Dear Colleagues,

It is my pleasure to present you the 155th issue of the Magellanic Clouds Newsletter.

This edition seems to concentrate on star clusters and dynamics (from small to large scale) but there are plenty of other interesting new results to read about.

If you are looking for a postdoctoral job opportunity there’s an exciting one in Michigan to work with Sally Oey.

Suggestions for pictures (images, spectra, graphs, formulæ...) for the cover of the newsletter remain welcome – just send it by e-mail to astro.mcnews@keele.ac.uk

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

Editorially Yours,
Jacco van Loon
Spectral analysis of IGR J01572−7259 during its 2016 outburst
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We report on the results of the XMM–Newton observation of IGR J01572−7259 during its most recent outburst in 2016 May, the first since 2008. The source reached a flux $f \sim 10^{-10}$ erg cm$^{-2}$ s$^{-1}$, which allowed us to perform a detailed analysis of its timing and spectral properties. We obtained a pulse period $P_{\text{spin}} = 11.58208(2)$ s. The pulse profile is double peaked and strongly energy dependent, as the second peak is prominent only at low energies and the pulsed fraction increases with energy. The main spectral component is a power-law model, but at low energies, we also detected a soft thermal component, which can be described with either a blackbody or a hot plasma model. Both the EPIC and RGS spectra show several emission lines, which can be identified with the transition lines of ionized N, O, Ne, and Fe and cannot be described with a thermal emission model. The phase-resolved spectral analysis showed that the flux of both the soft excess and the emission lines vary with the pulse phase: the soft excess disappears in the first pulse and becomes significant only in the second, where also the Fe line is stronger. This variability is difficult to explain with emission from a hot plasma, while the reprocessing of the primary X-ray emission at the inner edge of the accretion disc provides a reliable scenario. On the other hand, the narrow emission lines can be due to the presence of photo-ionized matter around the accreting source.

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Explosions of blue supergiants from binary mergers for SN 1987A
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Based on the work of Menon and Heger (2017), we present the bolometric light curves and spectra of the explosions of blue supergiant progenitors from binary mergers. We study SN 1987A and two other peculiar Type IIP supernovae: SN 1998A and SN 2006V. The progenitor models were produced using the stellar evolution code Kepler and then exploded using the 1D radiation hydrodynamic code Crab. The explosions of binary merger models exhibit an overall better fit to the light curve of SN 1987A than previous single star models, due to their lower helium-core masses, larger envelope masses, and smaller radii. The merger model that best matches the observational constraints of the progenitor of SN 1987A and the light curve, is a model with a radius of 37 R$_\odot$, an ejecta mass of 20.6 M$_\odot$, an explosion energy of 1.7 Bethe, a nickel mass of 0.073 M$_\odot$, and a nickel mixing velocity of 3,000 km s$^{-1}$. This Model also works for SN 1998A and is comparable with earlier estimates from semi-analytic models. In the case of SN 2006V, however, a model with a radius of 150 R$_\odot$ and ejecta mass of 19.1 M$_\odot$ matches the light curve. These parameters are significantly higher than predictions from semi-analytic models for the progenitor of this supernova.

Submitted to MNRAS  
The minimum mass of rotating main sequence stars and its impact on the nature of extended main sequence turn-offs in intermediate-age star clusters in the Magellanic Clouds

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Extended main sequence turn-offs (eMSTOs) are a common feature in color–magnitude diagrams (CMDs) of young and intermediate-age star clusters in the Magellanic Clouds. The nature of eMSTOs is still debated. The most popular scenarios are extended star formation and ranges of stellar rotation rates. Here we study implications of a kink feature in the main sequence (MS) of young star clusters in the Large Magellanic Cloud (LMC). This kink shows up very clearly in new Hubble Space Telescope observations of the 700-Myr-old cluster NGC 1831, and is located below the region in the CMD where multiple or wide MSes, which are known to occur in young clusters and thought to be due to varying rotation rates, merge together into a single MS. The kink occurs at an initial stellar mass of $1.45 \pm 0.02 \, M_\odot$; we posit that it represents a lower limit to the mass below which the effects of rotation on the energy output of stars are rendered negligible at the metallicity of these clusters. Evaluating the positions of stars with this initial mass in CMDs of massive LMC star clusters with ages of $\sim 1.7$ Gyr that feature wide eMSTOs, we find that such stars are located in a region where the eMSTO is already significantly wider than the MS below it. This strongly suggests that stellar rotation cannot fully explain the wide extent of eMSTOs in massive intermediate-age clusters in the Magellanic Clouds. A distribution of stellar ages still seems necessary to explain the eMSTO phenomenon.

Accepted for publication in The Astrophysical Journal (Letters)

Cluster kinematics and stellar rotation in NGC 419 with MUSE and adaptive optics

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We present adaptive optics (AO) assisted integral-field spectroscopy of the intermediate-age star cluster NGC 419 in the Small Magellanic Cloud. By investigating the cluster dynamics and the rotation properties of main sequence turn-off stars (MSTO), we demonstrate the power of AO-fed MUSE observations for this class of objects. Based on 1 049 radial velocity measurements, we determine a dynamical cluster mass of $1.4 \pm 0.2 \times 10^5 \, M_\odot$ and a dynamical mass-to-light ratio of 0.67±0.08, marginally higher than simple stellar population predictions for a Kroupa initial mass function. A stacking analysis of spectra at both sides of the extended MSTO reveals significant rotational broadening. Our analysis further provides tentative evidence that red MSTO stars rotate faster than their blue counterparts. We find average $v \sin i$ values of $87 \pm 16 \, \text{km s}^{-1}$ and $130 \pm 22 \, \text{km s}^{-1}$ for blue and red MSTO stars, respectively. Potential systematic effects due to the low spectral resolution of MUSE can reach 30 km s$^{-1}$ but the difference in $v \sin i$ between the populations is unlikely to be affected.

Accepted for publication in MNRAS
Dynamical Monte Carlo simulations of 3-D galactic systems in axisymmetric and triaxial potentials

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We describe the dynamical behavior of isolated old (≥ 1 Gyr) objects-like Neutron Stars (NSs). These objects are evolved under smooth, time-independent, gravitational potentials, axisymmetric and with a triaxial dark halo. We analysed the geometry of the dynamics and applied the Poincaré section for comparing the influence of different birth velocities. The inspection of the maximal asymptotic Lyapunov (λ) exponent shows that dynamical behaviors of the selected orbits are nearly the same as the regular orbits with 2-DOF, both in axisymmetric and triaxial when (φ, q_z) = (0, 0). Conversely, a few chaotic trajectories are found with a rotated triaxial halo when (φ, q_z) = (90°, 1.5). The tube orbits preserve direction of their circulation around either the long or short axis as appeared in the triaxial potential, even when every initial condition leads to different orientations. The Poincaré section shows that there are 2-D invariant tori and invariant curves (islands) around stable periodic orbits that bound to the surface of 3-D tori.

The regularity of several prototypical orbits offer the means to identify the phase-space regions with localized motions and to determine their environment in different models, because they can occupy significant parts of phase-space depending on the potential. This is of particular importance in Galactic Dynamics.

Published in Publications of the Astronomical Society of Australia

Impact of the Galactic disk and Large Magellanic Cloud on the trajectories of hypervelocity stars ejected from the Galactic Center

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We consider how the gravity of the Galactic disk and the Large Magellanic Cloud (LMC) modifies the radial motions of hypervelocity stars (HVSs) ejected from the Galactic Center. For typical HVSs ejected towards low (high) Galactic latitudes, the disk bends trajectories by up to 30° (3° to 10°). For many lines-of-sight through the Galaxy, the LMC produces similar and sometimes larger deflections. Bound HVSs suffer larger deflections than unbound HVSs. Gravitational focusing by the LMC also generates a factor of two overdensity along the line-of-sight towards the LMC. With large enough samples, observations can detect the non-radial orbits and the overdensity of HVSs towards the LMC. For any Galactic potential model, the Galactic rest-frame tangential velocity provides an excellent way to detect unbound and nearly bound HVSs within 10 kpc of the Sun. Similarly, the rest-frame radial velocity isolates unbound HVSs beyond 10–15 kpc from the Sun. Among samples of unbound HVSs, measurements of the radial and tangential velocity serve to distinguish Galactic Center ejections from other types of high velocity stars.

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The Carnegie RR Lyraë program: mid-infrared period–luminosity relations of RR Lyraë stars in Reticulum

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We analysed 30 RR Lyrae stars (RRLs) located in the Large Magellanic Cloud (LMC) globular cluster Reticulum that were observed in the 3.6 and 4.5 µm passbands with the Infrared Array Camera (IRAC) on board of the Spitzer Space Telescope. We derived new mid-infrared (MIR) period–luminosity (PL) relations. The zero points of the PL relations were estimated using the trigonometric parallaxes of five bright Milky Way (MW) RRLs measured with the Hubble Space Telescope (HST) and, as an alternative, we used the trigonometric parallaxes published in the first Gaia data release (DR1) which were obtained as part of the Tycho–Gaia Astrometric Solution (TGAS) and the parallaxes of the same stars released with the second Gaia data release (DR2). We determined the distance to Reticulum using our new MIR PL relations and found that distances calibrated on the TGAS and DR2 parallaxes are in a good agreement and, generally, smaller than distances based on the HST parallaxes, although they are still consistent within the respective errors. We conclude that Reticulum is located ∼ 3 kpc closer to us than the barycentre of the LMC.

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Accurate radial velocity and metallicity of the Large Magellanic Cloud old globular clusters NGC 1928 and NGC 1939

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We present results obtained from spectroscopic observations of red giants located in the fields of the Large Magellanic Cloud (LMC) globular clusters (GCs) NGC 1928 and NGC 1939. We used the GMOS and AAOmega+2dF spectrographs to obtain spectra centred on the CaII triplet, from which we derived individual radial velocities (RVs) and metallicities. From cluster members we derived mean RVs of \( \text{RV}_{\text{NGC 1928}} = 249.58 \pm 4.65 \, \text{km} \, \text{s}^{-1} \) and \( \text{RV}_{\text{NGC 1939}} = 258.85 \pm 2.08 \, \text{km} \, \text{s}^{-1} \), and mean metallicities of [Fe/H]_{NGC 1928} = −1.30 ± 0.15 dex and [Fe/H]_{NGC 1939} = −2.00 ± 0.15 dex. We found that both GCs have RVs and positions consistent with being part of the LMC disc, so that we rule out any possible origin but that in the same galaxy. By computing the best solution of a disc that fully contains each GC, we obtained circular velocities for the 15 known LMC GCs. We found that 11/15 of the GCs share the LMC rotation derived from HST and Gaia DR2 proper motions. This outcome reveals that the LMC disc existed since the very early epoch of the galaxy formation and experienced the steep relatively fast chemical enrichment shown by its GC metallicities. The four remaining GCs turned out to have circular velocities not compatible with an in situ cluster formation, but rather with being stripped from the SMC.

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The fate of supernova-heated gas in star-forming regions of the LMC: lessons for galaxy formation?

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Galactic winds and fountains driven by supernova-heated gas play an integral role in re-distributing gas in galaxies, depositing metals in the circumgalactic medium (CGM), and quenching star formation. The interplay between these outflows and ram pressure stripping due to the galaxy’s motion through an ambient medium may enhance these effects by converting fountain flows into expelled gas. In this paper, we present controlled, 3D simulations of ram pressure stripping combined with thermally driven, local outflows from clustered supernovae in an isolated disk galaxy modeled on the Large Magellanic Cloud (LMC), a dwarf satellite of the Milky Way on its first infall. Observational evidence of local outflows emanating from supergiant shells in the LMC and a trailing filament of HI gas originating from these regions – with no obvious Leading Arm counterpart – may represent a perfect example of this process. Our simulations present a proof-of-concept that ram pressure can convert fountain flows into expelled gas. We find that fountains launched near the peak star formation time of the LMC can comprise part of the LMC filament in the Trailing Stream, but with lower column densities than observed. Larger, more numerous outflows from the LMC may be possible and may contribute more mass, but higher inertia gas will lengthen the timescale for this gas to be swept away by ram pressure. Given the high resolution observations, increased knowledge of star formation histories, and growing evidence of multiphase, ionized outflows, the LMC is an ideal test-bed for future wind models.

Published in The Astrophysical Journal

Detection of a cyclotron line in SXP 15.3 during its 2017 outburst

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We report the results of AstroSat and NuSTAR observations of the Be/X-ray binary pulsar SXP 15.3 in the Small Magellanic Cloud during its outburst in late 2017, when the source reached a luminosity level of ~ 10³⁸ erg s⁻¹, close to the Eddington limit. The unprecedented broadband coverage of the source allowed us to perform timing and spectral analysis between 3 and 80 keV. The pulse profile exhibits a significant energy dependence, and morphs from a double peaked profile to a single broad pulse at energies > 15 keV. This can be explained by a spectral hardening during an intensity dip seen between the two peaks of the pulse profile. We detect a Cyclotron Resonance Scattering Feature (CRSF) at ~ 5 keV in the X-ray spectrum, independent of the choice of the continuum model. This indicates a magnetic field strength of 6 × 10¹¹ G for the neutron star.

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Available from [arxiv.org](http://arxiv.org/abs/1807.10696)
Different stellar rotations in the two main sequences of the young globular cluster NGC 1818: the first direct spectroscopic evidence

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We present a spectroscopic analysis of main-sequence (MS) stars in the young globular cluster NGC 1818 (age \(\sim\) 40 Myr) in the Large Magellanic Cloud. Our photometric survey of Magellanic Clouds clusters has revealed that NGC 1818, similar to other young objects with ages \(\lesssim\) 600 Myr, displays not only an extended MS turnoff (eMSTO), as observed in intermediate-age clusters (age \(\sim\) 1–2 Gyr), but also a split MS. The most straightforward interpretation of the double MS is the presence of two stellar populations: a sequence of slowly rotating stars lying on the blue-MS (bMS) and a sequence of fast rotators, with rotation close to the breaking speed, defining a red-MS (rMS). We report the first direct spectroscopic measurements of projected rotational velocities \(v\sin i\) for the double MS, eMSTO, and Be stars of a young cluster. The analysis of line profiles includes non-local thermodynamic equilibrium effects, required for correctly deriving \(v\sin i\) values. Our results suggest that: (i) the mean rotation for bMS and rMS stars is \(v\sin i = 71 \pm 10\) km s\(^{-1}\) (\(\sigma = 37\) km s\(^{-1}\)) and \(v\sin i = 202 \pm 23\) km s\(^{-1}\) (\(\sigma = 91\) km s\(^{-1}\)), respectively; (ii) eMSTO stars have different \(v\sin i\), which are generally lower than those inferred for rMS stars, and (iii) as expected, Be stars display the highest \(v\sin i\) values. This analysis supports the idea that distinct rotational velocities play an important role in the appearance of multiple stellar populations in the color–magnitude diagrams of young clusters, and poses new constraints on the current scenarios.

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Comment on “An excess of massive stars in the local 30 Doradus starburst”

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Schneider et al. (Science, 2018) used an ad hoc statistical method in their calculation of the stellar initial mass function. Adopting an improved approach, we reanalyse their data and determine a power law exponent of \(2.05^{+0.13}_{-0.14}\). Alternative assumptions regarding data set completeness and the star formation history model can shift the inferred exponent to \(2.11^{+0.15}_{-0.16}\) and \(2.15^{+0.13}_{-0.13}\), respectively.

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and from [http://adsabs.harvard.edu/abs/2018Sci...361.6506F](http://adsabs.harvard.edu/abs/2018Sci...361.6506F)
Search for an intrinsic metallicity spread in old globular clusters of the Large Magellanic Cloud

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We report for the first time on the magnitude of the intrinsic $[\text{Fe}/H]$ spread among ten old globular clusters (GCs) of the Large Magellanic Cloud (LMC). Such spreads are merely observed in approximately five per cent of the Milky Way GCs and recently gained more attention in theoretical models of GC evolution. We derived metallicities with a typical precision of $0.05 \text{ dex} \leq \sigma[\text{Fe}/H] \leq 0.20 \text{ dex}$ for an average of 14 red giant branch stars per GC from Strömgren photometry. The respective, metallicity-sensitive indices have been calibrated to precise and accurate high-dispersion spectroscopy. For all clusters we found null $[\text{Fe}/H]$ spreads with a typical uncertainty of 0.04 dex, with the possible exception of NGC 1786 that shows an intrinsic dispersion of $0.07 \pm 0.04 \text{ dex}$. The mean, observed standard deviation of the derived metallicities for nearly 40 per cent of our GC sample amounted to smaller than 0.05 dex. At present, we cannot exclude that the remaining GCs also have intrinsic Fe-abundance variations in excess of 0.05 dex, but in order to significantly detect those, the measurement errors on individual $[\text{Fe}/H]$-values would need to be lowered to the 0.03–0.07 dex level. These findings suggest, along with those from ages and light-element abundances, that the LMC GCs studied here are alike to the majority of Galactic GCs.

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Velocity profiles of $[\text{C}\,\text{II}]$, $[\text{C}\,\text{I}]$, CO, and $[\text{O}\,\text{I}]$ and physical conditions in four star-forming regions in the Large Magellanic Cloud

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Aims: The aim of our study is to investigate the physical properties of the star-forming interstellar medium (ISM) in the Large Magellanic Cloud (LMC) by separating the origin of the emission lines spatially and spectrally. The LMC provides a unique local template to bridge studies in the Galaxy and high redshift galaxies because of its low metallicity and proximity, enabling us to study the detailed physics of the ISM in spatially resolved individual star-forming regions. Following Okada et al. (2015, Paper I), we investigate different phases of the ISM traced by carbon-bearing species in four star-forming regions in the LMC, and model the physical properties using the KOSMA-\textit{τ} PDR model.

Methods: We mapped 3–13 arcmin\textsuperscript{2} areas in 30 Dor, N 158, N 160 and N 159 along the molecular ridge of the LMC in $[\text{C}\,\text{II}] 158 \mu\text{m}$ with GREAT on board SOFIA. We also observed the same area with CO(2–1) to (6–5), $^{13}\text{CO}(2–1)$ and (3–2), [C\,\text{I}] $^3P_1$–$^3P_0$ and $^3P_2$–$^3P_1$ with APEX. For selected positions in N 159 and 30 Dor, we observed [O\,\text{I}] 145 $\mu\text{m}$ and [O\,\text{I}] 63 $\mu\text{m}$ with upGREAT. All spectra are velocity resolved.

Results: In all four star-forming regions, the line profiles of CO, $^{13}\text{CO}$, and [C\,\text{I}] emission are similar, being reproduced by a combination of Gaussian profiles defined by CO(3–2), whereas [C\,\text{II}] typically shows wider line profiles or an additional velocity component. At several positions in N 159 and 30 Dor, we observed the velocity-resolved [O\,\text{I}] 145 $\mu\text{m}$ and 63 $\mu\text{m}$ lines for the first time. At some positions, the [O\,\text{I}] line profiles match those of CO, at other positions they are more similar to the [C\,\text{II}] profiles. We interpret the different line profiles of CO, [C\,\text{II}] and [O\,\text{I}] as contributions from spatially separated clouds and/or clouds in different physical phases, which give different line ratios depending on their physical properties. We modeled the emission from the CO, [C\,\text{II}], [C\,\text{I}], and [O\,\text{I}] lines and the far-infrared continuum emission using the latest KOSMA-\textit{τ} PDR model, which treats the dust-related physics consistently and computes the dust continuum SED together with the line emission of the chemical species. We find that the line and continuum emissions are not well-reproduced by a single clump ensemble. Toward the CO peak at N 159 W, we
propose a scenario that the CO, [CII], and [O I] 63 μm emission are weaker than expected because of mutual shielding among clumps.

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The effect of metallicity on Cepheid period–luminosity relations from a Baade–Wesselink analysis of Cepheids in the Milky Way and Magellanic Clouds

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The extragalactic distance scale builds on the Cepheid period–luminosity (PL) relation. Decades of work have not yet convincingly established the sensitivity of the PL relation to metallicity. This currently prevents a determination of the Hubble constant accurate to 1% from the classical Cepheid–SN Ia method. In this paper, we want to carry out a strictly differential comparison of the absolute PL relations obeyed by classical Cepheids in the Milky Way (MW), LMC and SMC galaxies. Taking advantage of the substantial metallicity difference among the Cepheid populations in these three galaxies, we want to establish a possible systematic trend of the PL relation absolute zero point as a function of metallicity, and determine the size of such an effect in optical and near-infrared photometric bands. We are using the IRSB Baade–Wesselink type method as calibrated by Storm et al. to determine individual distances to the Cepheids in our samples in MW, LMC and SMC. For our analysis, we use a greatly enhanced sample of Cepheids in the SMC (31 stars) as compared to the small sample (5 stars) available in our previous work. We use the distances to determine absolute Cepheid PL relations in optical and near-infrared bands in each of the three galaxies. Our distance analysis of 31 SMC Cepheids with periods from 4–69 days yields tight PL relations in all studied bands, with slopes consistent with the corresponding LMC and MW relations. Adopting the very accurately determined LMC slopes for the optical and near-infrared bands, we determine the zero point offsets between the corresponding absolute PL relations in the 3 galaxies. We find that in all bands the metal-poor SMC Cepheids are intrinsically fainter than their more metal-rich counterparts in the LMC and MW. In the $K$ band the metallicity effect is $-0.23 \pm 0.06$ mag dex$^{-1}$ while in the $V, (V-I)$ Wesenheit index it is slightly stronger, $-0.34 \pm 0.06$ mag dex$^{-1}$. We find some evidence that the PL relation zero point-metallicity relation might be nonlinear, becoming steeper for lower metallicities. Using sizeable Cepheid samples in the MW, LMC and SMC with very accurate photometric and radial velocity data we establish the metallicity sensitivity of the Cepheid PL relations in the optical and near-infrared regimes. We find a significant effect in all bands in the sense that the more metal-poor SMC Cepheids are intrinsically fainter than their LMC and Galactic counterparts. We find suggestive evidence that the metallicity sensitivity of the PL relation might be nonlinear, being small in the range between solar and LMC Cepheid metallicity, and becoming steeper towards the lower-metallicity regime.

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Molecular Clouds associated with the Type Ia SNR N 103 B in the Large Magellanic Cloud

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N 103 B is a Type Ia supernova remnant (SNR) in the Large Magellanic Cloud (LMC). We carried out new $^{12}$CO($J = 3–2$) and $^{12}$CO($J = 1–0$) observations using ASTE and ALMA. We have confirmed the existence of a giant molecular cloud (GMC) at $v_{\text{LSR}} \sim 245$ km s$^{-1}$ towards the southeast of the SNR using ASTE $^{12}$CO($J = 3–2$) data at an angular resolution of $\sim 25\arcsec$ ($\sim 6$ pc in the LMC). Using the ALMA $^{12}$CO($J = 1–0$) data, we have spatially resolved CO clouds along the South-Eastern edge of the SNR with an angular resolution of $\sim 1\farcs8$ ($\sim 0.4$ pc in the LMC). The molecular clouds show an expanding gas motion in the position–velocity diagram with an expansion velocity of $\sim 5$ km s$^{-1}$. The spatial extent of the expanding shell is roughly similar to that of the SNR. We also find tiny molecular clumps in the directions of optical nebula knots. We present a possible scenario that N 103 B exploded in the wind-bubble formed by the accretion winds from the progenitor system, and is now interacting with the dense gas wall. This is consistent with a single-degenerate scenario.

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The three-dimensional distributions of Type II Cepheids and Anomalous Cepheids in the Magellanic Clouds. Do these stars belong to the old, young or intermediate-age population?

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The nature of Type II Cepheids and Anomalous Cepheids is still not well known and their evolutionary channels leave many unanswered questions. One of the characteristic features directly related to the age of stars is their spatial distribution. We use complete collection of classical pulsating stars in the Magellanic Clouds discovered by the OGLE project, to compare their spatial distributions. In this analysis we use 9649 Classical Cepheids (DCEPs),
Anomalous Cepheids (ACEPs), 338 Type II Cepheids (T2CEPs) and 46 443 RR Lyræ stars (RR Lyr) from both Magellanic Clouds. We compute three-dimensional Kolmogorov–Smirnov tests for every possible pair of T2CEPs and ACEPs with DCEPs, and RR Lyr stars. We confirm that BL Her stars are as old as RR Lyr variables – their spatial distributions are similar, and they create a vast halo around both galaxies. We discover that spatial distribution of W Vir stars has attributes characteristic for both young and old stellar populations. Hence, it seems that these similarities are related to the concentration of these stars in the center of the Large Magellanic Cloud, and the lack of a vast halo. This leads to the conclusion that W Vir variables could be a mixture of old and intermediate-age stars. Our analysis of the three-dimensional distributions of ACEPs shows that they differ significantly from DCEPs. Statistical tests of ACEPs distributions with RR Lyr distributions give ambiguous results. We consider that these two distributions can be similar through the vast halos they create. This similarity would confirm ACEPs evolution scenario that assumes coalescence of a binary system.

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The re-acceleration of the shock wave in the radio remnant of SN 1987A

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We report on updated radio imaging observations of the radio remnant of Supernova 1987A (SN 1987A) at 9 GHz, taken with the Australia Telescope Compact Array (ATCA), covering a 25-year period (1992–2017). We use Fourier modeling of the supernova remnant to model its morphology, using both a torus model and a ring model, and find both models show an increasing flux density, and have shown a continuing expansion of the remnant. As found in previous studies, we find the torus model most accurately fits our data, and has shown a change in the remnant expansion at Day 9,300 ± 210 from 2,300 ± 200 km s^{-1} to 3,610 ± 240 km s^{-1}. We have also seen an increase in brightness in the western lobe of the remnant, although the eastern lobe is still the dominant source of emission, unlike what has been observed at contemporary optical and X-ray wavelengths. We expect to observe a reversal in this asymmetry by the year ~ 2020, and note the South-Eastern side of the remnant is now beginning to fade, as has also been seen in optical and X-ray data. Our data indicate that high-latitude emission has been present in the remnant from the earliest stages of the shockwave interacting with the equatorial ring around Day 5,000. However, we find the emission has become increasingly dominated by the low-lying regions by Day 9,300, overlapping with the regions of X-ray emission. We conclude that the shockwave is now leaving the equatorial ring, exiting first from the South-East region of the remnant, and is re-accelerating as it begins to interact with the circumstellar medium beyond the dense inner ring.

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Hints for multiple populations in intermediate-age clusters of the Small Magellanic Cloud

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We report on the magnitude of the intrinsic [Fe/H] spread in the Small Magellanic Cloud (SMC) intermediate-age massive clusters NGC 339, 361, Lindsay 1 and 113, respectively. In order to measure the cluster metallicity dispersions, we used accurate Strömgren photometry of carefully selected cluster red giant branch (RGB) stars. We determined the Fe-abundance spreads by employing a maximum likelihood approach. The spreads obtained using the more accurate photometry of the brighter RGB stars resulted to be marginal ($\sim 0.05 \pm 0.03$ dex) for NGC 339 and NGC 361, while for Lindsay 1 and Lindsay 113 we obtained metallicity spreads of $0.00 \pm 0.04$ dex. From these results, we speculated with the possibility that NGC 361 is added to the group of four SMC clusters with observational evidence of multiple populations (MPs). Furthermore, in the context of the present debate about the existence of Fe-abundance inhomogeneities among old clusters with MPs, these outcomes put new constrains to recent theoretical speculations for making this phenomenon visible.

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New constraints on the nature and origin of the Leading Arm of the Magellanic Stream

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We present a new precision measurement of gas-phase abundances of S, O, N, Si, Fe, P, Al, Ca as well as molecular hydrogen ($H_2$) in the Leading Arm (region II, LAII) of the Magellanic Stream (MS) towards the Seyfert galaxy NGC 3783. The results are based on high-quality archival ultraviolet/optical/radio data from various different instruments (HST/STIS, FUSE, AAT, GBT, GB140ft, ATCA). Our study updates previous results from lower-resolution data and provides for the first time a self-consistent component model of the complex multi-phase absorber, delivering important constraints on the nature and origin of LAII. We derive a uniform, moderate alpha abundance in the two main absorber groups at +245 and +190 km s$^{-1}$ of $\alpha$/H = 0.30 ± 0.05 solar, a low nitrogen abundance of N/H = 0.05 ± 0.01 solar, and a high dust content with substantial dust depletion values for Si, Fe, Al, and Ca. These alpha, N, and dust abundances in LAII are similar to those observed in the Small Magellanic Cloud (SMC). From the analysis of the $H_2$ absorption, we determine a high thermal pressure of $P/k = 1680$ K cm$^{-3}$ in LAII, in line with the idea that LAII is located in the inner Milky Way halo at a $z$-height of $< 20$ kpc where it hydrodynamically interacts with the ambient hot coronal gas. Our study supports a scenario, in which LAII stems from the break-up of a metal- and dust-enriched progenitor cloud that was recently (200–500 Myr ago) stripped from the SMC.

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The 30 year search for the compact object in SN 1987A

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Despite more than 30 years of searches, the compact object in Supernova (SN) 1987A has not yet been detected. We present new limits on the compact object in SN 1987A using millimeter, near-infrared, optical, ultraviolet, and X-ray observations from ALMA, VLT, HST, and Chandra. The limits are approximately 0.1 mJy (0.1 × 10−26 erg s−1 cm−2 Hz−1) at 213 GHz, 1 L⊙ (6 × 10−29 erg s−1 cm−2 Hz−1) in optical if our line-of-sight is free of ejecta dust, and 1036 erg s−1 (2 × 10−30 erg s−1 cm−2 Hz−1) in 2–10 keV X-rays. Our X-ray limits are an order of magnitude less constraining than previous X-ray limits because we use a more realistic ejecta absorption model based on three-dimensional neutrino-driven SN explosion models (Alp et al. 2018). The allowed bolometric luminosity of the compact object is 22 L⊙ if our line-of-sight is free of ejecta dust, or 138 L⊙ if dust-obscured. Depending on assumptions, these values limit the effective temperature of a neutron star to < 4–8 MK and do not exclude models, which typically are in the range 3–4 MK. For the simplest accretion model, the accretion rate for an efficiency η is limited to < 10−11 η−1 M⊙ yr−1, which excludes most models. For pulsar activity modeled by a rotating magnetic dipole in vacuum, the limit on the magnetic field strength (B) for a given spin period (P) is B ≤ 5 × 1014 P−2 G s−2, which firmly excludes pulsars comparable to the Crab. By combining information about radiation reprocessing and geometry, it is likely that the compact object is a dust-obscured thermally-emitting neutron star, which may appear as a region of higher-temperature ejecta dust emission.

Postdoctoral Fellow

Applications are invited for a postdoctoral research fellow at the University of Michigan to work with Prof. Sally Oey on topics related to massive stars, feedback, and/or Ly-continuum/Lyα radiative transfer from starbursts. The successful candidate will have access to the University of Michigan telescope facilities, including the twin 6.5-m Magellan Telescopes, the MDM 2.4-m and 1.3-m telescopes at Kitt Peak, and privileged access to NOEMA and Swift. The department has a vibrant environment with several journal clubs and discussion groups. This position is available immediately, initially available for one year, with likely extension to two or three years, pending funding and satisfactory performance. The ideal candidate will have a published track record of observational work in the described area of research.

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