Dear Colleagues,

It is my pleasure to present you the 102nd issue of the Magellanic Clouds Newsletter. A variety of diverse topics were addressed each in more than a single contribution: supernova remnants (N 132D, N 49, 1987A), young stellar objects, chemical compositions (including ice, and ammonia), star clusters, variables stars (including distance determinations), with lots on AGB stars — they are, indeed, common inhabitants! (cf. the announcement of the Vienna meeting next Summer)

Hurray for Sundar, who has presented us with a Ph.D. thesis on mass return into the interstellar medium of the LMC. His reward is a job in Paris — not bad!

The next issue is planned to be distributed on the 1st of February 2010. I would like to already wish you a wonderful and peaceful New Year!

Editorially Yours,
Jacco van Loon
Rb-rich Asymptotic Giant Branch stars in the Magellanic Clouds


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We present high-resolution ($R \sim 60,000$) optical spectra of a carefully selected sample of heavily obscured and presumably massive O-rich Asymptotic Giant Branch (AGB) stars in the Magellanic Clouds (MCs). We report the discovery of strong Rb lines at 7800 Å in four Rb-rich LMC stars at luminosities equal to or greater than the standard adopted luminosity limit for AGB stars ($M_{\text{bol}} \sim -7.1$ mag), confirming that “Hot Bottom Burning” (HBB) may produce a flux excess in the more massive AGB stars. In the SMC sample, just one of the five stars with $M_{\text{bol}} < -7.1$ mag was detected in Rb; the other stars may be massive red supergiants. The Rb-rich LMC AGB stars might have stellar masses of at least $\sim 6-7$ $M_\odot$. Our abundance analysis show that these Rb-rich stars are extremely enriched in Rb by up to $10^3-10^5$ times solar but seem to have only mild Zr enhancements. The high Rb/Zr ratios, if real, represent a severe problem for the $s$-process, even if the $^{22}$Ne source is operational as expected for massive AGB stars; it is not possible to synthesize copious amounts of Rb without also overproducing Zr. The solution to the problem may lie with an incomplete present understanding of the atmospheres of luminous AGB stars.

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Cosmic Origins Spectrograph observations of the chemical composition of LMC N132D

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We present new far-ultraviolet spectra of an oxygen-rich knot in the Large Magellanic Cloud supernova remnant N132D, obtained with the Hubble Space Telescope-Cosmic Origins Spectrograph. Moderate resolution ($\Delta v \approx 200$ km s$^{-1}$) spectra in the HST far-ultraviolet bandpass (1150Å $\leq \lambda \leq 1750$ Å) show emission from several ionization states of oxygen as well as trace amounts of other species. We use the improvements in sensitivity and resolving power offered by COS to separate contributions from different velocity components within the remnant, as well as emission from different species within the oxygen-rich knot itself. This is the first time that compositional and velocity structure in the ultraviolet emission lines from N132D has been resolved, and we use this to assess the chemical composition of the remnant. No nitrogen is detected in N132D and multiple carbon species are found at velocities inconsistent with the main oxygen component. We find helium and silicon to be associated with the oxygen-rich knot, and use the reddening-corrected line strengths of OIII], OIV], O V, and Si IV to constrain the composition and physical characteristics of this oxygen-rich knot. We find that models with a silicon-to-oxygen abundance ratio of $N($Si$)/N($O$) = 10^{-2}$ can reproduce
the observed emission for a shock velocity of $\approx 130 \text{ km s}^{-1}$, implying a mass of $\sim 50 \text{ M}_\odot$ for the N 132D progenitor star.

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Tracers of stellar mass-loss. I. Optical and near-IR surface brightness fluctuations

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We present optical and IR integrated colours and SBF magnitudes, computed from stellar population synthesis models that include emission from the dusty envelopes surrounding mass-loosing TP-AGB stars. We explore the effects of varying the mass-loss rate by one order of magnitude around the fiducial value, modulating accordingly both the stellar parameters and the output spectra of the TP-AGB stars plus their dusty envelopes. The models are single burst, and range in age from a few Myr to 14 Gyr, and in metallicity between $Z = 0.0001$ and $Z = 0.07$; they combine new calculations for the evolution of stars in the TP-AGB phase (Marigo & Girardi 2007), with star plus envelope SEDs produced with the radiative transfer code DUSTY (Ivezić et al. 1999). We compare these models to optical and near-IR data of single AGB stars and Magellanic star clusters. This comparison validates the current understanding of the role of mass-loss in determining stellar parameters and spectra in the TP-AGB. However, neither broad-band colours nor SBF measurements in the optical or the near-IR can discern global changes in the mass-loss rate of a stellar population. Finally, we predict that mid-IR SBF measurements can pick out such changes, and actually resolve whether a relation between metallicity and mass-loss exists.

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The Optical Gravitational Lensing Experiment. The OGLE-III catalog of variable stars. IV. Long-Period Variables in the Large Magellanic Cloud


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The fourth part of the OGLE-III catalog of variable stars comprises 91,995 long-period variables (LPVs) in the Large Magellanic Cloud (LMC). This sample consist of 79,200 OGLE Small Amplitude Red Giants (OSARGs), 11,128 semiregular variables (SRVs) and 1667 Mira stars. The catalog data include basic photometric and astrometric properties of the stars, long-term multi-epoch $VI$ photometry and finding charts. We describe the methods used for the identification and classification of LPVs. The distribution of $I$-band amplitudes for carbon-rich stars shows two maxima, corresponding to Miras and SRVs. Such a distinction between Miras and
SRVs is not obvious for oxygen-rich stars. We notice additional period–luminosity sequence located between Wood’s sequences C and C’ and populated by SRVs.

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A Spitzer Space Telescope far-infrared spectral atlas of compact sources in the Magellanic Clouds. I. The Large Magellanic Cloud

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We present far-infrared spectra, \(\lambda=52–93 \, \mu m\), obtained with the Spitzer Space Telescope in the Spectral Energy Distribution mode of its MIPS instrument, of a representative sample of the most luminous compact far-infrared sources in the Large Magellanic Cloud. These include carbon stars, OH/IR Asymptotic Giant Branch (AGB) stars, post-AGB objects and Planetary Nebulae, the R CrB-type star HV 2671, the OH/IR red supergiants WOH G064 and IRAS 05280–6910, the three B[e] stars IRAS 04530–6916, R 66 and R 126, the Wolf-Rayet star Brey 3a, the Luminous Blue Variable (LBV) R 71, the supernova remnant N 49, a large number of young stellar objects (YSOs), compact H II regions and molecular cores, and a background galaxy at a redshift \(z \simeq 0.175\). We use the spectra to constrain the presence and temperature of cold dust and the excitation conditions and shocks within the neutral and ionized gas, in the circumstellar environments and interfaces with the surrounding interstellar medium (ISM). First, we introduce a spectral classification scheme. Then, we measure line strengths, dust temperatures, and IR luminosities. Objects associated with star formation are readily distinguished from evolved stars by their cold dust and/or fine-structure lines. Evolved stars, including the LBV R 71, lack cold dust except in some cases where we argue that this is swept-up ISM. This leads to an estimate of the duration of the prolific dust-producing phase (“superwind”) of several thousand years for both RSGs and massive AGB stars, with a similar fractional mass loss experienced despite the different masses. We tentatively detect line emission from neutral oxygen in the extreme RSG WOH G064, which suggests a large dust-free cavity with implications for the wind driving. In N 49, the shock between the supernova ejecta and ISM is revealed in spectacular fashion by its strong [O I] \(\lambda63-\mu m\) emission and possibly water vapour; we estimate that 0.2 M\(_{\odot}\) of ISM dust was swept up. On the other hand, some of the compact H II regions display pronounced [O III] \(\lambda88-\mu m\) emission. The efficiency of photo-electric heating in the interfaces of ionized gas and molecular clouds is estimated at 0.1–0.3%. We confirm earlier indications of a low nitrogen content in the LMC. Evidence for solid state emission features is found in both young and evolved objects, but the carriers of these features remain elusive; some of the YSOs are found to contain crystalline water ice. The spectra constitute a valuable resource for the planning and interpretation of observations with the Herschel Space Observatory and the Stratospheric Observatory For Infrared Astronomy (SOFIA).

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High resolution X-ray imaging of supernova remnant 1987A

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We report observations of the remnant of supernova 1987A with the High Resolution Camera (HRC) onboard the Chandra X-ray Observatory. A direct image from the HRC resolves the annular structure of the X-ray remnant, confirming the morphology previously inferred by deconvolution of lower resolution data from the Advanced CCD Imaging Spectrometer. Detailed spatial modeling shows that the a thin ring plus a thin shell gives statistically the best description of the overall remnant structure, and suggests an outer radius $0.96'' \pm 0.05'' \pm 0.03''$ for the X-ray-emitting region, with the two uncertainties corresponding to the statistical and systematic errors, respectively. This is very similar to the radius determined by a similar modeling technique for the radio shell at a comparable epoch, in contrast to previous claims that the remnant is 10–15% smaller at X-rays than in the radio band. The HRC observations put a flux limit of $0.010 \text{ cts s}^{-1}$ (99% confidence level, 0.08–10 keV range) on any compact source at the remnant center. Assuming the same foreground neutral hydrogen column density as towards the remnant, this allows us to rule out an unobscured neutron star with surface temperature $T_{\infty} > 2.5 \text{ MK}$ observed at infinity, a bright pulsar wind nebula or a magnetar.

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Integrated $K$-band spectra of old and intermediate-age globular clusters in the Large Magellanic Cloud

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Current stellar population models have arguably the largest uncertainties in the near-IR wavelength range, partly due to a lack of large and well calibrated empirical spectral libraries. In this paper we present a project, which aim it is to provide the first library of luminosity weighted integrated near-IR spectra of globular clusters to be used to test the current stellar population models and serve as calibrators for the future ones. Our pilot study presents spatially integrated $K$-band spectra of three old ($> 10 \text{ Gyr}$) and metal poor ([Fe/H] $\sim -1.4$), and three intermediate age (1–2 Gyr) and more metal rich ([Fe/H] $\sim -0.4$) globular clusters in the LMC. We measured the line strengths of the Na\textsc{i}, Ca\textsc{i} and $^{12}\text{CO}(2–0)$ absorption features. The Na\textsc{i} index decreases with the increasing age and decreasing metallicity of the clusters. The $D_{\text{CO}}$ index, used to measure the $^{12}\text{CO}(2–0)$ line strength, is significantly reduced by the presence of carbon-rich TP-AGB stars in the globular clusters with age $\sim 1 \text{ Gyr}$. This is in contradiction with the predictions of the stellar population models of Maraston (2005). We find that this disagreement is due to the different CO absorption strength of carbon-rich Milky Way TP-AGB stars used in the models and the LMC carbon stars in our sample. For globular clusters with age $> 2 \text{ Gyr}$ we find $D_{\text{CO}}$ index measurements consistent with the model predictions.

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The Araucaria project. The distance to the Small Magellanic Cloud from near-infrared photometry of RR Lyrae variables

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We have obtained deep infrared $J$ and $K$ band observations of nine $4.9' \times 4.9'$ fields in the Small Magellanic Cloud (SMC) with the ESO New Technology Telescope equipped with the SOFI infrared camera. In these fields, 34 RR Lyrae stars catalogued by the OGLE collaboration were identified. Using different theoretical and empirical calibrations of the infrared period–luminosity–metallicity relation, we find consistent SMC distance moduli, and find a best true distance modulus to the SMC of $18.97 \pm 0.03$ (statistical) $\pm 0.12$ (systematic) mag which agrees well with most independent distance determinations to this galaxy, and puts the SMC 0.39 mag more distant than the LMC for which our group has recently derived, from the same technique, a distance of 18.58 mag.

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How universal are the young cluster sequences? The cases of LMC, SMC, M 83 and the Antennae

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Recently a new analysis of cluster observations in the Milky Way found evidence that clustered star formation may work under tight constraints with respect to cluster size and density, implying the presence of just two sequences of young massive cluster. These two types of clusters each expand at different rates with cluster age. Here we investigate whether similar sequences exist in other nearby galaxies. We find that while for the extragalactic young stellar clusters the overall trend in the cluster-density scaling is quite comparable to the relation obtained for Galactic clusters, there are also possible difference. For the LMC and SMC clusters the densities are below the Galactic data points and/or the core radii are smaller than those of data points with comparable density. For M 83 and the Antenna clusters the core radii are possibly comparable to the Galactic clusters but it is not clear whether they exhibit similar expansion speeds. These findings should serve as an incentive to perform more systematic observations and analysis to answer the question of a possible similarity between young galactic and extragalactic star clusters sequences.

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Physical parameters of the Small Magellanic Cloud RR Lyrae stars and the distance scale

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We present a careful and detailed light curve analysis of RR Lyrae stars in the Small Magellanic Cloud (SMC) discovered by the Optical Gravitational Lensing Experiment (OGLE) project. Out of 536 single mode RR Lyrae stars selected from the database, we have investigated the physical properties of 335 ‘normal looking’ RRab stars and 17 RRc stars

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We present a careful and detailed light curve analysis of RR Lyrae stars in the Small Magellanic Cloud (SMC) discovered by the Optical Gravitational Lensing Experiment (OGLE) project. Out of 536 single mode RR Lyrae stars selected from the database, we have investigated the physical properties of 335 ‘normal looking’ RRab stars and 17 RRc stars
that have good quality photometric light curves. We have also been able to estimate the distance modulus of the cloud which is in good agreement with those determined from other independent methods. The Fourier decomposition method has been used to study the basic properties of these variables. Accurate Fourier decomposition parameters of 536 RR Lyrae stars in the OGLE-II database are computed. Empirical relations between the Fourier parameters and some physical parameters of these variables have been used to estimate the physical parameters for the stars from the Fourier analysis. Further, the Fourier decomposition of the light curves of the SMC RR Lyrae stars yields their mean physical parameters as: [Fe/H] = −1.56 ± 0.25, $M = 0.55 ± 0.01\, M_\odot$, $T_{\text{eff}} = 6404 ± 12\, K$, $\log L = 1.60 ± 0.01\, L_\odot$ and $M_V = 0.78 ± 0.02\, \text{mag}$ for 335 RRab variables and $[\text{Fe/H}] = −1.90 ± 0.13, M = 0.82 ± 0.18\, M_\odot$, $T_{\text{eff}} = 7177 ± 16\, K$, $\log L = 1.62 ± 0.02\, L_\odot$ and $M_V = 0.76 ± 0.05\, \text{mag}$ for 17 RRc stars. Using the absolute magnitude, intensity-weighted mean magnitude and the phase-weighted mean magnitude of the RR Lyrae stars, the mean distance modulus to the SMC is estimated to be $18.86 ± 0.01\, \text{mag}$, $18.83 ± 0.01\, \text{mag}$ and $18.84 ± 0.01\, \text{mag}$ respectively from the RRab stars. From the RRc stars, the corresponding distance modulus values are found to be $18.92 ± 0.04\, \text{mag}$, $18.89 ± 0.04\, \text{mag}$ and $18.89 ± 0.04\, \text{mag}$ respectively. Since Fourier analysis is a very powerful tool for the study of the physical properties of the RR Lyrae stars, we emphasize the importance of exploring the reliability of the calculation of Fourier parameters together with the uncertainty estimates keeping in view the large collections of photometric light curves that will become available from variable star projects of the future.

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Ice chemistry in embedded young stellar objects in the Large Magellanic Cloud


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We present spectroscopic observations of a sample of 15 embedded young stellar objects (YSOs) in the Large Magellanic Cloud (LMC). These observations were obtained with the Spitzer Infrared Spectrograph (IRS) as part of the SAGE-Spec Legacy program. We analyze the two prominent ice bands in the IRS spectral range: the bending mode of CO₂ ice at 15.2 μm and the ice band between 5 and 7 μm that includes contributions from the bending mode of water ice at 6 μm amongst other ice species. The 5–7 μm band is difficult to identify in our LMC sample due to the conspicuous contribution to the ice profile, 2 μm that includes contributions from the bending mode of water ice at 6 μm amongst other ice species. The 5–7 μm band is difficult to identify in our LMC sample due to the conspicuous presence of PAH emission superimposed onto the ice spectra. We identify water ice in the spectra of two sources; the spectrum of one of those sources also exhibits the 6.8 μm ice feature attributed to ammonium and methanol. We model the CO₂ band in detail, using the combination of laboratory ice profiles available in the literature. We find that a significant fraction (> 50%) of CO₂ ice is locked in a water-rich component, consistent with what is observed for Galactic sources. The majority of the sources in the LMC also require a pure-CO₂ contribution to the ice profile, evidence of thermal processing. There is a suggestion that CO₂ production might be enhanced in the LMC, but the size of the available sample precludes firmer conclusions. We place our results in the context of the star formation environment in the LMC.

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An *HST* view of the interstellar environments of Young Stellar Objects in the Large Magellanic Cloud


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We have used archival *HST* Hα images to study the immediate environments of massive and intermediate-mass young stellar object (YSO) candidates in the Large Magellanic Cloud (LMC). The sample of YSO candidates, taken from Gruendl & Chu (2009), was selected based on *Spitzer* IRAC and MIPS observations of the entire LMC and complementary ground-based optical and near-infrared observations. We found *HST* Hα images for 99 YSO candidates in the LMC, of which 82 appear to be genuine YSOs. More than 95% of the YSOs are found to be associated with molecular clouds. YSOs are seen in three different kinds of environments in the Hα images: in dark clouds, inside or on the tip of bright-rimmed dust pillars, and in small HII regions. Comparisons of spectral energy distributions for YSOs in these three different kinds of environments suggest that YSOs in dark clouds are the youngest, YSOs with small HII regions are the most evolved, and YSOs in bright-rimmed dust pillars span a range of intermediate evolutionary stages. This rough evolutionary sequence is substantiated by the presence of silicate absorption features in the *Spitzer* IRS spectra of some YSOs in dark clouds and in bright-rimmed dust pillars, but not those of YSOs in small HII regions. We present a discussion on triggered star formation for YSOs in bright-rimmed dust pillars or in dark clouds adjacent to HII regions. As many as 50% of the YSOs are resolved into multiple sources in high-resolution *HST* images. This illustrates the importance of using high-resolution images to probe the true nature and physical properties of YSOs in the LMC.

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The low-mass Initial Mass Function in the 30 Doradus starburst cluster


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We present deep *Hubble Space Telescope* (HST) NICMOS 2 F160W band observations of the central 56″ × 57″ (14 pc × 14.25 pc) region around R 136 in the starburst cluster 30Dor (NGC 2070) located in the Large Magellanic Cloud. Our aim is to derive the stellar Initial Mass Function (IMF) down to ∼ 1 M⊙ in order to test whether the IMF in a massive metal-poor cluster is similar to that observed in nearby young clusters and the field in our Galaxy. We estimate the mean age of the cluster to be 3 Myr by combining our F160W photometry with previously obtained HST WFPC2 optical F555W and F814W band photometry and comparing the stellar locus in the color–magnitude diagram with main sequence and pre-main sequence isochrones. The color–magnitude diagrams show the presence of differential extinction and possibly an age spread of a few Myr. We convert the magnitudes into masses adopting both a single mean age of 3 Myr isochrone and a constant star formation history from 2 to 4 Myr. We derive the IMF after correcting for incompleteness due to crowding. The faintest stars detected have a mass of 0.5 M⊙ and the data are more than 50% complete outside a radius of 5 pc down to a mass limit of 1.1 M⊙ for 3 Myr old objects. We find an IMF of \( \frac{dN}{dlogM} \propto M^{-1.20\pm0.2} \) over the mass range 1.1–20 M⊙ only slightly shallower than a Salpeter IMF. In particular, we find no strong evidence for a flattening of the IMF down to 1.1 M⊙ at a distance of 5 pc from the center, in contrast to a flattening at 2 M⊙ at a radius of 2 pc, reported in a previous optical HST study. We examine several possible reasons for the different results including the possible presence of mass segregation and the effects of
differential extinction, particularly for the pre-main sequence sources. If the IMF determined here applies to the whole cluster, the cluster would be massive enough to remain bound and evolve into a relatively low-mass globular cluster.

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Characterizing magnetohydrodynamic turbulence in the Small Magellanic Cloud

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We investigate the nature and spatial variations of turbulence in the Small Magellanic Cloud (SMC) by applying several statistical methods on the neutral hydrogen (H\textsubscript{i}) column density image of the SMC and a database of isothermal numerical simulations. By using the 3\textsuperscript{rd} and 4\textsuperscript{th} statistical moments we derive the spatial distribution of the sonic Mach number (M\textsubscript{s}) across the SMC. We find that about 90\% of the H\textsubscript{i} in the SMC is subsonic or transonic. However, edges of the SMC ‘bar’ have M\textsubscript{s} \sim 4 and may be tracing shearing or turbulent flows. Using numerical simulations we also investigate how the slope of the spatial power spectrum depends on both sonic and Alfvén Mach numbers. This allows us to gauge the Alfvén Mach number of the SMC and conclude that its gas pressure dominates over the magnetic pressure. The super-Alfvénic nature of the H\textsubscript{i} gas in the SMC is also highlighted by the bispectrum, a three-point correlation function which characterizes the level of non-Gaussianity in wave modes. We find that the bispectrum of the SMC H\textsubscript{i} column density displays similar large-scale correlations as numerical simulations, however it has localized enhancements of correlations. In addition, we find a break in correlations at a scale of \sim 160 pc. This may be caused by numerous expanding shells of a similar size.

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An evaluation of the excitation class parameter for the central stars of Planetary Nebulae

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The three main methods currently in use for estimating the excitation class of planetary nebulae (PNe) central stars are compared and evaluated using 586 newly discovered and previously known PNe in the Large Magellanic Cloud (LMC). In order to achieve this we ran a series of evaluation tests using line ratios derived from de-reddened, flux calibrated spectra. Pronounced differences between the methods are exposed. Diagrams were created by comparing excitation classes with H\textbeta line fluxes. The best methods are then compared to published temperatures using the Zanstra method and assessed for their ability to reflect central star effective temperatures and evolution. As a result we call for a clarification of the term ‘excitation class’ according to the different input parameters used. The first method, which we refer to as Ex\textsubscript{neb} relies purely on the ratios of certain key emission lines. The second method, which we refer to as Ex\textsubscript{\textalpha} includes modeling to create a continuous variable and, for optically thick PNe in the Magellanic Clouds, is designed to relate more closely to intrinsic stellar parameters. The third method, we refer to as Ex\textsubscript{[O\textsc{iii}]/H\textbeta} since the [O\textsc{iii}]/H\textbeta ratio is used in isolation to other temperature diagnostics. Each of these methods is shown to have serious drawbacks when used as an indicator for central star temperature. Finally, we suggest a new method (Ex\textsubscript{\rho}) for estimating excitation class incorporating both the [O\textsc{iii}]/H\beta and the He\textit{ii} 4686/H\beta ratios. Although any attempt to provide accurate central star temperatures using the excitation class derived from nebula lines will always be limited,
we show that this new method provides a substantial improvement over previous methods with better agreement to temperatures derived through the Zanstra method.

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First detection of ammonia in the Large Magellanic Cloud: The kinetic temperature of dense molecular cores in N 159 W

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The first detection of ammonia (NH₃) is reported from the Magellanic Clouds. Using the Australia Telescope Compact Array, we present a targeted search for the \((J,K) = (1,1)\) and \((2,2)\) inversion lines towards seven prominent star-forming regions in the Large Magellanic Cloud (LMC). Both lines are detected in the massive star-forming region N 159 W, which is located in the peculiar molecular ridge south of 30 Doradus, a site of extreme star formation strongly influenced by an interaction with the Milky Way halo. Using the ammonia lines, we derive a kinetic temperature of \(\sim 16\) K, which is 2–3 times below the previously derived dust temperature. The ammonia column density, averaged over \(\sim 17''\) is \(\sim 6 \times 10^{12} \text{ cm}^{-2}\) \(< 1.5 \times 10^{13} \text{ cm}^{-2}\) over 9'' in the other six sources) and we derive an ammonia abundance of \(\sim 10^{-10}\) with respect to molecular hydrogen. This fractional abundance is 2–5 orders of magnitude below those observed in Galactic star-forming regions. The nitrogen abundance in the LMC (\(\sim 10\%\) solar) and the high UV flux, which can photo-dissociate the particularly fragile NH₃ molecule, must both contribute to the low fractional NH₃ abundance, and we likely only see the molecule in an ensemble of the densest, best shielded cores of the LMC.

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Conference Paper

Star clusters with dual red clumps

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A few star clusters in the Magellanic Clouds present composite structures in red clump region of their colour magnitude diagrams (CMD). The most striking case is NGC 419 in the SMC, where the red clump is composed of a main blob together with a marked secondary feature. This structure is demonstrated to be real and corresponds to the simultaneous presence of stars which passed through electron degeneracy after central H-exhaustion, and those which did not (Girardi et al. 2009). This rare occurrence in a single cluster allows us to set stringent constraints to its age and to the efficiency of convective core overshooting during the main sequence. In this talk, we present a more detailed analysis of NGC 419 together with a first look at other populous LMC clusters which are apparently in the same phase, namely NGC 1751, NGC 1783, NGC 1806, NGC 1846, NGC 1852, and NGC 1917. Moreover, we compare these Magellanic Cloud cases with their Galactic counterparts, NGC 752 and NGC 7789 (Mermilliod et al. 1998; Girardi et al. 2000). We emphasise the extraordinary potential of these clusters as absolute calibration marks in the age scale of
Star clusters as simple stellar populations

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In this paper I review to what extent we can understand the photometric properties of star clusters, and low mass unresolved galaxies in general, in terms of population synthesis models designed to describe Simple Stellar Populations (SSPs), i.e., groups of stars born at the same time, in the same region of space, and out of a gas cloud of homogeneous chemical composition. The photometric properties predicted by these models do not readily match the observations of most star clusters, unless we take into account properly the expected variation in the number of stars occupying sparsely populated evolutionary stages due to stochastic fluctuations in the IMF. In this case, population synthesis models reproduce remarkably well the full observed ranges of integrated colors and absolute magnitudes of star clusters of various ages and metallicities. The disagreement between model predictions and the observations of cluster colors and magnitudes may indicate problems or deficiencies in the modeling, and not necessarily tell us that star clusters do not behave as SSPs. Matching the photometric properties of star clusters using SSP models is a necessary condition for clusters to be considered simple stellar populations, but not a sufficient one. Composite models, with a complex star formation history, also match the observed cluster colors.

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Chemical evolution of star clusters

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I discuss the chemical evolution of star clusters, with emphasis on old globular clusters, in relation to their formation histories. Globular clusters clearly formed in a complex fashion, under markedly different conditions from any younger clusters presently known. Those special conditions must be linked to the early formation epoch of the Galaxy and must not have occurred since. While a link to the formation of globular clusters in dwarf galaxies has been suggested, present-day dwarf galaxies are not representative of the gravitational potential wells within which the globular clusters formed. Instead, a formation deep within the proto-Galaxy or within dark-matter minihaloes might be favoured. Not all globular clusters may have formed and evolved similarly. In particular, we may need to distinguish Galactic halo from Galactic bulge clusters.

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The physical properties of red supergiants

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Red supergiants (RSGs) are an evolved He-burning phase in the lifetimes of moderately high mass (10–25 M☉) stars. The physical properties of these stars mark them as an important and extreme stage of massive stellar evolution, but determining these properties has been a struggle for many years. The cool extended atmospheres of RSGs place them in an extreme position on the Hertzsprung–Russell diagram and present a significant challenge to the conventional assumptions of stellar atmosphere models. The dusty circumstellar environments of these stars can potentially complicate the determination of their physical properties, and unusual RSGs in the Milky Way and neighboring galaxies present a suite of enigmatic properties and behaviors that strain, and sometimes even defy, the predictions of stellar evolutionary theory. However, in recent years our understanding of RSGs, including the models and methods applied to our observations and interpretations of these stars, has changed and grown dramatically. This review looks back at some of the latest work that has progressed our understanding of RSGs, and considers the many new questions posed by our ever-evolving picture of these cool massive stars.

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The mass-loss return from Asymptotic Giant Branch stars to the Large Magellanic Cloud using data from the SAGE survey

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The asymptotic giant branch (AGB) phase is the penultimate stage of evolution for low- and intermediate-mass stars. Nucleosynthesis products transported from the helium-fusing shell to the outer, cooler regions form gas molecules and dust grains whose chemistry depends on whether oxygen or carbon is more abundant on the surface. Radiation pressure causes the oxygen- or carbon-rich dust to flow outward, dragging the gas along. Such outflows inject a significant amount of material into the interstellar medium (ISM), seeding new star formation. AGB mass loss is thus a crucial component of galactic chemical evolution. The Large Magellanic Cloud (LMC) is an excellent site for AGB studies. Over 40,000 AGB candidates have been identified using photometric data from the Spitzer Space Telescope Surveying The Agents of a Galaxy’s Evolution (SAGE) mid-infrared (MIR) survey, including about 35,000 oxygen-rich, 7000 carbon-rich and 1400 “extreme” sources. For the first time, SAGE photometry reveals two distinct populations of O-rich sources in the LMC: a faint population that gradually evolves into C-rich stars and a bright, massive population that circumvents this evolution, remaining O-rich.

This work aims to quantify the mass-loss return from AGB stars to the LMC, a rough estimate for which is derived from the amount of MIR dust emission in excess of that from starlight. I show that this excess flux is a good proxy for the mass-loss rate, and I calculate the total AGB injection rate to be (5.9–13) ×10−3 M☉ yr⁻¹. A more accurate determination requires detailed dust radiative transfer (RT) modeling. For this purpose, I present a grid of C-rich AGB models generated by the RT code 2DUST, spanning a range of effective temperatures, gravities, dust shell radii and optical depths as well as a baseline set of dust properties obtained by modeling a carbon star, data for which was acquired as part of the spectroscopic follow-up to SAGE. AGB stars are the best laboratories for dust studies, and the development of a model grid will reinforce future research in this field.

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Announcement

Why galaxies care about AGB stars II.
Shining examples and common inhabitants

Stars are conspicuous components of galaxies, and the sites of the creation of most chemical elements. Due to their brightness and their production of heavy elements, stars on the Asymptotic Giant Branch (AGB) play an important role for understanding stellar and galactic evolution. This conference aims to build a bridge between AGB research and its application to the modelling of stellar populations and the chemical evolution of galaxies. Current developments and challenges on both sides will be discussed to reach an understanding of possibilities, limitations, and needs in both areas, and hence to improve our knowledge about the role of AGB stars in the context of galaxies. This is the follow-up meeting to the Vienna conference on a similar topic in August 2006.

This time the focus of the meeting will be:
— Complex Atmospheres & Interiors: Dynamics, Evolution & Abundances
— Environment: Mass Loss, Chemistry & Geometry
— Common Inhabitants: Population Studies & Synthesis Models
— Out There: Magellanic Clouds, Local Group & Beyond
— Perspectives Near and Far: ALMA, Herschel, JWST, ELTs, ...

A list of invited speakers is available on our webpage

http://www.univie.ac.at/galagb.

The conference will be hosted by the Austrian Society for Astronomy and Astrophysics and the Department of Astronomy at the University of Vienna. The meeting is supported by the IAU Working Group on Abundances in Red Giants, by the IK "Cosmic Matter Cycle" at the University of Vienna, and by the Robert F. Wing Support Fund at Ohio State University.

Preregistration is now open and possible via our webpage.

We are looking forward to seeing you in Vienna in August 2010!

Thomas Lebzelter in the name of the SOC and LOC.

See also http://www.univie.ac.at/galagb