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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our please to present the 108$^{\rm th}$ issue of the AGB Newsletter. It features a diverse range in topics, from papers on oxygen-rich material surrounding carbon-rich stars, to a series on photo-ionization modelling of planetary nebulae. Very exciting is the evidence for thermally pulsing AGB stars in the high-redshift Universe (Maraston et al.).

The AGB Newsletter is actively being used by a fast growing number of people. To maximise the impact that your postings will have, do not forget to tell your PhD students and colleagues about the Newsletter, and ask them to be put on the mailinglist by registering on the website.

The next issue will be distributed on the 2$^{\rm nd}$ of June; the deadline for contributions is the 1$^{\rm st}$ of June.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

The presence of thermally pulsing AGB stars can be detected in galaxies at redshifts as high as 6 or more.

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

Infrared spectra and visibilities as probes of the outer atmospheres of red supergiant stars

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In the light of the recent results of the stellar interferometry, we examine the nature of the extra molecular layer outside the photosphere of red supergiant stars, so far studied mostly with the use of the infrared spectra. Although the visibility data are more direct probes of the spatial structure of the outer atmosphere, it is essential that they are analyzed in combination with the spectral data of a wide spectral coverage. In the case of the M2 supergiant μ Cephei, several sets of data, both spectra and visibilities, strongly suggested the presence of an extra-molecular layer (which we referred to as *molsphere* for simplicity) , and the basic parameters of the *molsphere* are estimated to be: excitation temperature $T_{\rm ex} \approx 1600\,{\rm K}$, column densities of CO and H_2O molecules $N_{\rm col} \approx 3.0 \times 10^{20}\,{\rm cm}^{-2}$, and located at about one stellar radii above the photosphere or $R_{\rm in} \approx 2.0\,R_*$. The result shows reasonable agreement with the one based on the infrared spectra alone, and this may be because the infrared spectra already include some information on the spatial structure of the outer atmosphere. It is important, however, that the model inferred from the spectra is now fully supported with the recent visibility data. In the case of the M2 supergiant α Orionis, the infrared spectra and visibilities show a consistent picture in that its *molsphere* is closer to the photosphere ($R_{\rm in} \approx 1.3\,R_*$) with higher gas temperature ($T_{\rm ex} \approx 2250\,{\rm K}$) and lower gas column density ($N_{\rm col} \approx 10^{20}\,{\rm cm}^{-2}$), compared with that of μ Cep. Some controversy on the interpretation of the mid infrared data of α Orionis can be reconciled. Given that the presence of the extra molecular layer is reasonably well established, consistently with the spectral and visibility data, in at least two representative red supergiant stars α Orionis and μ Cephei, the major unsolved problem is how to understand the origin of such a rather warm and dense layer in the outer atmosphere.

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Available from astro-ph/0603705
and from http://www.mtk.ioa.s.u-tokyo.ac.jp/∼ttsuji

Lithium abundances for early F stars: New observational constraints for the Li dilution

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Aims : To investigate any correlation between Li abundances and rotational velocities among F–G evolved stars, we study a large sample of early F stars from the Bright Star Catalogue (BSC), most of them classified in the literature as giant stars. Methods : Physical parameters and Li abundances are estimated for each star, often for the first time, by comparing observed and synthetic spectra. We analyse the position of the stars in the H–R Diagram based on Hipparcos data using stellar evolutionary tracks and we discuss their Li abundances and projected rotational velocities. Results : Observed stars are mostly on the turnoff, with masses between 1.5 and 2.0 $M_\odot$. The stars with measured A(Li) abundance show high Li content, most of them with abundance near the cosmic value. The A(Li) versus $V \sin i$ diagram shows the same trend as reported in previous studies : fast rotators ($V \sin i \gtrsim 30\,{\rm km\,s}^{-1}$) are also stars with high Li content, whereas slow rotators present a wide range of values of A(Li), ranging from no detected Li to the cosmic value.

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Broad-band photometric colors and effective temperature calibrations for late-type giants. II. Z<0.02

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We investigate the effects of metallicity on the broad-band photometric colors of late-type giants, and make a comparison of synthetic colors with observed photometric properties of late-type giants over a wide range of effective temperatures ($T_{\rm eff}$ = 3500 − 4800 K) and gravities ($\log g$ = 0.0 − 2.5), at $[M/H]$ = −1.0 and −2.0. The influence of metallicity on the synthetic photometric colors is small at effective temperatures above ∼ 3800 K, but the effects grow larger at lower $T_{\rm eff}$, due to the changing efficiency of molecule formation which reduces molecular opacities at lower $[M/H]$. To make a detailed comparison of the synthetic and observed photometric colors of late type giants in the $T_{\rm eff}$–color and color–color planes (which is done at two metallicities, $[M/H]$ = −1.0 and −2.0), we derive a set of new $T_{\rm eff}$–$\log g$–color relations based on synthetic photometric colors, at $[M/H]$ = −0.5, −1.0, −1.5, and −2.0. These relations are based on the $T_{\rm eff}$–$\log g$ scales that we derive employing literature data for 152 late-type giants in 10 Galactic globular clusters (with metallicities of the individual stars between $[M/H]$ = −0.7 and −2.5), and synthetic colors produced with the `PHOENIX`, `MARCS` and `ATLAS` stellar atmosphere codes. Combined with the $T_{\rm eff}$–$\log g$–color relations at $[M/H]$ = 0.0 (Kučinskas et al. 2005), the set of new relations covers metallicities $[M/H] = 0.0 \ldots -2.0$ ($\Delta[M/H]$ = 0.5), effective temperatures $T_{\rm eff} = 3500 \ldots 4800$ K ($\Delta T_{\rm eff}$ = 100 K), and gravities $\log g = -0.5 \ldots 3.0$. The new $T_{\rm eff}$–$\log g$–color relations are in good agreement with published $T_{\rm eff}$–color relations based on observed properties of late-type giants, both at $[M/H]$ = −1.0 and −2.0. The differences in all $T_{\rm eff}$–color planes are typically well within ∼ 100 K. We find, however, that effective temperatures predicted by the scales based on synthetic colors tend to be slightly higher than those resulting from the $T_{\rm eff}$–color relations based on observations, with the offsets up to ∼ 100 K. This is clearly seen both at $[M/H]$ = −1.0 and −2.0, especially in the $T_{\rm eff}$–$(B-V)$ and $T_{\rm eff}$–$(V-K)$ planes. The consistency between $T_{\rm eff}$–$\log g$–color scales based on synthetic colors calculated with different stellar atmosphere codes is very good, with typical differences being well within $\Delta T_{\rm eff} \sim 70$ K at $[M/H]$ = −1.0 and $\Delta T_{\rm eff} \sim 40$ K at $[M/H]$ = −2.0.

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Analysis of 26 Barium Stars I. Abundances

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We present a detailed analysis of 26 barium stars, including dwarf barium stars, providing their atmospheric parameters ($T_{\rm eff}$, $\log g$, [Fe/H], $v_{\rm t}$) and elemental abundances. We aim at deriving gravities and luminosity classes of the sample stars, in particular to confirm the existence of dwarf barium stars. Accurate abundances of chemical elements were derived. Abundance ratios between nucleosynthetic processes, by using Eu and Ba as representatives of the r- and s-processes are presented. High-resolution spectra with the FEROS spectrograph at the ESO-1.5m Telescope, and photometric data with Fotrap at the Zeiss telescope at the LNA were obtained. The atmospheric parameters were derived in an iterative way, with temperatures obtained from colour-temperature calibrations. The abundances were derived using spectrum synthesis for Li, Na, Al, alpha-, iron peak, s- and r-elements atomic lines, and C and N molecular lines. Atmospheric parameters in the range $4300 < T_{\rm eff} < 6500$, $-1.2 <$[Fe/H]< 0.0 and $1.4 < \log g < 4.6$

were derived, confirming that our sample contains giants, subgiants and dwarfs. The abundance results obtained for Li, Al, Na, alpha- and iron peak elements for the sample stars show that they are compatible with the values found in the literature for normal disk stars in the same range of metallicities. Enhancements of C, N and heavy elements relative to Fe, that characterise barium stars, were derived and showed that [X/Ba] vs. [Ba/H] and [X/Ba] vs. [Fe/H] present different behaviour as compared to [X/Eu] vs. [Eu/H] and [X/Eu] vs. [Fe/H], reflecting the different nucleosynthetic sites for the s- and r-processes.

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Analysis of 26 Barium Stars II. Contributions of s-, r- and p-processes in the production of heavy elements.

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Barium stars show enhanced abundances of the slow neutron capture (s-process) heavy elements, and for this reason they are suitable objects for the study of s-process elements. The aim of this work is to quantify the contributions of the s-, r- and p-processes for the total abundance of heavy elements from abundances derived for a sample of 26 barium stars. The abundance ratios between these processes and neutron exposures were studied. The abundances of the sample stars were compared to those of normal stars thus identifying the fraction relative to the s-process main component. The fittings of the σN curves (neutron capture cross section times abundance, plotted against atomic mass number) for the sample stars suggest that the material from the companion asymptotic giant branch star had approximately the solar isotopic composition as concerns fractions of abundances relative to the s-process main component. The abundance ratios of heavy elements, hs, ls and s and the computed neutron exposure are similar to those of post-AGB stars. For some sample stars, an exponential neutron exposure fits well the observed data, whereas for others, a single neutron exposure provides a better fit. The comparison between barium and AGB stars supports the hypothesis of binarity for the barium star formation. Abundances of r-elements that are part of the s-process path in barium stars are usually higher than those in normal stars,and for this reason, barium stars seemed to be also enriched in r-elements, although in a lower degree than s-elements. No dependence on luminosity classes was found in the abundance ratios behaviour among the dwarfs and giants of the sample barium stars.

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Searching for flickering variability in several symbiotic stars and related objects: BX Mon, V471 Per, RS Oph, V627 Cas, CI Cam, V886 Her, Z And, T CrB, MWC 560, V407 Cyg

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UBVRI photometry observations of 10 symbiotic stars and related objects obtained in the period 2002-2003 are presented. Analysing differential light curves we found rapid light variations with timescales of tens of minutes and significant amplitudes in the well-known flickerers MWC 560, RS Oph, V407 Cyg and T CrB. MWC 560 and V407 Cyg demonstrate quasi periodic oscillations (QPO) with similar amplitudes and timescales. Flickering and unusual flare in V627 Cas as well as some indications of flickering presence in BX Mon are detected. The existence of 29 minutes oscillations in Z And with an amplitude $\sim$0.02 mag in U band is confirmed. Only one symbiotic star, V471

Per, and both non symbiotic, CI Cam and V886 Her seem to be constant on flickering timescales. Nevertheless, small night to night changes in the brightness of V886 Her were observed as well.

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Galactic Planetary Nebulae with Wolf-Rayet Nuclei III. Kinematical Analysis of a Large Sample of Nebulae.

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Expansion velocities ($V_{\rm exp}$) of different ions and line widths at the base of the lines are measured and analyzed for 24 PNe with [WC]-type nuclei (WRPNe), 9 PNe ionized by WELS (WLPNe) and 14 ordinary PNe. A comparative study of the kinematical behavior of the sample clearly demonstrates that WRPNe have in average 40-45% larger $V_{\rm exp}$, and possibly more turbulence than WLPNe and ordinary PNe. WLPNe have velocity fields very much alike the ones of ordinary PNe, rather than the ones of WRPNe. All the samples (WRPNe, WLPNe and ordinary PNe) show expansion velocities increasing with age indicators, for example $\langle V_{\rm exp}\rangle$ is larger for low-density nebulae and also it is larger for nebulae around high-temperature stars. This age effect is much stronger for evolved WRPNe, suggesting that the [WC] winds have been accelerating the nebulae for a long time, while for non-WRPNe the acceleration seems to stop at some point when the star reaches a temperature of about 90,000-100,000 K. Non-WR nebulae reach a maximum $V_{\rm exp}$ of about 30 km/s while evolved WRPNe reach maximum $V_{\rm exp}$ of about 40 km/s. For all kind of objects (WRPNe and non-WRPNe) it is found that in average $V_{\rm exp}({\rm N}^{+})$ is slightly larger than $V_{\rm exp}({\rm O}^{++})$, indicating that the nebulae present acceleration of the external shells.

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On Modeling the NIR Two-Color Locus of OH / IR Stars with a Constant dM/dt

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OH/IR stars fall on a well-defined locus in two-color NIR plots. This locus is replicated by a sequence of self-consistent radiative-transfer models of shells with long-term constant mass-loss provided (i) the initial stellar SED has NIR colors matching those at the foot of the locus, and (ii) that a cold-silicate dust opacity function is used. The models depend on the public code DUSTY. The NIR locus is also followed by models of detached shells: our models are based on shells generated by a constant dM/dt within which a central hole grows, so an expansion-time chronology can be attached to the color evolution of a detached shell. This also provides an upper limit on the time for 1612 MHz masers to disappear after dM/dt $\rightarrow$ 0. The brevity of this time-scale shows that the pumping of 1612 MHz masers is very dependant on the reprocessing of the stellar radiation field occurring within $< 5r_d$ of the star (where r_d is the radius of the hottest dust), which explains why they can disappear on time-scales of less than two decades. Our second concern is to explain the distribution along the NIR locus of the OH/IR stars with the reddest IRAS colors, which appear to have "detached" shells, even though many are MIR variables. Since the NIR locus is followed by shells generated by any form of dM/dt, whether constant, interrupted, or periodic, these MIR variables show that most thick, oxygen-rich, circumstellar shells exhibit a severe cyclical modulation in their mass-loss rates, as predicted by Simis (2001).

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Evolution of 1612 MHz Maser Emission in Expanding Circumstellar Shells

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Observations show that 1612 MHz masers of OH/IR stars can fade on a timescale of a decade. This fading is probably associated with the switch from rapid mass loss, which is ultimately linked with an internal He-shell flash, to the much slower mass loss supported by more quiescent conditions. We study the observed maser decay with a composite computational model, comprising a time-dependent chemical model of the envelope, and a radiation transfer model which provides the maser pumping. Our combined model is able to reproduce the rapid decay of maser intensity, following a sudden drop in the stellar mass-loss rate. The explanation for the rapid fall in maser emission is not a fall in the OH number density, or the kinetic temperature in the inverted layers, but the loss of a radiative pump route which carries population from level 1 to level 4 via levels 16, 15 and 11. The loss of these pump routes is a result, in turn, of a greatly reduced energy density of 53 μm radiation.

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Full evolutionary models for PG1159 stars. Implications for the helium-rich O(He) stars

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We present full evolutionary calculations appropriate to post-AGB PG1159 stars for a wide range of stellar masses. We take into account the complete evolutionary stages of PG1159 progenitors starting from the Zero Age Main Sequence. We consider the two kinds of Born Again Scenarios, the very late thermal pulse (VLTP) and the late thermal pulse (LTP), that give rise to hydrogen-deficient compositions. The location of our PG1159 tracks in the effective temperature - gravity diagram and their comparison with previous calculations as well as the resulting surface compositions are discussed at some length. Our results reinforce the idea that the different abundances of ^{14}N observed at the surface of those PG1159 stars with undetected hydrogen is an indication that the progenitors of these stars would have evolved through a VLTP episode, where most of the hydrogen content of the remnant is burnt, or LTP, where hydrogen is not burnt but instead diluted to very low surface abundances. We derive new values for spectroscopical masses based on these new models. We discuss the correlation between the presence of planetary nebulae and the ^{14}N abundance as another indicator that ^{14}N-rich objects should come from a VLTP episode while ^{14}N-deficient ones should be the result of a LTP. Finally, we discuss an evolutionary scenario that could explain the existence of PG1159 stars with unusually high helium abundances and a possible evolutionary connection between these stars and the low mass O(He) stars.

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Oxygen-rich disk in the V778 Cyg system resolved

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Various scenarios have been proposed to explain the presence of silicate features associated with carbon stars, such as V778 Cyg. We have attempted to constrain these theories by means of mapping water maser mission from V778 Cyg. The 22 GHz water maser emission from this star has been mapped using MERLIN with an astrometric accuracy of 25 mas. The spatially- and kinematically-resolved maser complex is displaced by ∼190 mas from the position of the C-star as measured 10 years earlier using Tycho. Our simulations and analysis of available data show that this position difference is unlikely to be due to proper motion if V778 Cyg is at the assumed distance of 1.4 kpc. The maser components seem to form a distorted S-shaped structure extended over ∼18 mas with a clear velocity gradient. We propose a model which explains the observed water maser structure as an O-rich warped disk around a companion of the C-star in V 778 binary system, which is seen almost edge-on. Analysis of observational data, especially those obtained with MERLIN, suggests that V778 Cyg (and, by implication, other silicate carbon stars) are binary systems composed of a C-rich star and a companion which stores circumstellar O-rich material.

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SiO in C-rich circumstellar envelopes of AGB stars: effects of non-LTE chemistry and grain adsorption

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Reported here are new multi-transition millimetre SiO line observations of a sample of carbon stars, including J=8-7 observations with the APEX telescope. A combination of low- and high-energy lines are important in constraining the abundance distribution. Detailed radiative transfer modelling reveal that the fractional abundance of SiO in these C-rich environments can be several orders of magnitude higher than predicted by equilibrium stellar atmosphere chemistry. In fact, the SiO abundance distribution of carbon stars closely mimic that of M-type (O-rich) AGB stars. A possible explanation for this behaviour is a shock-induced chemistry, but also the influence of dust grains, both as a source for depletion as well as production of SiO, needs to be further investigated. As observed for M-type AGB stars, a clear trend that the SiO fractional abundance decreases as the mass-loss rate of the star increases is found for the carbon stars, as would be the case if SiO is accreted onto dust grains.

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3-D Photoionization Structure and Distances of Planetary Nebulae III. NGC 6781

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Continuing our series of papers on the three-dimensional (3-D) structures of and accurate distances to Planetary Nebulae (PNe), we present our study of the planetary nebula NGC 6781. For this object we construct a 3-D photoionization model and, using the constraints provided by observational data from the literature we determine the detailed 3-D structure of the nebula, the physical parameters of the ionizing source and the first precise distance. The procedure consists in simultaneously fitting all the observed emission line morphologies, integrated intensities and the 2-D density map from the [SII] line ratios to the parameters generated by the model, and in an iterative way obtain the best fit for the central star parameters and the distance to NGC 6781, obtaining values of 950 ± 143 pc and $385\,L_{\odot}$ for the distance and luminosity of the central star respectively. Using theoretical evolutionary tracks of intermediate and low mass stars, we derive the mass of the central star of NGC 6781 and its progenitor to be $0.60 \pm 0.03\,M_{\odot}$ and $1.5 \pm 0.5\,M_{\odot}$ respectively.

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Low-Mass Binary Induced Outflows from Asymptotic Giant Branch Stars

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A significant fraction of planetary nebulae (PNe) and proto-planetary nebulae (PPNe) exhibit aspherical, axisymmetric structures, many of which are highly collimated. The origin of these structures is not entirely understood, however recent evidence suggests that many observed PNe harbor binary systems, which may play a role in their shaping. In an effort to understand how binaries may produce such asymmetries, we study the effect of low-mass ($< 0.3\ M_{\odot}$) companions (planets, brown dwarfs and low-mass main sequence stars) embedded into the envelope of a $3.0\ M_{\odot}$ star during three epochs of its evolution (Red Giant Branch, Asymptotic Giant Branch (AGB), interpulse AGB). We find that common envelope evolution can lead to three qualitatively different consequences: (i) direct ejection of envelope material resulting in a predominately equatorial outflow, (ii) spin-up of the envelope resulting in the possibility of powering an explosive dynamo driven jet and (iii) tidal shredding of the companion into a disc which facilitates a disc driven jet. We study how these features depend on the secondary's mass and discuss observational consequences.

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3-D Photoionization Structure and Distances of Planetary Nebulae II. Menzel 1

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We present the results of a spatio-kinematic study of the planetary nebula Menzel 1 using spectro-photometric mapping

and a 3-D photoionization code. We create several 2-D emission line images from our long-slit spectra, and use these to derive the line fluxes for 15 lines, the Hα/Hβ extinction map, and the [SII] line ratio density map of the nebula. We use our photoionization code constrained by these data to derive the three-dimensional nebular structure and ionizing star parameters of Menzel 1 by simultaneously fitting the integrated line intensities, the density map, and the observed morphologies in several lines, as well as the velocity structure. Using theoretical evolutionary tracks of intermediate and low mass stars, we derive a mass for the central star of $0.63 \pm 0.05 M_{\odot}$. We also derive a distance of 1050 ± 150pc to Menzel 1.

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3-D Photoionization Structure and Distances of Planetary Nebulae I. NGC 6369

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We present the results of mapping the planetary nebula NGC 6369 using multiple long slit spectra taken with the CTIO 1.5m telescope. We create two dimensional emission line images from our spectra, and use these to derive fluxes for 17 lines, the Hα/Hβ extinction map, the [SII] line ratio density map, and the [NII] temperature map of the nebula. We use our photoionization code constrained by these data to determine the distance, the ionizing star characteristics, and show that a clumpy hour-glass shape is the most likely three-dimensional structure for NGC 6369. Note that our knowledge of the nebular structure eliminates all uncertainties associated with classical distance determinations, and our method can be applied to *any spatially resolved emission line nebula*. We use the central star, nebular emission line, and optical+IR luminosities to show that NGC 6369 is matter bound, as about 70% of the Lyman continuum flux escapes. Using evolutionary tracks from Blöcker (1995) we derive a central star mass of about $0.65\,M_{\odot}$.

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A Hot DQ White Dwarf in the Open Star Cluster M35

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We report the discovery of a hot DQ white dwarf, NGC 2168:LAWDS 28, that is a likely member of the 150-Myr old cluster NGC 2168 (Messier 35). The spectrum of the white dwarf is dominated by CII features. The effective temperature is difficult to estimate but likely $\gtrsim 20,000$ K based on the temperatures of hot DQs with similar spectra. NGC2168:LAWDS 28 provides further evidence that hot DQs may be the "missing" high-mass helium-atmosphere white dwarfs. Based on published studies, we find that the DBA WD LP 475-242 is likely a member of the Hyades open cluster, as often assumed. These two white dwarfs are the entire sample of known He-atmosphere white dwarfs in open clusters with turnoff masses $\geq 2\ M_{\odot}$. Based on the number of known cluster DA white dwarfs and a redetermination of the H-atmosphere:He-atmosphere ratio, commonly known as the DA:DB ratio, we re-examine the hypothesis that the H- to He-atmosphere ratio in open clusters is the same as the ratio in the field. Under this hypothesis, we calculate that five He-atmosphere WDs are expected to have been discovered, with a probability of finding fewer than three He-atmosphere white dwarfs of 0.08, or at the $\approx 2\sigma$ level.

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Bringing VY Canis Majoris Down to Size: An Improved Determination of Its Effective Temperature

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The star VY CMa is a late-type M supergiant with many peculiarities, mostly related to the intense circumstellar environment due to the star's high mass-loss rate. Claims have been made that would suggest this star is considerably more luminous ($L \sim 5 \times 10^5 L_\odot$) and larger ($R \sim 2800 R_\odot$) than other Galactic red supergiants (RSGs). Indeed, such a location in the H-R diagram would be well in the "Hayashi forbidden zone" where stars cannot be in hydrostatic equilibrium. These extraordinary properties, however, rest upon an assumed effective temperature of 2800-3000 K, far cooler than recent work have shown RSGs to be. To obtain a better estimate, we fit newly obtained spectrophotometry in the optical and NIR with the same MARCS models used for our recent determination of the physical properties of other RSGs; we also use $V-K$ and $V-J$ from the literature to derive an effective temperatures. We find that the star likely has a temperature of 3650 K, a luminosity $L \sim 6 \times 10^4 L_\odot$, and a radius of $\sim 600 R_\odot$ These values are consistent with VY CMa being an ordinary evolved $15 M_\odot$ RSG, and agree well with the Geneva evolutionary tracks. We find that the circumstellar dust region has a temperature of 760 K, and an effective radius ∼130 AU, if spherical geometry is assumed for the latter. What causes this star to have such a high mass-loss, and large variations in brightness (but with little change in color), remains a mystery at present, although we speculate that perhaps this star (and NML Cyg) are simply normal RSGs caught during an unusually unstable time.

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Near-IR Spectroscopy of OH/IR stars in the Galactic Centre

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Context. Galactic Centre (GC) OH/IR stars can be, based on the expansion velocities of their circumstellar shells, divided into two groups which are kinematically different and therefore are believed to have evolved from different stellar populations. Aims. To study the metallicity distribution of the OH/IR stars population in the GC on basis of a theoretical relation between EW(Na), EW(Ca) and EW(CO) and the metallicity. Methods. For 70 OH/IR stars in the GC, we obtained near-IR spectra. The equivalent line widths of Na I, Ca I, ^{12}CO(2,0) and the curvature of the spectrum around 1.6 μm due to water absorption are determined. Results. The near-IR spectrum of OH/IR stars is influenced by several physical processes. OH/IR stars are variable stars suffering high mass-loss rates. The dust that is formed around the stars strongly influences the near-IR spectra and reduces the equivalent line widths of Na I, Ca I. A similar effect is caused by the water content in the outer atmosphere of the OH/IR star. Because of these effects, it is not possible with our low resolution near-infrared spectroscopy to determine the metallicities of these stars.

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Envelope Expansion with Core Collapse. III. Similarity Isothermal Shocks in a Magnetofluid

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We explore magnetohydrodynamic (MHD) solutions for envelope expansions with core collapse (EECC) with isothermal MHD shocks in a quasi-spherical symmetry and outline potential astrophysical applications of such magnetized shock flows. By including a random magnetic field in a gas medium, we further extend the recent isothermal shock results of Bian & Lou who have unified earlier similarity isothermal shock solutions of Tsai & Hsu, of Shu et al. and of Shen & Lou in a more general framework. MHD shock solutions are classified into three classes according to the downstream characteristics near the core. Class I solutions are those characterized by free-fall collapses towards the core downstream of an MHD shock, while Class II solutions are those characterized by Larson-Penston (LP) type near the core downstream of an MHD shock. Class III solutions are novel, sharing both features of Class I and II solutions with the presence of a sufficiently strong magnetic field as a prerequisite. Various MHD processes may occur within the regime of these isothermal MHD shock similarity solutions, such as sub-magnetosonic oscillations, free-fall core collapses, radial contractions and expansions. Both possibilities of perpendicular and oblique MHD shocks are analyzed. Under the current approximation of MHD EECC solutions, only perpendicular shocks are systematically calculated. These similarity MHD shocks propagate at either sub-magnetosonic or super-magnetosonic constant speeds. We can construct Class I, II and III MHD shocks matching with an isothermal magnetostatic outer envelope or an MHD breeze. We can also construct families of twin MHD shock solutions as well as an 'isothermal MHD shock' separating two magnetofluid regions of two different yet constant temperatures. The versatile behaviours of such MHD shock solutions may be utilized to model a wide range of astrophysical problems, including star formation in magnetized molecular clouds, 'MHD champagne flows' in HII regions around luminous massive OB stars, MHD link between the asymptotic giant branch phase to the proto-planetary nebula phase with a hot central magnetized white dwarf, relativistic MHD pulsar winds in supernova remnants, radio afterglows of soft gamma-ray repeaters and so forth.

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Evidence for TP-AGB stars in high redshift galaxies, and their effect on deriving stellar population parameters

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We explore the effects of stellar population models on estimating star formation histories, ages and masses of high redshift galaxies. The focus is on the Thermally-Pulsing Asymptotic Giant Branch (TP-AGB) phase of stellar evolution, whose treatment is a source of major discrepancy among different evolutionary population synthesis. In particular, besides the models usually adopted in the literature, we use models (by Maraston 2005), in which the contribution of the TP-AGB phase is calibrated with local stellar populations and is the dominant source of bolometric and near-IR energy for stellar populations in the age range 0.2 to 2 Gyr. These models also have an underlying different treatment of convective overshooting and Red Giant Branch stars. For our experiment we use a sample of high-z ($1.4 \leq z \leq 2.5$) galaxies in the Hubble Ultra Deep Field held to be mostly in passive evolution, with low-resolution UV-spectroscopy and spectroscopic redshifts from GRAPES, and *Spitzer* IRAC and MIPS photometry from the Great Observatories

Origins Deep Survey. We choose these galaxies because their mid-UV spectra exhibit features typical of A- or F-type stars, therefore TP-AGB stars ought to be expected in post-Main Sequence. We find that indeed the TP-AGB phase plays a key role in the interpretation of *Spitzer* data for high-z galaxies, when the rest-frame near-IR is sampled. When fitting without dust reddening, the models with the empirically-calibrated TP-AGB phase always reproduce better the observed spectral energy distributions (SEDs), in terms of a considerably smaller χ^2. Allowing for dust reddening improves the fits with literature models in some cases. In both cases, the results from Maraston models imply younger ages by factors up to 6 and lower stellar masses (by $\sim 60\%$ on average). The observed strengths of the Mg_{uv} spectral feature compare better to the predicted ones in the case of the Maraston models, implying a better overall consistency of SED fitting. Finally, we find that photometric redshifts improve significantly using these models on the SEDs extending over the IRAC bands. These results are primarily the consequence of the treatment of the TP-AGB phase in the Maraston models, which produces models with redder rest-frame optical to near-IR colors. This work provides the first direct evidence of TP-AGB stars in the primeval Universe.

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Conference Papers

Binary post-AGB stars and their Keplerian discs

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In this contribution we give a progress report on our systematic study of a large sample of post-AGB stars. The sample stars were selected on the basis of their infrared colours and the selection criteria were tuned to discover objects with hot dust in the system. We started a very extensive, multi-wavelength programme which includes the analysis of our radial velocity monitoring; our optical high-resolution spectra; our groundbased N-band spectral data as well as the Spitzer full spectral scans; the broad-band SED and the high spatial-resolution interferometric experiments with the VLTI. In this contribution we highlight the main results obtained so far and argue that all systems in our sample are indeed binaries, which are surrounded by dusty Keplerian circumbinary discs. The discs play a lead role in the evolution of the systems.

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The re-emergence of 1612 MHz masers in IRAS 19479+2111

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IRAS 19479+2111 exhibited an idiosyncratic set of 1612 MHz masers with peak intensities of 134 to 271 mJy & velocities of 2 -10 km/s when first searched in May 1987. These had completely disappeared when the object was revisited in June 2000 after the completion of the Arecibo Gregorian upgrade, and were not seen at any of the 10 epochs checked during the next 2.5 yr. Our observations set a < 2 mJy limit on the intensity of any 1612 MHz emission during 2000-2002, so the masers had faded by a factor >100 for an interval much longer than the likely 350-450 d pulsation period. This OH/IR star, which only has a 12% IRAS probability of being a MIR variable, was thus considered to be "dead" (ApJ 576, 445). Nevertheless we now have to report the reappearance since June 2005

of 1612 MHz masers in the same velocity range with evolving intensities of 20 - 90 mJy. Hence the intensity of 1612 MHz masers in OH/IR stars, besides being subjected to a regular factor of 2-3 change with pulsation period, may also exhibit a much larger and longer-period modulation.

The likely explanation for this new phenomenon is the existence of an interaction between the dust formation and mass-loss processes, which was modelled for carbon stars by Simis (A&A 371, 205) to reproduce the ring-like optical-intensity enhancements seen in PPN & PN shells. When this occurs in the circumstellar shell (CS) of a low-mass star, the change in dM/dt can be large enough to switch the maser-pump ON or OFF. A recent time-dependent modelling study of 1612 MHz masers (astro-ph/0509218) shows they disappear <10 yr after mass-loss stops, as a result of changes in the reprocessing of the SED by the dense innermost portion of a CS, which changes the 53 μm pump. Our observation therefore points to the applicability of Simis′s process to O-rich stars.

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