Editorial

Dear Colleagues,

It is my pleasure to present you the 131st issue of the Magellanic Clouds Newsletter. Enjoy!

Want your results on the front cover of the newsletter? Just send a picture (preferably postscript format) and brief description to astro.mcnews@keele.ac.uk.

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

Editorially Yours,
Jacco van Loon
OGLE-LMC-ECL-11893: The discovery of a long-period eclipsing binary with a circumstellar disk

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We report the serendipitous discovery of a disk-eclipse system OGLE-LMC-ECL-11893. The eclipse occurs with a period of 468 days, a duration of about 15 days, and a deep (up to \(\Delta m_I \approx 1.5\)), peculiar, and asymmetric profile. A possible origin of such an eclipse profile involves a circumstellar disk. The presence of the disk is confirmed by the \(H\alpha\) line profile from the follow-up spectroscopic observations, and the star is identified as Be/Ae type. Unlike the previously known disk-eclipse candidates, the eclipses of OGLE-LMC-ECL-11893 retain the same shape throughout the span of \(\sim 17\) yr (13 orbital periods), indicating no measurable orbital precession of the disk.

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Spitzer SAGE-Spec: Near infrared spectroscopy, dust shells, and cool envelopes in extreme Large Magellanic Cloud AGB stars

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\(K\)-band spectra are presented for a sample of 39 Spitzer IRS SAGE-Spec sources in the Large Magellanic Cloud. The spectra exhibit characteristics in very good agreement with their positions in the near infrared–Spitzer color–magnitude diagrams and their properties as deduced from the Spitzer IRS spectra. Specifically, the near infrared spectra show strong atomic and molecular features representative of oxygen-rich and carbon-rich asymptotic giant branch stars, respectively. A small subset of stars were chosen from the luminous and red extreme "tip" of the color–magnitude diagram. These objects have properties consistent with dusty envelopes but also cool, carbon-rich "stellar" cores.
Modest amounts of dust mass loss combine with the stellar spectral energy distribution to make these objects appear extreme in their near infrared and mid infrared colors. One object in our sample, HV 915, a known post asymptotic giant branch star of the RV Tau type exhibits CO 2.3-µm band head emission consistent with previous work that demonstrates the object has a circumstellar disk.

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New objects with the B[e] phenomenon in the Large Magellanic Cloud

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The study is aimed at discovering new objects with the B[e] phenomenon in the Large Magellanic Cloud. We report medium-resolution optical spectroscopic observations of two newly found (ARDB 54 and NOMAD 0181−0125572) and two previously known (Hen S-59 and Hen S-137) supergiants with the B[e] phenomenon in the Large Magellanic Cloud. The observations were obtained with the GMOS spectrograph at the southern Gemini telescope. Optical spectra of ARDB 54 and NOMAD 0181−0125572 are presented for the first time as well as their fundamental parameters. We found that the Balmer line profiles of Hen S-59 and Hen S-137 were different from those observed in their spectra nearly 20 years ago. We suggest a higher effective temperature and luminosity for both objects. With the new fundamental parameters, the lowest luminosity for known supergiants with the B[e] phenomenon in the Magellanic Clouds is higher than previously thought (log \(L/L_{\odot}\) ∼ 4.5 instead of 4.0). Hen S-59 may be a binary system based on its UV excess, variable \(B-V\) colour index and radial velocity of emission lines, and periodically variable \(I\)-band brightness.

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Discovery of SXP 265, a Be/X-ray binary pulsar in the Wing of the Small Magellanic Cloud

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We identify a new candidate for a Be/X-ray binary in the XMM-Newton slew survey and archival Swift observations that is located in the transition region of the Wing of the Small Magellanic Cloud and the Magellanic Bridge. We investigated and classified this source with follow-up XMM-Newton and optical observations. We model the X-ray spectra and search for periodicities and variability in the X-ray observations and the OGLE I-band light curve. The optical counterpart has been classified spectroscopically, with data obtained at the SAAO 1.9m telescope, and photometrically, with data obtained using GROND at the MPG 2.2m telescope. The X-ray spectrum is typical of a high-mass X-ray binary with an accreting neutron star. We detect X-ray pulsations, which reveal a neutron-star spin period of \(P_s = (264.516 \pm 0.014)\) s. The source likely shows a persistent X-ray luminosity of a few \(10^{35}\) erg s\(^{-1}\) and in addition type-I outbursts that indicate an orbital period of ∼ 146 d. A periodicity of 0.867 d, found in the optical light curve, can be explained by non-radial pulsations of the Be star. We identify the optical counterpart and classify it as a B1−2II−Ive star. This confirms SXP 265 as a new Be/X-ray binary pulsar originating in the tidal structure between the Magellanic Clouds.

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Constraining globular cluster formation through studies of young massive clusters – III. A lack of gas and dust in massive stellar clusters in the LMC and SMC

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Scenarios that invoke multiple episodes of star formation within young globular clusters (GCs) to explain the observed chemical and photometric anomalies in GCs, require that clusters can retain the stellar ejecta of the stars within them and accrete large amounts of gas from their surroundings. Hence, it should be possible to find young massive clusters in the local Universe that contain significant amounts (> 10\%) of the cluster mass of gas and/or dust within them. Recent theoretical studies have suggested that clusters in the Large Magellanic Cloud (LMC) with masses in excess of $10^4 M_\odot$, and ages between 30 and $\sim$ 300 Myr, should contain such gas reservoirs. We have searched for H\textsubscript{i} gas within 12 LMC (and 1 SMC) clusters and also for dust using Spitzer 70-\mu m and 160-\mu m images. No clusters were found to contain gas and/or dust. While two of the clusters have H\textsubscript{i} at the same (projected) position and velocity, the gas does not appear to be centred on the clusters, but rather part of nearby clouds or filaments, suggesting that the gas and cluster are not directly related. This lack of gas (< 1\% of the stellar mass) is in strong tension with model predictions, and may be due to higher stellar feedback than has been previously assumed or due to the assumptions used in the previous calculations.

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Search for surviving companions in type Ia supernova remnants

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The nature of the progenitor systems of type Ia supernovae is still unclear. One way to distinguish between the single-degenerate scenario and double-degenerate scenario for their progenitors is to search for the surviving companions. Using a technique that couples the results from multi-dimensional hydrodynamics simulations with calculations of the structure and evolution of main-sequence- and helium-rich surviving companions, the color and magnitude of main-sequence- and helium-rich surviving companions are predicted as functions of time. The surviving companion candidates in Galactic type Ia supernova remnants and nearby extragalactic type Ia supernova remnants are discussed. We find that the maximum detectable distance of main-sequence surviving companions (helium-rich surviving companions) is 0.6–4 Mpc (0.4–16 Mpc), if the apparent magnitude limit is 27 in the absence of extinction, suggesting that the Large and Small Magellanic Clouds and the Andromeda Galaxy are excellent environments in which to search for surviving companions. However, only five Ia SNRs have been searched for surviving companions, showing little support for the standard channels in the singe-degenerate scenario. To better understand the progenitors of type Ia supernovae, we encourage the search for surviving companions in other nearby type Ia supernova remnants.

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The extinction law inside the 30 Doradus nebula

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We have studied the interstellar extinction in a field of \(\sim 3' \times 3'\) at the core of the 30 Doradus nebula, including the central R 136 cluster, in the Large Magellanic Cloud. Observations at optical and near-infrared wavelengths, obtained with the WFC 3 camera on board the Hubble Space Telescope, show that the stars belonging to the red giant clump are spread across the colour–magnitude diagrams because of the considerable and uneven levels of extinction in this region. Since these stars share very similar physical properties and are all at the same distance, they allow us to derive the absolute extinction in a straightforward and reliable way. Thus we have measured the extinction towards about 180 objects and the extinction law in the range 0.3–1.6 \(\mu m\). At optical wavelengths, the extinction curve is almost parallel to that of the diffuse Galactic interstellar medium. Taking the latter as a template, the value of \(R_V = 4.5 \pm 0.2\) that we measure indicates that in the optical there is an extra grey component due to a larger fraction of large grains. At wavelengths longer than \(\sim 1 \mu m\), the contribution of this additional component tapers off as \(\lambda^{-1.5}\), like in the Milky Way, suggesting that the nature of the grains is otherwise similar to those in our Galaxy. These results are consistent with the addition of “fresh” large grains by supernova explosions, as recently revealed by Herschel and ALMA observations of SN 1987A.

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Physical nature of the [S II]-bright shell nebulae N 70 and N 185

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N 70 and N 185 are two large (\(\geq 100\) pc in diameter) shell nebulae in the Large Magellanic Cloud (LMC). Their high [SII]/H\(\alpha\) ratios rival those of supernova remnants (SNRs), but they are not confirmed as SNRs. To study their physical nature, we have obtained XMM-Newton X-ray observations and high-dispersion long-slit échelle spectroscopic observations of these two nebulae. The X-ray spectra of both nebulae can be well interpreted with an optically thin thermal (\(~\sim 0.2\) keV) plasma with the average LMC abundance in a collisional ionization equilibrium. N 70 encompasses the OB association LH 114. Although N 70 has a modest expansion velocity and essentially thermal radio emission, its diffuse X-ray luminosity (\(~6.1 \times 10^{35}\) erg s\(^{-1}\)) is higher than that from a quiescent superbubble with N 70’s density, size, and expansion velocity; thus, N 70 is most likely a superbubble that is recently energized by an interior SNR. N 185 does not contain any known OB association, and its X-ray luminosity is an order of magnitude lower than expected if it is a quiescent superbubble. N 185 has nonthermal radio emission and has high-velocity material expanding at nearly 200 km s\(^{-1}\), similar to many known SNRs in the LMC. Its X-ray luminosity (\(~1.9 \times 10^{35}\) erg s\(^{-1}\)) is also consistent with that of an evolved SNR. We therefore suggest that N 185 is energized by a recent supernova.

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The HD 5980 multiple system: Masses and evolutionary status

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New spectroscopic observations of the LBV/WR multiple system HD 5980 in the Small Magellanic Cloud are used to address the question of the masses and evolutionary status of the two very luminous stars in the 19.3-d eclipsing binary system. Two distinct components of the N v 4944Å line are detected in emission and their radial velocity variations are used to derive masses of 61 and 66 M☉, under the assumption that binary interaction effects on this atomic transition are negligible. We propose that this binary system is the product of quasi-chemically homogeneous evolution with little or no mass transfer. Thus, both of these binary stars may be candidates for γ-ray burst progenitors or even pair instability supernovae. Analysis of the photospheric absorption lines belonging to the third-light object in the system confirm that it consists of an O-type star in a 96.56-d eccentric orbit (e = 0.82) around an unseen companion. The 5:1 period ratio and high eccentricities of the two binaries suggest that they may constitute a hierarchical quadruple system.

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Multi-frequency study of DEM L299 in the Large Magellanic Cloud

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We have studied the H ii region DEM L299 in the Large Magellanic Cloud to understand its physical characteristics and morphology in different wavelengths. We performed a spectral analysis of archived XMM-Newton EPIC data and studied the morphology of DEM L299 in X-ray, optical, and radio wavelengths. We used Hα, [S ii], and [O iii] data from the Magellanic Cloud Emission Line Survey and radio 21 cm line data from the Australia Telescope Compact Array (ATCA) and the Parkes telescope, and radio continuum data from ATCA and the Molonglo Synthesis Telescope. Our morphological studies imply that, in addition to the supernova remnant SNR B 0543−68.9 reported in previous studies, a superbubble also overlaps the SNR in projection. The position of the SNR is clearly defined through the [S ii]/Hα flux ratio image. Moreover, the optical images show a shell-like structure that is located farther to the north and is filled with diffuse X-ray emission, which again indicates the superbubble. Radio 21 cm line data show a shell around both objects. Radio continuum data show diffuse emission at the position of DEM L299, which appears clearly distinguished from the H ii region N 164 that lies South-West of it. We determined the spectral index of SNR B 0543−68.9 to be α = −0.34, which indicates the dominance of thermal emission and therefore a rather mature SNR. We determined the basic properties of the diffuse X-ray emission for the SNR, the superbubble, and a possible blowout region of the bubble, as suggested by the optical and X-ray data. We obtained an age of 8.9 (3.5–18.1) kyr for the SNR and a temperature of 0.64 (0.44–1.37) keV for the hot gas inside the SNR, and a temperature of the hot gas inside the superbubble of 0.74 (0.44–1.1) keV. We conclude that DEM L299 consists of a superposition of SNR B 0543−68.9 and a superbubble, which we identified based on optical data.

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No evidence of chemical anomalies in the bimodal turnoff cluster NGC 1806 in the LMC

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We have studied the chemical composition of NGC 1806, a massive, intermediate-age globular cluster that shows a double main sequence turnoff. We analyzed a sample of high-resolution spectra (secured with FLAMES at the Very Large Telescope) for 8 giant stars, members of the cluster, finding an average iron content of [Fe/H] = −0.60 ± 0.01 dex and no evidence of intrinsic star-to-star variations in the abundances of light elements (Na, O, Mg, Al). Also, the (m_F814W; m_F336W − m_F814W) color–magnitude diagram obtained by combining optical and near-UV Hubble Space Telescope photometry exhibits a narrow red giant branch, thus ruling out intrinsic variations of C and N abundances in the cluster. These findings demonstrate that NGC 1806 does not harbor chemically distinct sub-populations, at variance with what was found in old globular clusters. In turn, this indicates that the double main sequence turnoff phenomenon cannot be explained in the context of the self-enrichment processes usually invoked to explain the chemical anomalies observed in old globulars. Other solutions (i.e., stellar rotation, merging between clusters or collisions with giant molecular clouds) should be envisaged to explain this class of globulars.

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ASTE observations in the 345 GHz window towards the H II region N 113 of the Large Magellanic Cloud

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The H II region N 113 is located in the central part of the Large Magellanic Cloud (LMC) with an associated molecular cloud that is very rich in molecular species. Most of the previously observed molecular lines cover the frequency range 85–270 GHz. Thus, a survey and study of lines at the 345 GHz window is required for a more complete understanding of the chemistry and excitation conditions of this region. We mapped a region of 2.5′ × 2.5′ centred at N 113 using the Atacama Submillimeter Telescope Experiment in the 13CO J = 3–2 line with an angular and spectral resolution of 22″ and 0.11 km s⁻¹. In addition, we observed 16 molecular lines as single pointings towards its centre. From the 13CO J = 3–2 map we estimate the local thermodynamic equilibrium (LTE) and virial masses in about 1 × 10⁴ and 4.5 × 10⁴ M⊙ for the molecular cloud associated with N 113. From the dust continuum emission at 500 μm we additionally obtain a mass of gas of about 7 × 10³ M⊙. Towards the cloud centre we detected emission from 12CO, 13CO, C18O (3–2), HCN, HNC, HCO⁺, C₂H (4–3), and CS (7–6); these are the first reported detections of the HCN, HNC, and C₂H (4–3) lines from this region. We confirm the detection of CS (7–6), which was previously tentatively detected. From analysing the HCN, HNC, and C₂H lines we suggest that they might be emitted from a photodissociation region (PDR). Moreover, we suggest that the chemistry involving the C₂H lines in N 113 is probably similar to that in Galactic PDRs. We analysed the HCN J = 4–3, J = 3–2, and J = 1–0 lines with the code RADEX and we conclude that we observe very high density gas, between some 10⁵ and 10⁷ cm⁻³.

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Dust composition and mass-loss return from the luminous blue variable R 71 in the LMC

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\textbf{Context:} We present an analysis of mid- and far-infrared (IR) spectrum and spectral energy distribution (SED) of the luminous blue variable (LBV) R 71 in the Large Magellanic Cloud (LMC).

\textbf{Aims:} This work aims to understand the overall contribution of high-mass LBVs to the total dust-mass budget of the interstellar medium (ISM) of the LMC and compare this with the contribution from low-mass asymptotic giant branch (AGB) stars. As a case study, we analyze the SED of R 71.

\textbf{Methods:} We compiled all the available photometric and spectroscopic observational fluxes from various telescopes for a wide wavelength range (0.36–250 µm). We determined the dust composition from the spectroscopic data, and derived the ejected dust mass, dust mass-loss rate, and other dust shell properties by modeling the SED of R 71. We noted nine spectral features in the dust shell of R 71 by analyzing Spitzer Space Telescope spectroscopic data. Among these, we identified three new crystalline silicate features. We computed our model spectrum by using 3D radiative transfer code MCMax.

\textbf{Results:} Our model calculation shows that dust is dominated by amorphous silicates, with some crystalline silicates, metallic iron, and a very tiny amount of polycylic aromatic hydrocarbon (PAH) molecules. The presence of both silicates and PAHs indicates that the dust has a mixed chemistry. We derived a dust mass of 0.01 M\textsubscript{☉}, from which we arrive at a total ejected mass of \(\approx 5\) M\textsubscript{☉}. This implies a time-averaged dust mass-loss rate of \(2.5 \times 10^{-6}\) M\textsubscript{☉} yr\textsuperscript{-1} with an explosion about 4000 years ago. We assume that the other five confirmed dusty LBVs in the LMC loose mass at a similar rate, and estimate the total contribution to the mass budget of the LMC to be \(\approx 10^{-5}\) M\textsubscript{☉} yr\textsuperscript{-1}, which is comparable to the contribution by all the AGB stars in the LMC.

\textbf{Conclusions:} Based on our analysis on R 71, we speculate that LBVs as a class may be an important dust source in the ISM of the LMC.

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Sailing under the Magellanic Clouds: a DECam view of the Carina dwarf

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We present deep optical photometry from the DECam imager on the 4 m Blanco telescope of over 12 deg\textsuperscript{2} around the Carina dwarf spheroidal, with complete coverage out to 1° and partial coverage extending out to 2°6. Using a Poisson-based matched-filter analysis to identify stars from each of the three main stellar populations, old, intermediate, and young, we confirm the previously identified radial age gradient, distance, tidal radius, stellar radial profiles, relative stellar population sizes, ellipticity, and position angle. We find an angular offset between the three main elliptical populations of Carina, and find only tentative evidence for tidal debris, suggesting that past tidal interactions could have not significantly influenced the Carina dwarf. We detect stars in the vicinity of, but distinct to, the Carina
dwarf, and measure their distance to be $46 \pm 2$ kpc. We determine this population to be part of the halo of the Large Magellanic Cloud at an angular radius of over 20°. Due to overlap in colour–magnitude space with Magellanic stars, previously detected tidal features in the old population of Carina are likely weaker than previously thought.

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**Bruck 88: a young star cluster with an old age resemblance in the outskirts of the Small Magellanic Cloud**  
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I present spectroscopic and photometric results for the Small Magellanic Cloud (SMC) cluster Bruck 88. From the comparison of the cluster integrated spectrum with template cluster spectra I found that the Milky Way globular cluster template spectra are the ones which best resemble it. However, the extracted cluster colour–magnitude diagram reveals that Bruck 88 is a young cluster ($\log t = 8.1 \pm 0.1$). The derived cluster age is compatible with the presence of a Bright Red Giant (BRG) star located $\approx 2^\circ$6 in the sky from the cluster centre. I serendipitously observed HW 33, a star cluster located $\approx 3^\circ$ to the South-East from Bruck 88. I obtained for the cluster the same age as Bruck 88 and, surprisingly, a BRG star located within the cluster radius also appears to be compatible with the cluster age. I estimated the MK type of the BRG star in the Bruck 88 field to be in the range G9 II/Ib – K1 III. By combining the spectrum of a star within this MK type range with a 100–150 Myr template cluster integrated spectrum, I found that a proportion 85/15 in the sense BRG/template results in a spectrum which best resembles that of Bruck 88. This result confirms that a BRG star dominates the cluster integrated spectrum, so that it causes the globular cluster appearance of its integrated light.

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**On the effects of subvirial initial conditions and the birth temperature of R 136**  
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We investigate the effect of different initial virial temperatures, $Q$, on the dynamics of star clusters. We find that the virial temperature has a strong effect on many aspects of the resulting system, including among others: the fraction of bodies escaping from the system, the depth of the collapse of the system, and the strength of the mass segregation. These differences deem the practice of using “cold” initial conditions no longer a simple choice of convenience. The choice of initial virial temperature must be carefully considered as its impact on the remainder of the simulation can be profound. We discuss the pitfalls and aim to describe the general behavior of the collapse and the resultant system as a function of the virial temperature so that a well reasoned choice of initial virial temperature can be made. We make a correction to the previous theoretical estimate for the minimum radius, $R_{\text{min}}$, of the cluster at the deepest moment of collapse to include a $Q$ dependency, $R_{\text{min}} \approx Q + N^{-1/3}$, where $N$ is the number of particles. We use our numerical results to infer more about the initial conditions of the young cluster R 136. Based on our analysis, we find that R 136 was likely formed with a rather cool, but not cold, initial virial temperature ($Q \approx 0.13$). Using the same analysis method, we examined 15 other young clusters and found the most common initial virial temperature to be between 0.18 and 0.25.

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XMM-Newton study of 30 Dor C and a newly identified MCSNR J 0536−6913 in the Large Magellanic Cloud

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Aims: We present a detailed study of the superbubble 30 Dor C and the newly identified MCSNR J 0536−6913 in the Large Magellanic Cloud.

Methods: All available XMM-Newton data (flare-filtered exposure times of 420 ks EPIC-pn, 556 ks EPIC-MOS1, 614 ks EPIC-MOS2) were used to characterise the thermal X-ray emission in the region. An analysis of the non-thermal X-ray emission is also presented and discussed in the context of emission mechanisms previously suggested in the literature. These data are supplemented by X-ray data from Chandra, optical data from the Magellanic Cloud Emission Line Survey, and radio data from the Australia Telescope Compact Array and the Molonglo Observatory Synthesis Telescope.

Results: The brightest thermal emission towards 30 Dor C was found to be associated with a new supernova remnant, MCSNR J0536−6913. X-ray spectral analysis of MCSNR J0536−6913 suggested an ejecta-dominated remnant with lines of O, Ne, Mg, and Si, and a total 0.3−10 keV X-ray luminosity of ∼8 × 1034 erg s−1. Based on derived ejecta abundance ratios, we determined the mass of the stellar progenitor to be either ∼18 M⊙ or as high as ∼40 M⊙, though the spectral fits were subject to simplifying assumptions (e.g., uniform temperature and well-mixed ejecta).

The thermal emission from the superbubble exhibited enrichment by α-process elements, evidence for a recent core-collapse SNR interaction with the superbubble shell. We detected non-thermal X-ray emission throughout 30 Dor C, with the brightest regions being highly correlated with the Hα and radio shells. We created a non-thermal spectral energy distribution for the North-Eastern shell of 30 Dor C which was best-fit with an exponentially cut-off synchrotron model.

Conclusions: Thermal X-ray emission from 30 Dor C is very complex, consisting of a large scale superbubble emission at the eastern shell wall with the brightest emission due to MCSNR J0536−6913. The fact that the non-thermal spectral energy distribution of the superbubble shell was observed to roll-off is further evidence that the non-thermal X-ray emission from 30 Dor C is synchrotron in origin.

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The evolution of single B-type stars with a large angular momentum content

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The Geneva Stellar Evolution Group has recently presented an extended database of rotating stellar models at three different metallicities for nine different initial rotation parameters and ten different masses corresponding to spectral types from early- F to late- O. With these grids we have contributed to the understanding of the evolution of single rotating stars, and we intend to use them to produce synthetic stellar populations that fully account for the effects of stellar rotation. However, up to now we still lacked stellar evolutionary tracks that rotate close to the critical limit during the whole main-sequence (MS) phase. This occurs because the flat internal profile of rotation imposed at the zero-age main sequence (ZAMS) is modified by the action of meridional currents immediately after the ZAMS, causing the surface rotational velocity to decrease abruptly until it reaches a quasi-stationary state. We compute stellar models...
with non-solid rotation at the ZAMS, which allows us to obtain stellar evolutionary tracks with a larger content of angular momentum that rotate close to the breakup limit throughout the whole MS. We produced stellar models by removing the assumption that stars rotate as solid bodies at the ZAMS. We obtained the stellar structure at the ZAMS with a differentially rotating profile for three different metallicities by performing pre-MS calculations and by proposing ad hoc initial rotational profiles. We then computed the MS evolution and later phases of stellar evolution of these models, which attain rotational equatorial velocities close to the critical limit throughout their whole MS phase. Stellar models with solid rotation at the ZAMS adequately represent the overall characteristics and evolution of differentially rotating models of identical angular momentum content, but with a lower initial surface rotational velocity rate, at \( Z = 0.014 \), \( Z = 0.006 \), and \( Z = 0.002 \). For models with solid rotation at the ZAMS we therefore recommend to use as the initial rotational rate the values derived once the quasi-stationary state is reached, that is, after the abrupt decrease in surface velocity. By producing stellar structures at the ZAMS with differentially rotating profiles and larger angular momentum content than in our previous works, we obtain models that rotate close to the critical limit throughout the whole main sequence. These models have a longer MS lifetime and a higher surface chemical enrichment already at the end of the MS, particularly at \( Z = 0.002 \). Interestingly, the initial equatorial rotational velocities are virtually metallicity independent for all stellar models we computed in the B-type star range with the same mass and angular momentum content at the ZAMS. If, as some observational evidence indicates, B-type stars at \( Z = 0.002 \) rotate with a higher equatorial velocity at the ZAMS than stars with \( Z = 0.014 \), our finding would indicate that the angular momentum content of B-type stars in the SMC is higher than their Galactic counterparts.

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**Empirical period–color and amplitude–color relations for Classical Cepheids and RR Lyrae variables**

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We analyze Galactic, Large Magellanic Cloud and Small Magellanic Cloud Cepheids and RR Lyrae variables in terms of period–color (PC) and amplitude–color (AC) diagrams at the phases of maximum and minimum light. We compiled Galactic Cepheids \( V \)- and \( I \)-band data from the literature. We make use of optical bands light curve data from OGLE-III survey for Cepheids and RR Lyrae variables in the Magellanic Clouds. We apply the \( F \)-statistical test to check the significance of any variation in the slope of PC and AC relations for Cepheid variables. The PC relation at maximum light for Galactic Cepheids with periods longer than about 7 days is shallow and the corresponding AC relation is flat for the entire period range. For the fundamental mode Cepheids in the Magellanic Clouds, we find significant breaks in the PC and AC relations at both maximum and minimum light for periods around 10 days. The PC relation at maximum light for the Magellanic Clouds is flat for Cepheids with periods greater than 10 days. First overtone Cepheids with periods less than 2.5 days have a shallow PC relation at maximum light. For fundamental mode RR Lyrae, we confirm earlier work supporting a flat PC relation at minimum light and a significant relation between amplitude and color at maximum light. We find that no such relations exist for first overtone RR Lyrae stars. These findings are in agreement with stellar photosphere/hydrogen ionization front interaction considerations. These nonlinearities can provide strong constraints for models of stellar pulsation and evolution.

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The panchromatic high-resolution spectroscopic Survey of Local Group star clusters – I. General data reduction procedures for the VLT/X-shooter UVB and VIS arm

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Our dataset contains spectroscopic observations of 29 globular clusters in the Magellanic Clouds and the Milky Way performed with VLT/X-shooter. Here we present detailed data reduction procedures for the VLT/X-shooter UVB and VIS arm. These are not restricted to our particular dataset, but are generally applicable to different kinds of X-shooter data without major limitation on the astronomical object of interest. ESO’s X-shooter pipeline (v1.5.0) performs well and reliably for the wavelength calibration and the associated rectification procedure, yet we find several weaknesses in the reduction cascade that are addressed with additional calibration steps, such as bad pixel interpolation, flat fielding, and slit illumination corrections. Furthermore, the instrumental PSF is analytically modeled and used to reconstruct flux losses at slit transit and for optimally extracting point sources. Regular observations of spectrophotometric standard stars allow us to detect instrumental variability, which needs to be understood if a reliable absolute flux calibration is desired. A cascade of additional custom calibration steps is presented that allows for an absolute flux calibration uncertainty of less than ten percent under virtually every observational setup provided that the signal-to-noise ratio is sufficiently high. The wavelength calibration is found to be accurate to an uncertainty level of approximately 0.02 Å. We find that most of the X-shooter systematics can be reliably modeled and corrected for. This offers the possibility of comparing observations on different nights and with different telescope pointings and instrumental setups, thereby facilitating a robust statistical analysis of large datasets.

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The star formation history of the Magellanic Clouds derived from long-period variable star counts

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We present the first reconstruction of the star formation history (SFH) of the Large and Small Magellanic Clouds (LMC and SMC) using Long Period Variable stars. These cool evolved stars reach their peak luminosity in the near-infrared; thus, their K-band magnitudes can be used to derive their birth mass and age, and hence the SFH can be obtained. In the LMC, we found a 10-Gyr old single star formation epoch at a rate of \( \sim 1.5 \, M_\odot \, yr^{-1} \), followed by a relatively continuous SFR of \( \sim 0.2 \, M_\odot \, yr^{-1} \), globally. In the core of the LMC (LMC bar), a secondary, distinct episode is seen, starting 3 Gyr ago and lasting until \( \sim 0.5 \) Gyr ago. In the SMC, two formation epochs are seen, one \( \sim 6 \) Gyr ago at a rate of \( \sim 0.28 \, M_\odot \, yr^{-1} \) and another only \( \sim 0.7 \) Gyr ago at a rate of \( \sim 0.3 \, M_\odot \, yr^{-1} \). The latter is also discernible in the LMC and may thus be linked to the interaction between the Magellanic Clouds and/or Milky Way, while the formation of the LMC bar may have been an unrelated event. Star formation activity is concentrated in the central parts of the Magellanic Clouds now, and possibly has always been if stellar migration due to dynamical relaxation has been effective. The different initial formation epochs suggest that the LMC and SMC did not form as a pair, but at least the SMC formed in isolation.

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A new class of Wolf–Rayet stars: WN3/O3s

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Our new survey for Wolf–Rayet stars in the Magellanic Clouds is only 15\% complete but has already found 9 new WRs in the LMC. This suggests that the total WR population in the LMC may be underestimated by 10–40\%. Eight of the nine are WNs, demonstrating that the "observed" WC to WN ratio is too large, and is biased towards WC stars. The ninth is another rare WO star, the second we have found in the LMC in the past two years. Five (and possibly six) of the 8 WNs are of a new class of WRs, which pose a significant challenge to our understanding. Naively we would classify these stars as "WN3+O3V," but there are several reasons why such a pairing is unlikely, not the least of which is that the absolute visual magnitudes of these stars are faint, with \( M_V \sim -2.3 \) to \(-3.1 \) mag. We have performed a preliminary analysis with cmfgen, and we find that (despite the faint visual magnitudes) the bolometric luminosities of these stars are normal for early-type WNs. Our fitting suggests that these stars are evolved, with significantly enriched N and He. Their effective temperatures are also normal for early-type WNs. What is unusual about these stars is that they have a surprisingly small mass-loss rate compared to other early-type WNs. How these stars got to be the way they are (single star evolution? binary evolution?) remains an open question. For now, we are designating this class as WN3/O3, in analogy to the late-type WN "slash" stars.

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The VISTA near-infrared $YJK_s$ survey of the Magellanic Clouds system (VMC) has entered its core phase: about 50% of the observations across the Large and Small Magellanic Clouds (LMC, SMC), the Magellanic Bridge and Stream have already been secured and the data are processed and analysed regularly. The initial analyses, concentrated on the first two completed tiles in the LMC (including 30 Doradus and the South Ecliptic Pole), show the superior quality of the data. The photometric depth of the VMC survey allows the derivation of the star formation history (SFH) with unprecedented quality compared to previous wide-area surveys, while reddening maps of high angular resolution are constructed using red clump stars. The multi-epoch $K_s$-band data reveal tight period–luminosity relations for variable stars and permit the measurement of accurate proper motions of the stellar populations. The VMC survey continues to acquire data that will address many issues in the field of star and galaxy evolution.

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