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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 129$^{\rm th}$ issue of the AGB Newsletter.

The Super-AGB star meeting in London last month was a big success; 74 participants discussed whether these stars produce oxygen-neon white dwarfs or supernovae. With their mass loss ill constrained, either channel seems in principle possible, but observational constraints from white dwarf and supernova progenitor searches are becoming more meaningful. You can view the presentations at http://www.astro.keele.ac.uk/e-stars/ras2008/ras2008.html as they become available.

The next issue will be distributed on the 30$^{\rm th}$ of March; the deadline for contributions is the 29$^{\rm th}$ of March.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Super-AGB stars do not explode; not even at very low metallicity.

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)

The University of New South Wales Extrasolar Planet Search: a catalogue of variable stars from fields observed 2004–2007

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We present a new catalogue of variable stars compiled from data taken for the University of New South Wales Extrasolar Planet Search. From 2004 October to 2007 May, 25 target fields were each observed for 1-4 months, resulting in ∼87000 high precision light curves with 1600-4400 data points. We have extracted a total of 850 variable light curves, 659 of which do not have a counterpart in either the General Catalog of Variable Stars, the New Suspected Variables catalogue or the All Sky Automated Survey southern variable star catalogue. The catalogue is detailed here, and includes 142 Algol-type eclipsing binaries, 23 β Lyrae-type eclipsing binaries, 218 contact eclipsing binaries, 53 RR Lyrae stars, 26 Cepheid stars, 13 rotationally variable active stars, 153 uncategorised pulsating stars with periods < 10 d, including δ Scuti stars, and 222 long period variableswith variability on timescales of > 10 d. As a general application of variable stars discovered by extrasolar planet transit search projects, we discuss several astrophysical problems which could benefit from carefully selected samples of bright variables. These include: (i) the quest for contact binaries with the smallest mass ratio, which could be used to test theories of binary mergers; (ii) detached eclipsing binaries with pre-main-sequence components, which are important test objects for calibrating stellar evolutionary models; and (iii) RR Lyrae-type pulsating stars exhibiting the Blazhko-effect, which is one of the last great mysteries of pulsating star research.

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Distant future of the Sun and Earth revisited

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We revisit the distant future of the Sun and the solar system, based on stellar models computed with a thoroughly tested evolution code. For the solar giant stages, mass-loss by the cool (but not dust-driven) wind is considered in detail. Using the new and well-calibrated mass-loss formula of Schröder & Cuntz (2005, 2007), we find that the mass lost by the Sun as an RGB giant (0.332 $M_\odot$, 7.59 Gy from now) potentially gives planet Earth a significant orbital expansion, inversely proportional to the remaining solar mass.

According to these solar evolution models, the closest encounter of planet Earth with the solar cool giant photosphere will occur during the tip-RGB phase. During this critical episode, for each time-step of the evolution model, we consider the loss of orbital angular momentum suffered by planet Earth from tidal interaction with the giant Sun, as well as dynamical drag in the lower chromosphere. We find that planet Earth will not be able to escape engulfment, despite the positive effect of solar mass-loss. In order to survive the solar tip-RGB phase, any hypothetical planet would require a present-day minimum orbital radius of about 1.15 AU.

Furthermore, our solar evolution models with detailed mass-loss description predict that the resulting tip-AGB giant will not reach its tip-RGB size. The main reason is the more significant amount of mass lost already in the RGB phase

of the Sun. Hence, the tip-AGB luminosity will come short of driving a final, dust-driven superwind, and there will be no regular solar planetary nebula (PN). But a last thermal pulse may produce a circumstellar (CS) shell similar to, but rather smaller than, that of the peculiar PN IC 2149 with an estimated total CS shell mass of just a few hundredths of a solar mass.

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A multiwavelength analysis of the Halo Planetary Nebula DdDm-1

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We present new HST optical imagery as well as new UV and IR spectroscopic data obtained with the Hubble and Spitzer Space Telescopes, respectively, of the halo planetary nebula DdDm-1. For the first time we present a resolved image of this object which indicates that the morphology of DdDm-1 can be described as two orthogonal elliptical components in the central part surrounded by an extended halo. The extent of the emission is somewhat larger than was previously reported in the literature. We combine the spectral data with our own previously published optical measurements to derive nebular abundances of He, C, N, O, Ne, Si, S, Cl, Ar, and Fe. Our abundance determinations include the use of the newly developed program ELSA for obtaining abundances directly from emission line strengths along with detailed photoionization models to render a robust set of abundances for this object. The metallicity, as gauged by oxygen, is found to be 0.46 dex below the solar value, confirming DdDm-1's status as a halo PN. In addition, we find that Si and Fe are markedly underabundant, suggesting their depletion onto dust. The very low (but uncertain) C/O ratio suggests that the chemistry of the nebula should be consistent with an oxygen-rich environment. We find that the sulfur abundance of DdDm-1 is only slightly below the value expected based upon the normal lockstep behavior between S and O observed in H II regions and blue compact galaxies. The central star effective temperature and luminosity are estimated to be 55,000 K and 1000 $L_{\odot}$, respectively, implying an initial progenitor mass of <1 $M_{\odot}$. Finally, we report on a new radial velocity determination from echelle observations.

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Discovery of an open cluster with a possible physical association with a planetary nebula

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We report the discovery of a new open cluster (OC) in the Galaxy at $\ell = 167.0°$ and $b = -1.0°$. Its field includes the planetary nebula (PN) PK 167-0.1. We study the possible associations of the PN/OC pairs NGC 2818/NGC 2818A, NGC 2438/M 46 (NGC 2437), PK 6+2.5/NGC 6469, as well as of the PN PK 167-0.1 with New Cluster 1. The analyses are based on near-infrared colour-magnitude diagrams (CMDs) and stellar radial density profiles (RDPs). NGC 6469 is located in a heavily contaminated bulge field. The CMD morphology, especially for the latter two cases, is defined with a field star decontamination algorithm applied to the 2MASS J, H, and K_s photometry. Field decontamination for the OCs NGC 2818A and M 46 produced better defined CMDs and more accurate cluster parameters than in the

literature. Those pieces of evidence point to M 46 as physically associated with the PN NGC 2438. The same occurs for the OC NGC 2818A and the PN NGC 2818, however previous radial velocity arguments indicate that they are not associated. The OC NGC 6469 does not appear to be associated with the PN PK 6+2.5, which probably belongs to the bulge. Finally, the distance of the OC New Cluster 1 is consistent with a physical association with the PN PK 167-0.1.

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A spectral line survey in the 2 mm and 1.3 mm windows toward the carbon rich envelope of IRC +10216.

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We present the results of our spectral line surveys in the 2 mm and 1.3 mm windows toward the carbon rich envelope of IRC +10216. Totally 377 lines are detected, among which 360 lines are assigned to 57 known molecules (including 29 rare isotopomers and 2 cyclic isomers). Only 17 weak lines remain unidentified. Rotational lines of isotopomers ^{13}CCH and c-^{13}CCCH are detected for the first time in IRC +10216. The detection of the formaldehyde lines in this star is also confirmed. Possible abundance difference among the three ^{13}C substituted isotopic isomers of HC_3N is reported. Isotopic ratios of C and O are confirmed to be non-solar while those of S and Si to be nearly solar. Column densities have been estimated for 15 molecular species. Modified spectroscopic parameters have been calculated for NaCN, Na^{13}CN, KCN and SiC_2. Transition frequencies from the present observations were used to improve the spectroscopic parameters of Si^{13}CC, $^{29}SiC_2$ and $^{30}SiC_2$.

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Ultraviolet Spectroscopy of HD 44179

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We have re-analyzed the ultraviolet spectrum of HD 44179, the central star(s) of the Red Rectangle nebula, providing improved estimates of the column density, rotational, and vibrational temperatures of the 4$^{\rm th}$ Positive A-X system of CO in absorption. The flux shortward of 2200 Å is a complex blend of CO features with no discernible stellar photosphere, making the identification of other molecular species difficult, and the direct derivation of the dust extinction curve impossible. We confirm that the spin-forbidden CO (a-X) Cameron bands are likely produced by either collisional excitation or a chemical reaction, not photoexcitation, but with a higher internal vibrational excitation than previously determined. We also detect the spin-forbidden CO a′-X, d-X, and e-X absorption features. The hot CO (A-X) bands exhibit a blue-shift of $\sim$ 300 km s^{-1}, likely occurring close to the white dwarf star(s) suspected as the original source of the ultraviolet flux in the system, and forming the base of the outflow of material in the Red Rectangle. The OH "comet-band" system near 3000 Å is also analyzed, and estimates of its rovibrational temperatures determined. The source of the molecules studied in this system is still unknown, but may be a combination of gaseous

material associated with the star(s), or processed material from the surrounding dust torus.

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Integral field spectroscopy of planetary nebulae: mapping the line diagnostics and hydrogen-poor zones with VLT FLAMES

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Results from the first dedicated study of Galactic planetary nebulae (PNe) by means of optical integral field spectroscopy with the VLT FLAMES Argus integral field unit (IFU) are presented. Three typical Galactic-disk PNe have been mapped with the $11.''5 \times 7.''2$ Argus array: two dimensional spectral maps of the main shell of NGC 5882 and of large areas of NGC 6153 and 7009 with 297 spatial pixels per target were obtained at sub-arcsec resolutions. A corresponding number of 297 spectra per target were obtained in the 396.4 – 507.8 nm range. Spatially resolved maps of emission lines and of nebular physical properties such as electron temperatures, densities and ionic abundances were produced. The abundances of helium and of doubly ionized carbon and oxygen, relative to hydrogen, were derived from optical recombination lines (ORLs), while those of O^{2+} were also derived from the classic collisionally excited lines (CELs). The occurrence of the abundance discrepancy problem, pertaining to oxygen, was investigated by mapping the ratio of ORL/CEL abundances for O^{2+} (the *abundance discrepancy factor*; ADF) across the face of the PNe. The ADF varies between targets and also with position within the targets, attaining values of ~ 40 in the case of NGC 6153 and ~ 30 in the case of NGC 7009. Correlations of the ADF with geometric distance from the central star and plasma surface brightness (for NGC 6153), as well as with [O III] electron temperature, plasma ionization state and other physical properties of the targets are established. Very small values of the temperature fluctuation parameter in the plane of the sky, $t_A^2(O^{2+})$, are found in all cases.
It is argued that these results provide further evidence for the existence in run-of-the-mill PNe of a distinct nebular component consisting of hydrogen-deficient, super-metal-rich plasma. The zones containing this posited component appear as undulations in the C II and O II ORL abundance diagnostics of about 2 spatial pixels across, and so any associated structures should have physical sizes of less than ~ 1000 astronomical units. Regarding the origin of the inferred zones, we propose that circumstellar disks, Abell 30-type knots, or Helix-type cometary globules may be involved. Implications for emission line studies of nebulae are discussed.

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and from ygt@star.ucl.ac.uk, to request a high-resolution version

The single-degenerate channel for the progenitor of type Ia supernovae I: birth rate with different metallicities

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We have carried out a detailed study of the single-degenerate channel for the progenitor of type Ia supernovae (SNe Ia). In the model, a carbon-oxygen white dwarf (CO WD) accretes material from an unevolved or a slightly evolved non-degenerate companion to increase its mass to Chandrasekhar mass limit. Incorporating the prescription of Hachisu et

al. (1999) for the accretion efficiency into Eggleton's stellar evolution code and assuming that the prescription is valid for all metallicities, we performed binary stellar evolution calculations for more than 25,000 close WD binary systems with metallicities $Z = 0.06$, 0.05, 0.04, 0.03, 0.02, 0.01, 0.004, 0.001, 0.0003 and 0.0001. The initial parameter spaces for SNe Ia are presented in an orbital period-secondary mass ($\log P_{\rm i}$, $M_2^{\rm i}$) plane for each Z. Our results show that the parameter space changes with Z, i.e. both the initial mass of the secondary and the initial orbital period increase with metallicity. As a consequence, the lower mass limit of the CO WD, $M_{\rm WD}^{\rm min}$, for SNe Ia decreases with metallicity Z. The difference of $M_{\rm WD}^{\rm min}$ between $Z = 0.06$ and $Z = 0.0001$ is as large as 0.24 $M_\odot$. For convenience, our results are written into a FORTRAN code which can be downloaded at http://www.ynao.ac.cn/∼bps/download/xiangcunmeng.htm. Adopting the results above, we studied the birth rate of SNe Ia for various Z via binary population synthesis. From the study, we see that for a high Z, SNe Ia occur systemically earlier and the peak value of the birth rate is larger, if a single starburst is assumed. The Galactic birth rate from our study is lower than (but comparable to) that inferred from observations. Meanwhile, the results also indicate that 2002ic-like supernovae would possibly not occur in extremely low-metallicity circumstance if the delayed dynamical-instability model in Han & Podsiadlowski (2006) is appropriate.

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Metallicity effects on the modified wind momentum of CSPN

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Recent investigations on the central stars of planetary nebulae (CSPN) indicate that the masses based on model atmospheres can be much larger than the masses derived from theoretical mass-luminosity relations. Also, the dispersion in the relation between the modified wind momentum and the luminosity depends on the mass spread of the CSPN, and is larger than observed in massive hot stars. Since the wind characteristics probably depend on the metallicity, we analyze the effects on the modified wind momentum by considering the dispersion in this quantity caused by the stellar metallicity. Our CSPN masses are based on a relation between the core mass and the nebular abundances. We conclude that these masses agree with the known mass distribution both for CSPN and white dwarfs, and that the spread in the modified wind momentum can be explained by the observed metallicity variations.

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and from http://www.astro.iag.usp.br/∼maciel/research/research.html

Self–enrichment in Globular Clusters: is there a role for the super–asymptotic giant branch stars?

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In four globular clusters (GCs) a non negligible fraction of stars can be interpreted only as a very helium rich population. The evidence comes from the presence of a "blue" main sequence in ω Cen and NGC 2808, and from the very peculiar horizontal branch morphology in NGC 6441 and NGC 6388. Although a general consensus is emerging on the fact that self–enrichment is a common feature among GCs, the helium content required for these stars is $Y \gtrsim 0.35$, and it is difficult to understand how it can be produced without any —or, for ω Cen, without a considerable—associated metal enhancement. We examine the possible role of super–AGB stars, and show that they may provide the required high

helium. However, the ejecta of the most massive super–AGBs show a global CNO enrichment by a factor of $\simeq$4, due to the dredge–out process occurring at the second dredge up stage. If these clusters show no evidence for this CNO enrichment, we can rule out that at least the most massive super–AGBs evolve into O–Ne white dwarfs and take part in the formation of the second generation stars. This latter hypothesis may help to explain the high number of neutron stars present in GCs. The most massive super–AGBs would in fact evolve into electron–capture supernovae. Their envelopes would be easily ejected out of the cluster, but the remnant neutron stars remain into the clusters, thanks to their small supernova natal kicks.

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An atlas of synthetic line profiles of planetary nebulae

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We have constructed a grid of photoionization models of spherical, elliptical and bipolar planetary nebulae. Assuming different velocity fields, we have computed line profiles corresponding to different orientations, slit sizes and positions. The atlas is meant both for didactic purposes and for the interpretation of data on real nebulae. As an application, we have shown that line profiles are often degenerate, and that recovering the geometry and velocity field from observations requires lines from ions with different masses and different ionization potentials. We have also shown that the empirical way to measure mass-weighted expansion velocities from observed line widths is reasonably accurate if considering the HWHM. For distant nebulae, entirely covered by the slit, the unknown geometry and orientation do not alter the measured velocities statistically. The atlas is freely accessible from internet. The Cloudy_3D suite and the associated VISNEB tool are available on request.

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Asteroseismological measurements on PG 1159−035, the prototype of the GW Vir variable stars

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An asteroseismological study of PG 1159−035, the prototype of the GW Vir variable stars, has been performed on the basis of detailed and full PG 1159 evolutionary models presented by Miller Bertolami & Althaus (2006). We carried out extensive computations of adiabatic g-mode pulsation periods on PG 1159 evolutionary models with stellar masses spanning the range 0.530 to 0.741 $M_\odot$. These models were derived from the complete evolution of progenitor stars, including the thermally pulsing AGB phase and the born-again episode. We constrained the stellar mass of PG 1159−035 by comparing the observed period spacing with the asymptotic period spacing and with the average of the computed period spacings. We also employed the individual observed periods reported by Costa et al. (2007) to find a representative seismological model for PG 1159−035. We derive a stellar mass in the range 0.56−0.59 $M_\odot$ from the period-spacing data alone. We also find, on the basis of a period-fit procedure, an asteroseismological model representative of PG 1159−035 that reproduces the observed period pattern with an average of the period differences of $\overline{\delta\Pi_i} = 0.64 - 1.03$ s, consistent with the expected model uncertainties. The model has an effective temperature $T_{\rm eff} = 128\,000^{+8\,600}_{-2\,600}$ K, a stellar mass $M_\star = 0.565^{+0.025}_{-0.009}$ $M_\odot$, a surface gravity $\log g = 7.42^{+0.21}_{-0.12}$, a stellar luminosity and radius of $\log(L_\star/L_\odot) = 2.15 \pm 0.08$ and $\log(R_\star/R_\odot) = -1.62^{+0.06}_{-0.09}$, and a He-rich envelope thickness of $M_{\rm env} = 0.017$ $M_\odot$. The results of the period-fit analysis carried out in this work suggest that the surface gravity of PG 1159−035

would be $1\,\sigma$ larger than the spectroscopically inferred gravity. For our best-fit model of PG 1159−035, all of the pulsation modes are characterized by positive rates of period changes, at odds with the measurements by Costa & Kepler (2007).

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Evidence of thin helium envelopes in PG 1159 stars

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We present evidence that PG 1159 stars could harbour He–rich envelopes substantially thinner than those predicted by current evolutionary models with current estimates of mass loss, which may be attributable to an extensive mass–loss episode during the born–again AGB phase. Specifically, we show that the models with thin He–rich envelopes predict remarkably large magnitudes of the rates of period change of the trapped and untrapped modes observed in the pulsating star PG 1159−035. This is a consequence of the much shorter evolutionary timescale of the models with thin He–rich envelopes during the low–gravity PG 1159 regime. Our findings are particularly interesting in view of the suggestion of an evolutionary link between the helium–deficient PG 1159 star H1504+65 and the recently discovered white dwarfs with almost pure carbon atmospheres.

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M1-78: a nitrogen-rich Galactic compact H II region beyond the Perseus arm

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There is considerable controversy surrounding the nature of M1-78, a compact nebula located beyond the Perseus arm. It was first classified as a planetary nebula and is nowadays generally considered to be a compact H II region. To investigate the nature of M1-78 further, we present a detailed spectroscopic study in the optical and near-infrared. M1-78 is a high-density nebula with substantial physical differences between its two main morphological zones: a bright arc to the SW and a blob of emission in the NE. Specifically, the blob in the NE has a higher electron temperature and visual extinction than the SW arc. The most important result, however, is the confirmation of a nitrogen enrichment in M1-78. This enrichment is stronger at the location of the NE blob and is correlated with a defficiency in the O abundance and a (dubious) He enrichment. Such an abundance pattern is typical of ejecta nebulae around evolved massive stars such as Wolf-Rayet and Luminous Blue Variable stars. The spatial variations in the physical conditions and chemical abundances and the presence of more than one possible ionizing source indicates, however, that M1-78 is better described as a combination of a compact H II region + ejecta. Finally, we detect H_2 emission that extends over a large ($\sim 30''$) area around the ionized nebula. Analysis of the near-infrared H_2 lines indicates that the excitation mechanism is UV fluorescence.

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The Hobby-Eberly Telescope *Chemical Abundances of Stars in the Halo* (*CASH*) Project. I. The Lithium-, *s*-, and *r*-Enhanced Metal-Poor Giant HKII 17435−00532

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We present the first detailed abundance analysis of the metal-poor giant HKII 17435−00532. This star was observed as part of the University of Texas long-term project *Chemical Abundances of Stars in the Halo* (*CASH*). A spectrum was obtained with the High Resolution Spectrograph (HRS) on the Hobby-Eberly Telescope with a resolving power of $R \sim 15,000$. Our analysis reveals that this star may be located on the red giant branch, red horizontal branch, or early asymptotic giant branch. We find that this metal-poor ([Fe/H] = −2.2) star has an unusually high lithium abundance ($\log \varepsilon$ (Li) = +2.1), mild carbon ([C/Fe] = +0.7) and sodium ([Na/Fe] = +0.6) enhancement, as well as enhancement of both *s*-process ([Ba/Fe] = +0.8) and *r*-process ([Eu/Fe] = +0.5) material. The high Li abundance can be explained by self-enrichment through extra mixing that connects the convective envelope with the outer regions of the H-burning shell. If so, HKII 17435−00532 is the most metal-poor star in which this short-lived phase of Li enrichment has been observed. The Na and *n*-capture enrichment can be explained by mass transfer from a companion that passed through the thermally-pulsing AGB phase of evolution with only a small initial enrichment of *r*-process material present in the birth cloud. Despite the current non-detection of radial velocity variations (over ∼ 180 days), it is possible that HKII 17435−00532 is in a long-period or highly-inclined binary system, similar to other stars with similar *n*-capture enrichment patterns.

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s- and *r*-process element abundances in the CMD of 47 Tucanae using the Robert Stobie Spectrograph on SALT

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A recent study by Wylie et al. (2006) has revealed that *s*-process element abundances are enhanced relative to iron in both red giant branch and asymptotic giant branch stars of 47 Tucanae. A more detailed investigation into *s*-process element abundances throughout the colour-magnitude diagram of 47 Tucanae is vital in order to determine whether the observed enhancements are intrinsic to the cluster. This paper explores this possibility through observational and theoretical means. The visibility of *s*- and *r*-process element lines in synthetic spectra of giant and dwarf stars throughout the colour magnitude diagram of 47 Tucanae has been explored. It was determined that a resolving power of 10 000 was sufficient to observe *s*-process element abundance variations in globular cluster giant branch stars. These synthetic results were compared with the spectra of eleven 47 Tucanae giant branch stars observed during the performance verification of the Robert Stobie Spectrograph on the Southern African Large Telescope. Three *s*-process elements, Zr, Ba, Nd, and one *r*-process element, Eu, were investigated. No abundance variations were found such that [X/Fe] = 0.0 ± 0.5 dex. It was concluded that this resolving power, $R \sim 5\,000$, was not sufficient to obtain exact abundances but upper limits on the *s*-process element abundances could be determined.

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White dwarf spins from low mass stellar evolution models

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The prediction of the spins of the compact remnants is a fundamental goal of the theory of stellar evolution. Here, we confront the predictions for white dwarf spins from evolutionary models including rotation with observational constraints. We perform stellar evolution calculations for stars in the mass range 1... 3 $M_\odot$, including the physics of rotation, from the zero age main sequence into the TP-AGB stage. We calculate two sets of model sequences, with and without inclusion of magnetic fields. From the final computed models of each sequence, we deduce the angular momenta and rotational velocities of the emerging white dwarfs. While models including magnetic torques predict white dwarf rotational velocities between 2 and 10 km s^{-1}, those from the non-magnetic sequences are found to be one to two orders of magnitude larger, well above empirical upper limits. We find the situation analogous to that in the neutron star progenitor mass range, and conclude that magnetic torques may be required in order to understand the slow rotation of compact stellar remnants in general.

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A search for diffuse bands in the circumstellar envelopes of post-AGB stars

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In this work we present the results of a systematic search for diffuse bands (DBs, hereafter) in the circumstellar envelopes of a carefully selected sample of post-AGB stars. We concentrated on analyzing 9 of the DBs most commonly found in the interstellar medium. The strength of these features is determined using high-resolution optical spectroscopy, and the results obtained are compared with literature data on field stars affected only by interstellar reddening. Based on the weak features observed in the subsample of post-AGB stars dominated by circumstellar reddening, we conclude that the carrier(s) of these DBs must not be present in the circumstellar environment of these sources, or at least not under the excitation conditions in which DBs are formed. This conclusion is applicable to all the post-AGB stars studied, irrespective of the dominant chemistry or the spectral type of the star considered. A detailed radial velocity analysis of the features observed in individual sources confirms this result, as the Doppler shifts measured are found to be consistent with an interstellar origin.

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Water vapour masers in long-period variable stars. I. RX Boo and SV Peg

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Context: Water vapour maser emission from late-type stars characterises them as asymptotic-giant-branch stars with oxygen-rich chemistry that are losing mass at a substantial rate. Further conclusions on the properties of the stars, however, are hampered by the strong variability of the emission.
Aims: We wish to understand the reasons for the strong variability of H_2O masers in circumstellar shells of late-type stars. In this paper we study RX Bootis and SV Pegasi as representatives of semiregular variable stars (SRVs).
Methods: We monitored RX Boo and SV Peg in the 22-GHz maser line of water vapour with single-dish telescopes. The monitoring period covered two decades for RX Boo (1987 – 2007) and 12 years for SV Peg (1990 – 1995, 2000 – 2007). In addition, maps were obtained of RX Boo with the Very Large Array over several years.
Results: We find that most of the emission in the circumstellar shell of RX Boo is located in an incomplete ring with an inner radius of 91 mas (15 AU). A velocity gradient is found in a NW–SE direction. The maser region can be modelled as a shell with a thickness of 22 AU, which is only partially filled. The gas crossing time is 16.5 years. The ring-like structure and the velocity gradient remained stable for at least 11 years, while the maser line profiles varied strongly. This suggests that the spatial asymmetry is not accidental, so that either the mass loss process or the maser excitation conditions in RX Boo are not spherically symmetric. The strong variability of the maser spectral features is mainly due to incoherent intensity fluctuations of maser emission spots, which have lifetimes of the order of 1 year. We found no correlation between the optical and the maser variability in either star. The variability properties of the SV Peg masers do not differ substantially from those of RX Boo. There were fewer spectral features present, and the range of variations was narrower. The maser was active on the >10-Jy level only 1990 – 1992 and 2006/2007. At other times the maser was either absent (<1 Jy) or barely detectable.
Conclusions: The variability of H_2O masers in the SRVs RX Boo and SV Peg is due to the emergence and disappearance of maser clouds with lifetimes of ∼1 year. The emission regions do not evenly fill the shell of RX Boo leading to asymmetry in the spatial distribution, which persists at least an order of magnitude longer.

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Conference Papers

Atmospheric dynamics of red supergiant stars and applications to Interferometry

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We have written a 3D radiative transfer code that computes emerging spectra and intensity maps. We derive from radiative hydrodynamic (RHD) simulations of RSG stars carried out with CO5BOLD (Freytag et al. 2002) observables expected for red supergiant stars (RSG) especially for interferometric observations, with emphasis on small scale structures. We show that the convection-related surface structures are detectable in the H band with today's interferometers and that the diameter measurement should not be too dependent on the adopted model. The simulations

are a great improvement over parametric models for the interpretation of interferometric observations.

Oral contribution, published in SF2A 2007, eds. J. Bouvier, A. Chalabaev & C. Charbonnel
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Atmospheric dynamics of red supergiant stars and Interferometry

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We developed a 3D pure LTE radiative transfer code to derive observables expected for RSGs, with emphasis on small scale structures, from radiative-hydrodynamic (RHD) simulations of red supergiant stars (RSGs) carried out with CO5BOLD (Freytag et al. 2002). We show that the convection-related surface structures are observable with today's interferometers. Moreover, the RHD simulations are a great improvement over parametric models for the interpretation of interferometric observations.

Oral contribution, published in Perspectives in Radiative Transfer and Interferometry, EAS publication series
Available from arXiv:0802.1399

Spitzer/IRAC Observations of AGB stars

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We present here the first observation of galactic AGB stars with the InfraRed Array Camera (IRAC) onboard the Spitzer Space Telescope. Our sample consists of 48 AGB stars of different chemical signature, mass loss rate and variability class. For each star we have measured IRAC photometry and colors. Preliminary results shows that IRAC colors are sensitive to spectroscopic features associated to molecules and dust in the AGB wind. Period is only loosely correlated to the brightness of the stars in the IRAC bands. We do find, however, a tight period-color relation for sources classified as semiregular variables. This may be interpreted as the lack of warm dust in the wind of the sources in this class, as opposed to Mira variables that show higher infrared excess in all IRAC bands.

Oral contribution, published in "IX$^{\rm th}$ Torino Workshop on Evolution and Nucleosynthesis in AGB Stars", 22-26 October 2007, Perugia, Italy
Available from arXiv:0802.2292

η Carinae and Nebulae Around Massive Stars: Similarities to Planetary Nebulae?

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I discuss some observational properties of aspherical nebulae around massive stars, and conclusions inferred for how they may have formed. Whether or not these ideas are applicable to the shaping of planetary nebulae is uncertain, but the observed similarities between some PNe and bipolar nebulae around massive stars is compelling. In the well-observed case of η Carinae, several lines of observational evidence point to a scenario where the shape of its bipolar nebula resulted from an intrinsically bipolar explosive ejection event rather than an interacting winds scenario

occurring after ejection from the star. A similar conclusion has been inferred for some planetary nebulae. I also briefly mention bipolar nebulae around some other massive stars, such as the progenitor of SN 1987A and related blue supergiants.

Oral contribution, published in APN4
Available from arXiv:0802.1746

MS, S and C Stars in the Infrared. Luminosities and Mass Loss Rates

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In this note I present an outline of infrared (IR) photometric AGB properties, based on two samples of Galactic Long Period Variables (C- and S-type respectively). I show the various selection criteria used during the choice of the sources and describe the motivations of observing them at near- and mid-IR wavelengths. I discuss the problems encountered in estimating their luminosity and distance and motivate the methods I choose for this purpose. Properties of the luminosity functions and of the Hertzsprung-Russell (HR) diagrams obtained from the analysis are discussed. Finally, the choices made for estimating of the mass loss rates are described and preliminary results concerning them are shown.

Oral contribution, published in IX Torino Workshop
Available from arXiv:0802.0676

Infrared Properties Of AGB Stars: from Existing Databases to Antarctic Surveys

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We present here a study of the Infrared properties of Asymptotic Giant Branch stars (hereafter AGB) based on existing databases, mainly from space-borne experiments. Preliminary results about C and S stars are discussed, focusing on the topics for which future Infrared surveys from Antarctica will be crucial. This kind of surveys will help in making more quantitative our knowledge of the last evolutionary stages of low mass stars, especially for what concerns luminosities and mass loss.

Oral contribution, published in 1st ARENA Conference, EAS Publications Series, Volume 25, 2007, pp. 119-124
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Molecular Line Observations of the SiO Maser Source IRAS 19312+1950

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IRAS 19312+1950 is a unique SiO maser source, exhibiting a rich set of molecular radio lines, although SiO maser sources are usually identified as oxygen-rich evolved stars, in which chemistry is relatively simple comparing with

carbon-rich environments. The rich chemistry of IRAS 19312+1950 has raised a problem in circumstellar chemistry if this object is really an oxygen-rich evolved star, but its evolutional status is still controversial. In this paper, we briefly review the previous observations of IRAS 19312+1950, as well as presenting preliminary results of recent VLBI observations in maser lines. PDF file of the poster is available from http://www.geocities.jp/nakashima_junichi/

Poster contribution, published in IAU Symposium 251 (Organic Matter in Space)
Available from arXiv:0802.4132

Review Paper

Complete 2mm Spectral Line Survey (130-170 GHz) of Sgr B2N, Sgr B2OH, IRC +10 216, Orion (KL), Orion-S, W51M, and W3(IRS5)

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We report a complete 2mm spectral line survey (130-170 GHz) taken with the NRAO 12m Telescope between 1993 and 1995 toward the following sources: Sgr B2N, Sgr B2OH, IRC +10 216, Orion (KL), Orion-S, W51M, and W3(IRS5). Until very recently, this project was entirely the work of B. E. Turner. He wrote the original proposal, given below without changes or updates, and did all of the observing. B. E. Turner has fallen seriously ill and can no longer continue to work on the analysis of these data. The notes that follow the proposal give further information about the project and important information for users of these data.
The data are distributed using the Spectral Line Search Engine (SLiSE) developed by A. J. Remijan and M. J. Remijan. SLiSE is a data display tool that will contain all the fully reduced and calibrated archived data taken as part of this 2mm survey. SLiSE is fast, easy to use, and contains the necessary functionality to display the data taken from spectral line searches. For example, SLiSE contains functions to overlay possible molecule identifications based on a current line catalog as well as overlaying H and He recombination lines. It is a Java-based applet, so it is platform independent and easily accessed online. The only caveat is that SLiSE was built using Java 1.5, so an update to the user's Java may be necessary.
We request users of these data to give B. E. Turner and this work the appropriate citation and credit.

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and from http://www.cv.nrao.edu/Turner2mmLineSurvey/