that its orbital period increases with a rate of \( \dot{P} = +7.2(\pm 1.3) \times 10^{-8} \) years. Contrary to the common belief, we conclude that CAL87 is the first confirmed case of a wind-driven CBSS with an orbital period longer than 6 hours. The system is probably an evolved object that had an initial secondary mass of \( M_2 = 0.63 \, M_\odot \) but is currently reduced to about \( M_2 = 0.34 \, M_\odot \). We discuss evidence that other CBSS, like CAL83 and V Sge stars, like WX Cen, are probably also wind-driven systems. This may in fact be the rule, and systems with inverted mass ratio, the exception.

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Spectacular Trailing Streamers near LMC X-1: The First Evidence of a Jet?

Ryan Cooke\(^1\), Zdenka Kuncic\(^1\), Rob Sharp\(^2\) and Joss Bland-Hawthorn\(^2\)

\(^1\)University of Sydney, Australia
\(^2\)Anglo-Australian Observatory, Australia

We report VIMOS integral field spectroscopy of the N159F nebula surrounding LMCX-1. Our observations reveal a rich, extended system of emission line filaments lining the boundary of a large conical cavity identified in Spitzer mid-IR imaging. We find that X-ray photoionization cannot be solely responsible for the observed ionization structure of N159F. We propose that the extended filamentary emission is produced primarily by ionization from a shock driven by a presently unobserved jet from LMCX-1. We infer a shock velocity of \( v_s \sim 90 \, \text{km s}^{-1} \) and conclude that the jet responsible for the bow shock is presently undetected because it has switched off, rather than because it has a low surface brightness. This interpretation is consistent with the present soft X-ray spectral state of LMC X-1 and suggests the jet is intermittent.

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Supernova Remnants in the Large Magellanic Clouds IX: Multiwavelength Analysis of the Physical Structure of N49

J. Bilikova\(^1\), R. N. M. Williams\(^3\), Y.-H. Chu\(^1\), R. A. Gruendl\(^1\) and B. F. Lundgren\(^1\)

\(^1\)Astronomy Department, University of Illinois at Urbana-Champaign, 1002 W. Green St. Urbana, IL 61801, USA

We present a multiwavelength analysis of the supernova remnant N49 in the Large Magellanic Cloud. Using high-resolution Hubble Space Telescope WFPC2 images of Hα, [SII] and [OIII] emission, we study the morphology of the remnant and calculate the rms electron densities in different regions. We detect an offset of [OIII] and Hα emission peaks of about 0.5″, and discuss possible scenarios that could give rise to such high values. The kinematics of the remnant is analyzed by matching individual kinematic features in the echelle spectra obtained at CTIO with the morphological features revealed in the WFPC2 images. We detect narrow Hα emission component and identify it as the diffuse pre-shock recombination radiation, and discrete broad emission features that correspond to the shocked gas in filaments. The overall expansion of the remnant is \( \sim 250 \, \text{km s}^{-1} \). The dense clouds are shocked up to line-of-sight velocities of 250 km s\(^{-1}\) and the less dense gas up to 300 km s\(^{-1}\). A few cloudlets have even higher radial velocities, reaching up to 350 km s\(^{-1}\). We confirm the presence of the cavity in the remnant, and identify the center of explosion.
Using archival Chandra and XMM-Newton data, we observe the same trends in surface brightness distribution for the optical and X-ray images. We carry out the spectral analysis of three regions that represent the most significant optical features.

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**Progressive star formation in the young SMC cluster NGC 602**

*Lynn Redding Carlson¹, E. Sabbì², M. Sirianni²,³, J. L. Hora⁴, A. Nota²,³, M. Meixner², J. S. Gallagher, III⁵, M. S. Oey⁵, A. Pasquali⁷, L. J. Smith⁸,², M. Tosi⁹ and R. Walterbos¹⁰*

¹Johns Hopkins University, USA
²Space Telescope Science Institute, USA
³Space Telescope Operation Division, ESA
⁴Harvard-Smithsonian Center for Astrophysics, USA
⁵University of Wisconsin, USA
⁶University of Michigan, USA
⁷Max Planck Institut für Astronomie, Germany
⁸University College London, UK
⁹INAF-Osservatorio di Bologna, Italy
¹⁰New Mexico State University, USA

NGC 602 is a young stellar cluster located in a peripheral region of the Small Magellanic Cloud known as the wing. Far from the main body of the galaxy and abutting the Magellanic Bridge, the SMC’s wing is characterized by low gas and stellar content. With deep optical imaging from the Advanced Camera for Surveys (ACS) aboard the Hubble Space Telescope (HST), we have discovered an extensive pre-Main Sequence (PMS) population, with stellar masses in the range 0.6 - 3 M☉. These low mass PMS stars formed coevally with the central cluster about 4 Myr ago. Spitzer Space Telescope (Spitzer) images of the same region from the Infrared Array Camera (IRAC) also reveal a population of Young Stellar Objects (YSOs), some of which are still embedded in nebular material and most of which likely formed even more recently than the young stars detected with HST/ACS imaging. We infer that star formation started in this region about 4 Myr ago with the formation of the central cluster and gradually propagated towards the outskirts where star formation is presently ongoing.

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**Spitzer Infrared Spectrograph Observations of Magellanic Cloud Planetary Nebulae: the nature of dust in low metallicity circumstellar ejecta**

*L. Stanghellini¹, P. García-Lario², D. A. García-Hernández³, J. V. Perea-Calderón⁴, J. E. Davies³, A. Manchado⁵, E. Villaver⁶ and R. A. Shaw¹*

¹NOAO, Tucson, USA
²Herschel Science Centre, European Space Astronomy Centre (ESA), Villafranca, Spain
³The W. J. Mc Donald Observatory, University of Texas at Austin, USA
⁴European Space Astronomy Centre, INSA, Villafranca, Spain
⁵IAC, La Laguna, Spain
⁶STScI and ESA, Baltimore, USA

We present 5-40 μm spectroscopy of 41 planetary nebulae (PNe) in the Magellanic Clouds, observed with the Infrared Spectrograph on board the Spitzer Space Telescope. The spectra show the presence of a combination of nebular
emission lines and solid-state features from dust, superimposed on the thermal IR continuum. By analyzing the 25 LMC and 16 SMC PNe in our sample we found that the IR spectra of 14 LMC and 4 SMC PNe are dominated by nebular emission lines, while the other spectra show solid-state features. We observed that the solid-state features are compatible with carbon-rich dust grains (SiC, polycyclic aromatic hydrocarbons (PAHs), etc.) in most cases, except in three PNe showing oxygen-rich dust features. The frequency of carbonaceous dust features is generally higher in LMC than in SMC PNe.

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Large-Scale Gravitational Instability and Star Formation in the Large Magellanic Cloud

Chao-Chin Yang1, Robert A. Gruendl1, You-Hua Chu1, Mordecai-Mark Mac Low2 and Yasuo Fukui3

1University of Illinois, Urbana, IL 61801, USA
2American Museum of Natural History, New York, NY 10024-5192, USA
3Nagoya University, Chikusa-ku, Nagoya 464-8602, Japan

Large-scale star formation in disk galaxies is hypothesized to be driven by global gravitational instability. The observed gas surface density is commonly used to compute the strength of gravitational instability, but according to this criterion star formation often appears to occur in gravitationally stable regions. One possible reason is that the stellar contribution to the instability has been neglected. We have examined the gravitational instability of the Large Magellanic Cloud (LMC) considering the gas alone, and considering the combination of collisional gas and collisionless stars. We compare the gravitationally unstable regions with the on-going star formation revealed by Spitzer observations of young stellar objects. Although only 62% of the massive young stellar object candidates are in regions where the gas alone is unstable, some 85% lie in regions unstable due to the combination of gas and stars. The combined stability analysis better describes where star formation occurs. In agreement with other observations and numerical models, a small fraction of the star formation occurs in regions with gravitational stability parameter $Q > 1$. We further measure the dependence of the star formation timescale on the strength of gravitational instability, and quantitatively compare it to the exponential dependence expected from numerical simulations.

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INTEGRAL observations of the Small Magellanic Cloud

McBride et al.1

1Southampton University, UK

The first INTEGRAL observations of the Small Magellanic Cloud (carried out in 2003) are reported in which two sources are clearly detected. The first source, SMC X-1, shows a hard X-ray eclipse and measurements of its pulse period indicate a continuation of the long-term spin-up now covering $\sim$30 years. The second source is likely to be a high mass X-ray binary, and shows a potential periodicity of 6.8s in the IBIS lightcurve. An exact X-ray or optical counterpart cannot be designated, but a number of proposed counterparts are discussed. One of these possible counterparts shows a strong coherent optical modulation at $\sim$2.7d, which, together with the measured hard X-ray pulse period, would lead to this INTEGRAL source being classified as the fourth known high mass Roche lobe overflow system.

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Infrared integral field spectroscopy of SN 1987A

Karina Kjær1, Bruno Leibundgut1, Claes Fransson2, Per Gröningson2, Jason Spyromilio1 and Markus Kissler-Patig1

1ESO, Karl-Schwarzschild-Straße 2, 85748 Garching, Germany
2Dept. of Astronomy, Stockholm University, AlbaNova, 106 91 Stockholm, Sweden

Context: SN 1987A in the Large Magellanic Cloud is close enough for a study of the very late time evolution of a supernova and its transition to a supernova remnant. Nearly two decades after explosion we are witnessing the supernova shock wave engaging the inner circumstellar ring, which had been fluorescing since being ionised by the soft X-ray flash from shock breakout.

Aims: We follow the interaction of the supernova shock with the ring material. The spatially resolved information provides us with insight into the individual shock regions around the ring.

Methods: Near-infrared integral field spectroscopy observations with SINFONI/VLT of the SN-ring interaction is presented. SINFONI’s adaptive optics supported integral field spectrograph spatially resolves the ring and the data thus we obtain a better spatial understanding of the spectrum in different regions of the object.

Results: With a dynamical map of the interacting ring we determine parameters for its geometry. Since most of the IR emission lines originate behind the shock front we obtain an indication of the radial velocity of the shocked material after deconvolving the geometry. The ring geometry is consistent with a circle and we also derive a new, independent measurement of the systemic ring, and presumably also supernova, velocity. We find from the spatial distributions of the flux in the different emission lines the degree of cooling in the shocked material and follows the increases observed in the radio and X-rays. Emission from the ejecta is detected only in the strongest $[\text{Fe}^{II}]$ lines.

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The Unusual Variability of the Large Magellanic Cloud Planetary Nebula RPJ 053059–683542

Richard A. Shaw1, Armin Rest2,3, Guillermo Damke2, R. Chris Smith2, Warren A. Reid4,5 and Quentin A. Parker4,5

1National Optical Astronomy Observatory, USA
2National Optical Astronomy Observatory/Cerro Tololo Inter-American Observatory, Chile
3Dept. of Physics, Harvard University, USA
4Dept. of Physics, Macquarie University, Australia
5Anglo-Australian Observatory, Australia

We present images and light curves of the bipolar Planetary Nebula RPJ 053059-683542 that was discovered in the Reid-Parker AAO/UKST $H_\alpha$ survey of the Large Magellanic Cloud (LMC). The emission from this object appears entirely nebular, with the central star apparently obscured by a central band of absorption that bisects the nebula. The light curves, which were derived from images from the SuperMACHO project at CTIO, showed significant, spatially resolved variability over the period 2002 January through 2005 December. Remarkably, the emission from the two bright lobes of the nebula vary either independently, or similarly but with a phase lag of at least one year. The optical spectra show a low level of nebular excitation, and only modest N enrichment. Infrared photometry from the 2MASS and SAGE surveys indicates the presence of a significant quantity of dust. The available data imply that the central star has a close binary companion, and that the system has undergone some kind of outburst event that caused the nebular emission to first brighten and then fade. Further monitoring, high-resolution imaging, and detailed IR polarimetry and spectroscopy would uncover the nature of this nebula and the unseen ionizing source.

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An ATCA 20cm Radio Continuum Study of the Large Magellanic Cloud

A. Hughes\textsuperscript{1,2}, L. Staveley-Smith\textsuperscript{3}, S. Kim\textsuperscript{4}, M. Wolleben\textsuperscript{5,6} and M. Filipović\textsuperscript{7}

\textsuperscript{1}Swinburne University of Technology, Australia
\textsuperscript{2}Australia Telescope National Facility, Australia
\textsuperscript{3}University of Western Australia, Australia
\textsuperscript{4}Sejong University, South Korea
\textsuperscript{5}University of Alberta, Canada
\textsuperscript{6}National Research Council of Canada (Herzberg Institute of Astrophysics), Canada
\textsuperscript{7}University of Western Sydney, Australia

We present a mosaic image of the 1.4GHz radio continuum emission from the Large Magellanic Cloud (LMC) observed with the Australia Telescope Compact Array (ATCA) and the Parkes Telescope. The mosaic covers $10.8 \times 12.3$ square degrees with an angular resolution of 40\arcsec, corresponding to a spatial scale of 10pc in the LMC. The final image is suitable for studying emission on all scales between 40\arcsec and the surveyed area. In this paper, we discuss i) the characteristics of the LMC’s diffuse and compact radio continuum emission, ii) the fraction of the emission produced by thermal processes and the implied star formation rate in the LMC, and iii) variations in the radio spectral index across the LMC. Two non-standard reduction techniques that we used to process the ATCA visibility data may be of interest for future wide-field radio continuum surveys. The data are open to the astronomical community and should be a rich resource for studies of individual objects such as supernova remnants, H\textsc{ii} regions and planetary nebulae, as well as extended features such as the diffuse emission from synchrotron radiation.

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Neon and Sulfur Abundances of Planetary Nebulae in the Magellanic Clouds

J. Bernard-Salas\textsuperscript{1}, S.R. Pottasch\textsuperscript{2}, S. Gutenkunst\textsuperscript{1}, P.W. Morris\textsuperscript{3} and J.R. Houck\textsuperscript{3}

\textsuperscript{1}Cornell University, USA
\textsuperscript{2}Kapteyn Astronomical Institute, the Netherlands
\textsuperscript{3}NASA Herschel Science Center, USA

The chemical abundances of neon and sulfur for 25 planetary nebulae (PNe) in the Magellanic Clouds are presented. These abundances have been derived using mainly infrared data from the Spitzer Space Telescope. The implications for the chemical evolution of these elements are discussed. A comparison with similarly obtained abundances of Galactic PNe and H\textsc{ii} regions and Magellanic Clouds H\textsc{ii} regions is also given. The average neon abundances are $6.0 \times 10^{-5}$ and $2.7 \times 10^{-5}$ for the PNe in the Large and Small Magellanic Clouds respectively. These are $\sim 1/3$ and 1/6 of the average abundances of Galactic planetary nebulae to which we compare. The average sulfur abundances for the LMC and SMC are respectively $2.7 \times 10^{-6}$ and $1.0 \times 10^{-6}$. The Ne/S ratio (23.5) is on average higher than the ratio found in Galactic PNe (16) but the range of values in both data sets is similar for most of the objects. The neon abundances found in PNe and H\textsc{ii} regions agree with each other. It is possible that a few (3-4) of the PNe in the sample have experienced some neon enrichment, but for two of these objects the high Ne/S ratio can be explained by their very low sulfur abundances. The neon and sulfur abundances derived in this paper are also compared to previously published abundances using optical data and photo-ionization models.

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Reddening law and interstellar dust properties along Magellanic sight-lines

Frédéric Zagury

1Institut Louis de Broglie, 23 rue Marsoulan, 75012 Paris, France

This study establishes that SMC, LMC and Milky Way extinction curves obey the same extinction law which depends on the 2200 Å bump size and one parameter, and generalizes the Cardelli, Clayton & Mathis (1989) relationship. This suggests that extinction in all three galaxies is of the same nature. The role of linear reddening laws over all the visible/UV wavelength range, particularly important in the SMC but also present in the LMC and in the Milky Way, is also highlighted and discussed.

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Interstellar gas, dust and diffuse bands in the SMC


1Herschel Science Centre, European Space Astronomy Centre, Research and Scientific Support Department of ESA, Villafranca del Castillo, Ap. de Correos 50727, 28080 Madrid, Spain
2Astronomical Institute, University of Amsterdam, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands
3Astrophysics Research Centre, School of Mathematics and Physics, Queen’s University Belfast, Belfast, BT7 1NN, Northern Ireland
4School of Chemistry, The University of Nottingham, University Park, Nottingham, NG7 2RD, UK
5Astrobio Group, Leiden Institute of Chemistry, Leiden University, Einsteinweg 55, 2300 RA Leiden, The Netherlands
6ESA/SCI-SR, ESTEC, PO Box 299, 2200 AG Noordwijk, The Netherlands
7Kapteyn Astronomical Institute, University of Groningen, PO Box 800, 9700 AV Groningen, The Netherlands
8SETI Institute, 515 North Whisman Road, Mountain View, CA 94043, USA
9Astronomy Department, Whitman College, Walla Walla, WA 99362, USA
10Dept. of Physics & Astronomy, Louisiana State University, Baton Rouge, LA 7080, USA
11Steward Observatory, University of Arizona, Tucson, AZ 85721, USA
12Space Science Division, NASA Ames Research Center, Mail Stop 245-6, Moffett Field, California 94035, USA

Aims. In order to gain new insight into the unidentified identity of the diffuse interstellar band (DIB) carriers, this paper describes research into possible links between the shape of the interstellar extinction curve (including the 2175 Å bump and far-UV rise), the presence or absence of DIBs, and physical and chemical conditions of the diffuse interstellar medium (gas and dust) in the Small Magellanic Cloud (SMC).

Methods: We searched for DIB absorption features in VLT/UVES spectra of early-type stars in the SMC whose reddened lines-of-sight probe the diffuse interstellar medium of the SMC. Apparent column density profiles of interstellar atomic species (Na i, K i, Ca ii and Ti ii) are constructed to provide information on the distribution and conditions of the interstellar gas.

Results: The characteristics of eight DIBs detected toward the SMC wing target AzV 456 are studied and upper limits are derived for the DI3 equivalent widths toward the SMC stars AzV 398, AzV 214, AzV 18, AzV 65 and Sk 191. The amount of reddening is derived for these SMC sightlines, and, using RV and the H i column density, converted into a gas-to-dust ratio. From the atomic column density ratios we infer an indication of the strength of the interstellar radiation field, the titanium depletion level and a relative measure of turbulence/quiescence. The presence or absence of DIBs appears to be related to the shape of the extinction curve, in particular with respect to the presence or absence of the 2175 Å feature. Our measurements indicate that the DIB characteristics depend on the local physical conditions and chemical composition of the interstellar medium of the SMC, which apparently determine the rate of formation (and/or) destruction of the DIB carriers. The UV radiation field (via photoionisation and photo-destruction) and the metallicity (i.e. carbon abundance) are important factors in determining diffuse band strengths which can differ greatly both between and within galaxies.

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Large Magellanic Cloud Distance from Cepheid Variables using Least Squares Solutions

C. Ngeow\textsuperscript{1} and S. Kanbur\textsuperscript{2}

\textsuperscript{1}UIUC, USA
\textsuperscript{2}SUNY-Oswego, USA

Distance to the Large Magellanic Cloud (LMC) is determined using the Cepheid variables in the LMC. We combine the individual LMC Cepheid distances obtained from the infrared surface brightness method and a dataset with a large number of LMC Cepheids. Using the standard least squares method, the LMC distance modulus can be found from the ZP offsets of these two samples. We have adopted both a linear P-L relation and a “broken” P-L relation in our calculations. The resulting LMC distance moduli are $18.48 \pm 0.03$ mag and $18.49 \pm 0.04$ mag (random error only), respectively, which are consistent to the adopted 18.50 mag in the literature.

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Physical Properties of Red Supergiants

Philip Massey\textsuperscript{1}, Bertrand Plez\textsuperscript{2}, Emily M. Levesque\textsuperscript{3}, K. A. G. Olsen\textsuperscript{4}, David R. Silva\textsuperscript{5} and Geoffrey C. Clayton\textsuperscript{6}

\textsuperscript{1}Lowell Observatory, USA
\textsuperscript{2}GRAAL, Université de Montpellier II, CNRS, France
\textsuperscript{3}Institute for Astronomy, University of Hawai‘i, USA
\textsuperscript{4}Gemini Science Center, NOAO, USA
\textsuperscript{5}Thirty Meter Telescope, Pasadena, USA
\textsuperscript{6}Dept of Physics and Astronomy, Louisiana State University, USA

Red supergiants (RSGs) are an evolved stage in the life of intermediate massive stars ($< 25 \, M_\odot$). For many years their location in the H-R diagram was at variance with the evolutionary models. Using the MARCS stellar atmosphere models, we have determined new effective temperatures and bolometric luminosities for RSGs in the Milky Way, LMC, and SMC, and our work has resulted in much better agreement with the evolutionary models. We have also found evidence of significant visual extinction due to circumstellar dust. Although in the Milky Way the RSGs contribute only a small fraction ($< 1\%$) of the dust to the interstellar medium (ISM), in starburst galaxies or galaxies at large look-back times, we expect that RSGs may be the main dust source. We are in the process of extending this work now to RSGs of higher and lower metallicities using the galaxies M31 and WLM.

Available from arXiv:0708.2847
and from http://www.lowell.edu/users/massey/tenmasseyp.pdf
UV Spectroscopy of Metal-Poor Massive Stars in the Small Magellanic Cloud

Daniel J. Lennon\textsuperscript{1,2}

\textsuperscript{1}Isaac Newton Group, Spain
\textsuperscript{2}Instituto de Astrofísica de Canarias, Spain

The Hubble Space Telescope has provided the first clear evidence for weaker winds of metal-poor massive stars in the Small Magellanic Cloud, confirming theoretical predictions of the metallicity dependence of mass-loss rates and wind terminal velocities. For lower luminosity O-type stars however, derived mass-loss rates are orders of magnitude lower than predicted, and are at present unexplained.

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The Coolest Stars in the Clouds: Unusual Red Supergiants in the Magellanic Clouds

Emily M. Levesque\textsuperscript{1}, Philip Massey\textsuperscript{2}, K. A. G. Olsen\textsuperscript{3} and Bertrand Plez\textsuperscript{4}

\textsuperscript{1}Institute for Astronomy, University of Hawai‘i, USA
\textsuperscript{2}Lowell Observatory, USA
\textsuperscript{3}National Optical Astronomy Observatories, USA
\textsuperscript{4}GRAAL, Université de Montpellier II, CNRS, France

Red supergiants (RSGs) are a He-burning phase in the evolution of moderately high mass stars (10-25 M\(_\odot\)). The evolution of these stars, particularly at low metallicities, is still poorly understood. The latest-type RSGs in the Magellanic Clouds are cooler than the current evolutionary tracks allow, occupying the region to the right of the Hayashi limit where stars are no longer in hydrodynamic equilibrium. We have discovered four Cloud RSGs in this region that display remarkably similar unusual behavior. All of them show considerable variations in their V magnitudes and effective temperatures (and spectral types). Two of these stars, HV 11423 and [M2002] SMC 055188, have been observed in an M4.5 I state, considerably later and cooler than any other supergiant in the SMC. These stars suffer dramatic physical changes on timescales of months — when they are at their warmest, they are also brighter, more luminous, and show an increased amount of extinction. This variable extinction is characteristic of the effects of circumstellar dust, and can be connected with sporadic dust production from these stars in their cooler states. We suggest that these unusual properties are indicative of an unstable (and short-lived) evolutionary phase not previously associated with RSGs, and consider the implications such behavior could have for our understanding of the latest stages of massive star evolution in low-metallicity environments.


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Searching for a Pulsar in SN 1987A

R.N. Manchester\textsuperscript{1}

\textsuperscript{1}Australia Telescope National Facility, CSIRO, P.O. Box 76, Epping NSW 1710, Australia

SN 1987A offered a unique opportunity to detect a pulsar at the very beginning of its life and to study its early evolution. Despite many searches at radio and optical wavelengths, no pulsar has yet been detected. Details of a
recent search using the Parkes radio telescope are given. Limits on the X-ray, optical and radio luminosity of a point source at the centre of SN 1987A place limits on the properties of a central neutron star. However, neither these nor the pulsar limits preclude the presence of a relatively slowly rotating neutron star ($P \gtrsim 100$ ms) with a moderate surface dipole magnetic field in SN 1987A. Galactic studies suggest that a significant fraction of pulsars are born with parameters in this range. In view of this, continued searches for a pulsar in SN 1987A are certainly justified.


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