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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 148$^{\rm th}$ issue of the AGB Newsletter. You can read about the mystery of the missing vast majority of PNe, about the effect AGB stars have on measurements of galaxy masses, surface brightness fluctuations and the integrated spectra of clusters, about very high resolution imaging of CH Cygni, χ Cygni, and Betelgeuse, and magnetic fields, H I shells and the interaction between PNe and the ISM, more about PN kinematics in spiral galaxies, and the first two SAGE-Spec papers, and much more.

Four years later, Vienna is hosting the sequel to the very interesting and enjoyable conference "Why Galaxies Care About AGB Stars", in August next year.

The next issue is planned to be distributed on the 1$^{\rm st}$ of December 2009.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

The majority of AGB stars do not produce a planetary nebula.

Reactions to this statement or suggestions for next month's statement can be e-mailed to agbnews@astro.keele.ac.uk (please state whether you wish to remain anonymous)

Refereed Journal Papers

Resolving the asymmetric inner wind region of the yellow hypergiant IRC +10 420 with VLTI/AMBER in low and high spectral resolution mode

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IRC +10 420 is a massive evolved star belonging to the group of yellow hypergiants. Currently, this star is rapidly evolving through the Hertzprung–Russell diagram, crossing the so-called yellow void. IRC +10 420 is suffering from intensive mass loss which led to the formation of an extended dust shell. Moreover, the dense stellar wind of IRC +10 420 is subject to strong line emission. Our goal was to probe the photosphere and the innermost circumstellar environment of IRC +10 420, to measure the size of its continuum- as well as the Brackett γ (BrG) line-emitting region on milliarcsecond scales, and to search for evidence of an asymmetric distribution of IRC +10 420's dense, circumstellar gas. We obtained near-infrared long-baseline interferometry of IRC +10 420 with the AMBER instrument of ESO's Very Large Telescope Interferometer (VLTI). The measurements were carried out in May/June 2007 and May 2008 in low-spectral resolution mode in the JHK bands using three Auxillary Telescopes (ATs) at projected baselines ranging from 30 to 96m, and in October 2008 in high-spectral resolution mode in the K band around the BrG emission line using three Unit Telescopes (UTs) with projected baselines between 54 and 129m. The high-spectral resolution mode observations were analyzed by means of radiative transfer modeling using CMFGEN and the 2-D Busche & Hillier codes. For the first time, we have been able to absolutely calibrate the H- and K-band data and, thus, to determine the angular size of IRC +10 420's continuum- and BrG line-emitting regions. We found that both the low resolution differential and closure phases are zero within the uncertainty limits across all three bands. In the high-spectral resolution observations, the visibilities show a noticeable drop across the BrG line on all three baselines. We found differential phases up to $-25°$, in the redshifted part of the BrG line and a non-zero closure phase close to the line center. The calibrated visibilities were corrected for AMBER's limited field-of-view to appropriately account for the flux contribution of IRC +10 420's extended dust shell. From our low-spectral resolution AMBER data we derived FWHM Gaussian sizes of 1.05 ± 0.07 and 0.98 ± 0.10 mas for IRC +10 420's continuum-emitting region in the H and K bands, respectively. From the high-spectral resolution data, we obtained a FWHM Gaussian size of 1.014 ± 0.010 mas in the K-band continuum. The BrG-emitting region can be fitted with a geometric ring model with a diameter of $4.18^{+0.19}_{-0.09}$ mas, which is approximately 4 times the stellar size. The geometric model also provides some evidence that the BrG line-emitting region is elongated towards a position angle of 36°, well aligned with the symmetry axis of the outer reflection nebula. Assuming an unclumped wind and a luminosity of 6×10^5 $L_\odot$, the spherical radiative transfer modeling with CMGFEN yields a current mass-loss rate of $1.5 - 2.0 \times 10^{-5}$ $M_\odot$ yr^{-1} based on the BrG equivalent width. However, the spherical CMFGEN model poorly reproduces the observed line shape, blueshift, and extension, definitively showing that the IRC +10 420 outflow is asymmetric. Our 2-D radiative transfer modeling shows that the blueshifted BrG emission and the shape of the visibility across the emission line can be explained with an asymmetric bipolar outflow with a high density contrast from pole to equator (8–16), where the redshifted light is substantially diminished.

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Spinning-up the envelope before entering a common envelope phase

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We calculate the orbital evolution of binary systems where the primary star is an evolved red giant branch (RGB) star, while the secondary star is a low mass main sequence (MS) star or a brown dwarf. The evolution starts when a tidal interaction causes the secondary to spiral-in. Either a common envelope (CE) is formed in a very short time, or the system reaches synchronization and the spiraling-in process substantially slows down. Some of these systems later enter a CE phase. We find that for a large parameters space, binary systems reach stable synchronized orbit before the onset of a CE phase. Such stable synchronized orbits allow the RGB star to lose mass prior to the onset of the CE phase. Even after the secondary enters the giant envelope, the rotation velocity is high enough to cause enhanced mass loss rate. Our results imply that it is crucial to include the pre-CE evolution when studying the outcome of the CE phase. Although we have made the calculations for RGB stars, the results have implications for other evolved stars that interact with close companions.

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New high-precision measurement of the reaction rate of the ^{18}O(p,α)^{15}N reaction via THM

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The ^{18}O(p,α)^{15}N reaction rate has been extracted by means of the Trojan-Horse method. For the first time the contribution of the 20-keV peak has been directly evaluated, giving a value about 35% larger than previously estimated. The present approach has allowed to improve the accuracy of a factor 8.5, as it is based on the measured strength instead of educated guesses or spectroscopic measurements. The contribution of the 90-keV resonance has been determined as well, which turned out to be of negligible importance to astrophysics.

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Searching for faint planetary nebulae using the Digital Sky Survey

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Recent Hα surveys such as SHS and IPHAS have improved the completeness of the Galactic planetary nebula (PN) census. We now know of ∼3 000 PNe in the Galaxy, but this is far short of most estimates, typically ∼25 000 or more for the total population. The size of the Galactic PN population is required to derive an accurate estimate of the chemical enrichment rates of nitrogen, carbon, and helium. In addition, a high PN count (>20 000) is strong evidence

that most 1–8 $M_\odot$ main sequence stars will go through a PN phase, while a low count (<10 000) argues that special conditions (e.g., a close binary interaction) are required to form a PN. We describe a technique for finding hundreds more PNe using the existing data collections of the digital sky surveys, thereby improving the census of Galactic PNe.

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On the stellar masses of IRAC detected Lyman Break Galaxies at $z \sim 3$

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We present results of a large survey of the mid-IR properties of 248 Lyman Break Galaxies with confirmed spectroscopic redshift using deep Spitzer/IRAC observations in six cosmological fields. We model the Spectral Energy Distributions (SEDs) employing a revised version of the Bruzual and Charlot synthesis population code that incorporates a new treatment of the TP-AGB phase (CB07). Our primary aim is to investigate the impact of the AGB phase in the stellar masses of the LBGs, and compare our new results with previous stellar mass estimates. Based on the new CB07 code we find that the stellar masses of LBGs are smaller on average by a factor of ~ 1.4 compared to previous estimates. LBGs with 8 μm and/or 24 μm detections show higher masses ($M \sim 10^{11}$ $M_\odot$) than LBGs faint in the IRAC bands ($M \sim 10^9$ $M_\odot$). The ages of these massive LBGs are considerably higher than the rest of the population, indicating that they have been star-forming for at least ~ 1 Gyr. We also show how the addition of the IRAC bands, improves the accuracy of the estimated stellar masses and reduced the scatter on the derived M/L ratios. In particular, we present a tight correlation between the 8 μm IRAC band (rest-frame K for galaxies at $z \sim 3$) and the stellar mass. We calculate the number density of massive ($M > 10^{11}$ $M_\odot$) LBGs and find it to be $\Phi = (1.12 \pm 0.4) \times 10^{-5}$ Mpc^{-3}, ~ 1.5 times lower than that found by previous studies. Finally, based on UV-corrected SFRs we investigate the SFR-stellar mass correlation at $z \sim 3$, find it similar to the one observed at other redshifts and show that our data place the peak of the evolution of the specific star formation rate at $z \sim 3$.

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Differential chemical abundance analysis of a 47 Tuc AGB star with respect to Arcturus

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This study resolves a discrepancy in the abundance of Zr in the 47 Tucanæ asymptotic giant branch star Lee 2525. This star was observed using the Échelle spectrograph on the 2.3 m telescope at Siding Spring Observatory. The analysis was undertaken by calibrating Lee 2525 with respect to the standard giant star Arcturus. This work emphasises the importance of using a standard star with stellar parameters comparable to the star under analysis rather than a calibration with respect to the Sun (Koch & McWilliam 2008). Systematic errors in the analysis process are then minimised due to the similarity in atmospheric structure between the standard and programme stars. The abundances derived for Lee 2525 were found to be in general agreement with the Brown & Wallerstein (1992) values except for

Zr. In this study Zr has a similar enhancement ([Zr/Fe] = +0.51 dex) to another light *s*-process element, Y ([Y/Fe] = +0.53 dex), which reflects current theory regarding the enrichment of *s*-process elements by nuclear processes within AGB stars (Busso et al. 2001). This is contrary to the results of Brown & Wallerstein (1992) where Zr was under-abundant ([Zr/Fe] = −0.51 dex) and Y was over-abundant ([Y/Fe] = +0.50 dex) with respect to Fe.

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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, modifying 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, λ=52–93 μm, 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] λ63-μm 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] λ88-μm 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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3D simulations of M star atmosphere velocities and their influence on molecular FeH lines

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We present an investigation of the velocity fields in early to late M-type star hydrodynamic models, and we simulate their influence on FeH molecular line shapes. The M star model parameters range between $\log g$ of 3.0–5.0 and $T_{\rm eff}$ of 2500 K and 4000 K. Our aim is to characterize the $T_{\rm eff}$- and $\log g$ -dependence of the velocity fields and express them in terms of micro- and macro-turbulent velocities in the one dimensional sense. We present also a direct comparison between 3D hydrodynamical velocity fields and 1D turbulent velocities. The velocity fields strongly affect the line shapes of FeH, and it is our goal to give a rough estimate for the $\log g$ and $T_{\rm eff}$ parameter range in which 3D spectral synthesis is necessary and where 1D synthesis suffices. In order to calculate M-star structure models we employ the 3D radiative-hydrodynamics (RHD) code CO5BOLD. The spectral synthesis on these models is performed with the line synthesis code LINFOR3D. We describe the 3D velocity fields in terms of a Gaussian standard deviation and project them onto the line of sight to include geometrical and limb-darkening effects. The micro- and macro-turbulent velocities are determined with the "Curve of Growth" method and convolution with a Gaussian velocity profile, respectively. To characterize the $\log g$ and $T_{\rm eff}$ dependence of FeH lines, the equivalent width, line width, and line depth are regarded. The velocity fields in M-stars strongly depend on $\log g$ and $T_{\rm eff}$. They become stronger with decreasing $\log g$ and increasing $T_{\rm eff}$.

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The pulsation of χ Cygni imaged by optical interferometry — a novel technique to derive distance and mass of Mira stars

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We present infrared interferometric imaging of the S-type Mira star χ Cygni. The object was observed at four different epochs in 2005–2006 with the IOTA optical interferometer (H band). Images show up to 40% variation in the stellar diameter, as well as significant changes in the limb darkening and stellar inhomogeneities. Model fitting gave precise time-dependent values of the stellar diameter, and reveals presence and displacement of a warm molecular layer. The star radius, corrected for limb darkening, has a mean value of 12.1 mas and shows a 5.1 mas amplitude pulsation. Minimum diameter was observed at phase 0.94 ± 0.01. Maximum temperature was observed several days later at phase 1.02 ± 0.02. We also show that combining the angular acceleration of the molecular layer with CO ($\Delta v = 3$) radial velocity measurements yields a 5.9 ± 1.5 mas parallax. The constant acceleration of the CO molecules — during

80% of the pulsation cycle — lead us to argument for a free-falling layer. The acceleration is compatible with a gravitational field produced by a $2.1^{+1.5}_{-0.7}$ $M_\odot$ star. This last value is in agreement with fundamental mode pulsator models. We foresee increased development of techniques consisting in combining radial velocity with interferometric angular measurements, ultimately allowing total mapping of the speed, density, and position of the diverse species in pulsation driven atmospheres.

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Imaging the spotty surface of Betelgeuse in the H band

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This paper reports on H-band interferometric observations of Betelgeuse made at the three-telescope interferometer IOTA. We image Betelgeuse and its asymmetries to understand the spatial variation of the photosphere, including its diameter, limb darkening, effective temperature, surrounding brightness, and bright (or dark) star spots. We used different theoretical simulations of the photosphere and dusty environment to model the visibility data. We made images with parametric modeling and two image reconstruction algorithms: MIRA and WISARD. We measure an average limb-darkened diameter of 44.28 ± 0.15 mas with linear and quadratic models and a Rosseland diameter of 45.03 ± 0.12 mas with a MARCS model. These measurements lead us to derive an updated effective temperature of 3600 ± 66 K. We detect a fully-resolved environment to which the silicate dust shell is likely to contribute. By using two imaging reconstruction algorithms, we unveiled two bright spots on the surface of Betelgeuse. One spot has a diameter of about 11 mas and accounts for about 8.5% of the total flux. The second one is unresolved (diameter < 9 mas) with 4.5% of the total flux. Resolved images of Betelgeuse in the H band are asymmetric at the level of a few percent. The MOLsphere is not detected in this wavelength range. The amount of measured limb-darkening is in good agreement with model predictions. The two spots imaged at the surface of the star are potential signatures of convective cells.

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NSCC — a New Scheme of Classification of C-rich stars devised from optical and infrared observations

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A new classification system for carbon-rich stars is presented based on an analysis of 51 AGB carbon stars through

the most relevant classifying indices available. The extension incorporated, that also represents the major advantage of this new system, is the combination of the usual optical indices that describe the photospheres of the objects, with new infrared ones, which allow an interpretation of the circumstellar environment of the carbon-rich stars. This new system is presented with the usual spectral subclasses and C_2-, j-, MS- and temperature indices, and also with the new SiC- (SiC/C.A. abundance estimation) and τ- (opacity) indices. The values for the infrared indices were carried out through a Monte Carlo simulation of the radiative transfer in the circumstellar envelopes of the stars. The full set of indices, when applied to our sample, resulted in a more efficient system of classification, since an examination in a wide spectral range allows us to obtain a complete scenario for carbon stars.

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The central star of the planetary nebula NGC 6302

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NGC 6302 is one of the highest ionization planetary nebulae known and shows emission from species with ionization potential > 300 eV. The temperature of the central star must be $> 200\,000$ K to photoionize the nebula, and has been suggested to be up to $\sim 400\,000$ K. On account of the dense dust and molecular disc, the central star has not convincingly been directly imaged until now. NGC 6302 was imaged in six narrow band filters by Wide Field Camera 3 on HST as part of the Servicing Mission 4 Early Release Observations. The central star is directly detected for the first time, and is situated at the nebula centre on the foreground side of the tilted equatorial disc. The magnitudes of the central star have been reliably measured in two filters (F469N and F673N). Assuming a hot black body, the reddening has been measured from the (4688–6766 Å) colour and a value of $c = 3.1$, $A_V = 6.6$ mag determined. A G–K main sequence binary companion can be excluded. The position of the star on the HR diagram suggests a fairly massive PN central star of about 0.64 $M_\odot$ close to the white dwarf cooling track. A fit to the evolutionary tracks for $(T, L, t) = 200\,000$ K, 2000 $L_\odot$, 2200 yr), where t is the nebular age, is obtained; however the luminosity and temperature remain uncertain. The model tracks predict that the star is rapidly evolving, and fading at a rate of almost 1% per year. Future observations could test this prediction.

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Circumstellar H I and CO around the carbon stars V1942 Sgr and V CrB

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Context. The majority of stars that leave the main sequence are undergoing extensive mass loss, in particular during the asymptotic giant branch (AGB) phase of evolution. Observations show that the rate at which this phenomenon develops differs highly from source to source, so that the time-integrated mass loss as a function of the initial conditions (mass, metallicity, etc.) and of the stage of evolution is presently not well understood.

Aims. We are investigating the mass loss history of AGB stars by observing the molecular and atomic emissions of their circumstellar envelopes.
Methods. In this work we have selected two stars that are on the thermally pulsing phase of the AGB (TP-AGB) and for which high quality data in the CO rotation lines and in the atomic hydrogen line at 21 cm could be obtained.
Results. V1942 Sgr, a carbon star of the Irregular variability type, shows a complex CO line profile that may originate from a long-lived wind at a rate of $\sim 10^{-7}$ $M_\odot$ yr^{-1}, and from a young ($\lesssim 10^4$ yr) fast outflow at a rate of $\sim 5\,10^{-7}$ $M_\odot$ yr^{-1}. Intense H I emission indicates a detached shell with 0.044 $M_\odot$ of hydrogen. This shell probably results from the slowing-down, by surrounding matter, of the same long-lived wind observed in CO that has been active during $\sim 6\,10^5$ years. On the other hand, the carbon Mira V CrB is presently undergoing mass loss at a rate of $2\,10^{-7}$ $M_\odot$ yr^{-1}, but was not detected in H I. The wind is mostly molecular, and was active for at most $3\,10^4$ years, with an integrated mass loss of at most $6.5\,10^{-3}$ $M_\odot$.
Conclusions. Although both sources are carbon stars on the TP-AGB, they appear to develop mass loss under very different conditions, and a high rate of mass loss may not imply a high integrated mass loss.

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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 Gyr) and metal poor ([Fe/H] ~ -1.4), and three intermediate age (1–2 Gyr) and more metal rich ([Fe/H] ~ -0.4) globular clusters in the LMC. We measured the line strengths of the Na I, Ca I and ^{12}CO(2–0) absorption features. The Na I index decreases with the increasing age and decreasing metallicity of the clusters. The $D_{\rm CO}$ index, used to measure the ^{12}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 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 Gyr we find $D_{\rm CO}$ index measurements consistent with the model predictions.

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Properties of large-amplitude variable stars detected with Two Micron All Sky Survey public images

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We present a catalog of variable stars in the near-infrared wavelength detected with overlapping regions of the Two

Micron All Sky Survey public images, and discuss their properties. The investigated region is in the direction of the Galactic Center ($-30^\circ \lesssim l \lesssim 20^\circ$, $|b| \lesssim 20^\circ$), which covers the entire bulge. We have detected 136 variable stars, of which six are already known and 118 are distributed in the $|b| \leq 5^\circ$ region. Additionally, 84 variable stars have optical counterparts in Digitized Sky Survey images. The three diagrams (color–magnitude, light variance, and color–color diagrams) indicate that most of the detected variable stars should be large-amplitude and long-period variables such as Mira variables or OH/IR stars. The number density distribution of the detected variable stars implies that they trace the bar structure of the Galactic Bulge.

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The dense and asymmetric central star wind of the young PN He 2-138

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We present optical ESO time-series and UV archival (FUSE, HST, IUE) spectroscopy of the H-rich central star of He 2-138. Our study targets the central star wind in a very young planetary nebula, and explores physical conditions that may provide clues to the nature of the preceding post-AGB super-wind phases of the star. We provide evidence for a dense, slowly accelerating outflow that is variable on time-scales of hours. Line-synthesis modelling (SEI and CMFGEN) of low and high ionization UV and optical lines is interpreted in terms of an asymmetric, two-component outflow, where high-speed high-ionization gas forms mostly in the polar region. Slower, low ionization material is then confined primarily to a cooler equatorial component of the outflow. A dichotomy is also evident at photospheric levels. We also document temporal changes in the weak photospheric lines of He 2-138, with tentative evidence for a 0.36-day modulation in blue-to-red migrating features in the absorption lines. These structures may betray 'wave-leakage' of prograde non-radial pulsations of the central star. These multi-waveband results on the aspherical outflow of He 2-138 are discussed in the context of current interest in understanding the origin of axi- and point-symmetric planetary nebulae.

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The magnetic field of the evolved star W 43A

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The majority of the observed planetary nebulae exhibit elliptical or bipolar structures. Recent observations have shown that asymmetries already start during the last stages of the AGB phase. Theoretical modeling has indicated that magnetically collimated jets may be responsible for the formation of the non-spherical planetary nebulae. Direct measurement of the magnetic field of evolved stars is possible using polarization observations of different maser species occurring in the circumstellar envelopes around these stars. The aim of this project is to measure the Zeeman splitting caused by the magnetic field in the OH and H_2O maser regions occurring in the circumstellar envelope and bipolar outflow of the evolved star W 43A. We compare the magnetic field obtained in the OH maser region with the one measured in the H_2O maser jet. We used the UK Multi-Element Radio Linked Interferometer Network (MERLIN) to observe the polarization of the OH masers in the circumstellar envelope of W 43A. Likewise, we used the Green Bank Telescope (GBT) observations to measure the magnetic field strength obtained previously in the H_2O maser jet. We

report a measured magnetic field of ≈ 100 μG in the OH maser region of the circumstellar envelope around W 43A. The GBT observations reveal a magnetic field strength $B_{||} \approx 30$ mG changing sign across the H_2O masers at the tip of the red-shifted lobe of the bipolar outflow. We also find that the OH maser shell shows no sign of non-spherical expansion and that it probably has an expansion velocity that is typical for the shells of regular OH/IR stars. The GBT observations confirm that the magnetic field collimates the H_2O maser jet, while the OH maser observations show that a strong large scale magnetic field is present in the envelope surrounding the W 43A central star. The magnetic field in the OH maser envelope is consistent with the one extrapolated from the H_2O measurements, confirming that magnetic fields play an important role in the entire circumstellar environment of W 43A.

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Chemical depletion in the Large Magellanic Cloud: RV Tauri stars and the photospheric feedback from their dusty discs

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Aims: By studying the photospheric abundances of 4 RV Tauri stars in the LMC, we test whether the depletion pattern of refractory elements, seen in similar Galactic sources, is also common for extragalactic sources. Since this depletion process probably only occurs through interaction with a stable disc, we investigate the circumstellar environment of these sources.
Methods: A detailed photospheric abundance study was performed using high-resolution UVES optical spectra. To study the circumstellar environment we use photometric data to construct the spectral energy distributions of the stars, and determine the geometry of the circumstellar environment, whereas low-resolution Spitzer-IRS infrared spectra are used to trace its mineralogy.
Results: Our results show that, also in the LMC, the photospheres of RV Tauri stars are commonly affected by the depletion process, although it can differ significantly in strength from source to source. From our detailed disc modelling and mineralogy study, we find that this process, as in the Galaxy, appears closely related to the presence of a stable Keplerian disc. The newly studied extragalactic objects have similar observational characteristics as Galactic post-AGB binaries surrounded by a dusty disc, and are therefore also believed to be part of a binary system. One source shows a very small infrared excess, atypical for a disc source, but still has evidence for depletion. We speculate this could point to the presence of a very evolved disc, similar to debris discs seen around young stellar objects.

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Planetary nebulae in face-on spiral galaxies. III. Planetary nebula kinematics and disk mass

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Much of our understanding of dark matter halos comes from the assumption that the mass-to-light ratio (Υ) of spiral disks is constant. The best way to test this hypothesis is to measure the disk surface mass density directly via the kinematics of old disk stars. To this end, we have used planetary nebulae (PNe) as test particles and have measured the vertical velocity dispersion (σ_z) throughout the disks of five nearby, low-inclination spiral galaxies: IC 342, M 74 (NGC 628), M 83 (NGC 5236), M 94 (NGC 4736), and M 101 (NGC 5457). By using H I to map galactic rotation and the epicyclic approximation to extract σ_z from the line-of-sight dispersion, we find that, with the lone exception of M 101, our disks do have a constant Υ out to $\sim$3 optical scale lengths (h_R). However, once outside this radius, σ_z stops declining and becomes flat with radius. Possible explanations for this behavior include an increase in the disk mass-to-light ratio, an increase in the importance of the thick disk, and heating of the thin disk by halo substructure. We also find that the disks of early type spirals have higher values of Υ and are closer to maximal than the disks of later-type spirals, and that the unseen inner halos of these systems are better fit by pseudo-isothermal laws than by NFW models.

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IPHAS and the symbiotic stars. II. New discoveries and a sample of the most common mimics

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Knowledge of the total population of symbiotic stars in the Galaxy is important for understanding basic aspects of stellar evolution in interacting binaries and the relevance of this class of objects in the formation of supernovae of type Ia. In a previous paper, we presented the selection criteria needed to search for symbiotic stars in IPHAS, the INT Hα survey of the Northern Galactic plane. IPHAS gives us the opportunity to make a systematic, complete search for symbiotic stars in a magnitude-limited volume. Follow-up spectroscopy at different telescopes worldwide of a sample of sixty two symbiotic star candidates from paper I is presented. Seven out of nineteen S-type candidates observed spectroscopically are confirmed to be genuine symbiotic stars. The spectral type of their red giant components, as well as reddening and distance, were computed by modelling the spectra. Only one new D-type symbiotic system, out of forty-three candidates observed, was found. This was as expected (see discussion in our paper on the selection criteria). The object shows evidence for a high density outflow expanding at a speed larger than 65 km s^{-1}. Most of the other candidates are lightly reddened classical T Tauri stars and more highly reddened young stellar objects that may be either more massive young stars of HAeBe type or classical Be stars. In addition, a few notable objects have been found, such as three new Wolf-Rayet stars and two relatively high-luminosity evolved massive stars. We also found a helium-rich source, possibly a dense ejecta hiding a WR star, which is surrounded by a large ionized nebula. These spectroscopic data allow us to refine the selection criteria for symbiotic stars in the IPHAS survey and, more generally, to better understand the behaviour of different Hα emitters in the IPHAS and 2MASS colour–colour diagrams.

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First spatial resolution of the stellar components of the interacting binary CH Cygni

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We report the first resolved bispectrum speckle interferometry of the symbiotic binary CH Cyg. The measured component separation, $\rho = 42 \pm 2$ mas, is consistent with the one derived from the known spectroscopic orbit and distance. In particular, our result implies a total mass of the binary of $M_{\rm t} = M_{\rm g} + M_{\rm wd} = 3.7^{+3.5}_{-1.7}$ $\rm M_{\odot}$, which is in good agreement with the value $M_{\rm t} = 2.7^{+1.2}_{-0.6}$ $\rm M_{\odot}$ derived from the spectroscopic orbit solution for the red giant and evolutionary contraints. We also show that the radio jets and the bipolar outflow are not orthogonal to the orbital plane of the binary system.

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Conference Paper

Stellar models: firm evidence, open questions and future developments

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During this last decade our knowledge of the evolutionary properties of stars has significantly improved. This result has been achieved thanks to our improved understanding of the physical behavior of stellar matter in the thermal regimes characteristic of the different stellar mass ranges and/or evolutionary stages. This notwithstanding, the current generation of stellar models is still affected by several, not negligible, uncertainties related to our poor knowledge of some thermodynamical processes and nuclear reaction rates, as well as the efficiency of mixing processes. These drawbacks have to be properly taken into account when comparing theory with observations, to derive evolutionary properties of both resolved and unresolved stellar populations. In this paper we review the major sources of uncertainty along the main evolutionary stages, and emphasize their impact on population synthesis techniques.

Oral contribution, published in IAU Symposium 262 "Stellar Populations — Planning the Next Decade" of the XXVII$^{\rm th}$ IAU General Assembly held in Rio de Janeiro (Brazil), Proceeding eds. G. Bruzual & S. Charlot (Keynote review talk)
Available from arXiv:0909.4629

Review Paper

The rebrightening of planetary nebulae through ISM interaction

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The interaction of planetary nebulae (PNe) with the interstellar medium as they move through it is now acknowledged to be a major shaping effect not just for ancient and large PNe, but also for relatively young PNe with high speed central

stars. The most common effect is a rebrightening as the PN shell interacts with a pre-existing bow shock structure formed during the previous evolutionary phase of the central star. In this review, we consider this rebrightening in detail for the first time and discuss its origins, highlighting some observed examples. We go on to discuss the AGB star progenitors, reviewing the evidence for bow shock structures, and consider the progeny of rebrightened PNe — strongly disrupted objects which bear very little resemblance to typical PNe. Sh 2-68 is inferred to be perhaps the only documented case so far of such a PN.

Published in PASA (review paper, 8 pages, 5 figures, high resolution available from the author)
Available from arXiv:0910.2200

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