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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is a pleasure to present you the 192$^{\text{nd}}$ issue of the AGB Newsletter. There's something for everyone – what about the Nature paper on sodium, or the use of a Solar System exploration spacecraft to study our beloved red giants?

Please check the announcements at the end, related to a recent and upcoming meeting.

With reference to last month's *Food for Thought*, Noam Soker has been a strong proponent of the idea to look for the remnants of life in spherical planetary nebulæ. In these, there is no close binary star, thus increasing the likelihood of an Earth-like planet. He also cautions against calling the attention of advanced life. (None are registered with this newsletter; at least not of the alien variety.)

The next issue is planned to be distributed around the 1$^{\text{st}}$ of August.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Do planets become unbound during stellar death, thereby becoming free-floating?

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

Sodium content as a predictor of the advanced evolution of globular cluster stars

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The asymptotic giant branch (AGB) phase is the final stage of nuclear burning for low-mass stars. Although Milky Way globular clusters are now known to harbour (at least) two generations of stars they still provide relatively homogeneous samples of stars that are used to constrain stellar evolution theory. It is predicted by stellar models that the majority of cluster stars with masses around the current turn-off mass (that is, the mass of the stars that are currently leaving the main sequence phase) will evolve through the AGB phase. Here we report that all of the second-generation stars in the globular cluster NGC 6752 – 70 per cent of the cluster population – fail to reach the AGB phase. Through spectroscopic abundance measurements, we found that every AGB star in our sample has a low sodium abundance, indicating that they are exclusively first-generation stars. This implies that many clusters cannot reliably be used for star counts to test stellar evolution timescales if the AGB population is included. We have no clear explanation for this observation.

Published in Nature
Available from arXiv:1305.7090
and from http://www.nature.com/nature/journal/vaop/ncurrent/full/nature12191.html

Two barium stars in the open cluster NGC 5822

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Open clusters are very useful targets to constrain nucleosynthesis process with the luminosities of the stars because the distances of the clusters are better known than for field stars. We carried out a detailed spectroscopic analysis to derive the chemical composition of two red giants in the young open cluster NGC 5822, NGC 5822-2 and NGC 5822-201. We obtained abundances of C, N, O, Na, Mg, Al, Ca, Si, Ti, Ni, Cr, Y, Zr, La, Ce, and Nd. The atmospheric parameters of the studied stars and their chemical abundances were determined using high-resolution optical spectroscopy. We employ the local-thermodynamic-equilibrium model atmospheres of Kurucz and the spectral analysis code MOOG. The abundances of the light elements were derived using spectral synthesis technique. We found that NGC 5822-2 and 201 have, respectively, a mean overabundance of the elements created by the s-process, "s", in the notation [s/Fe] of 0.77 ± 0.12 and 0.83 ± 0.05. These values are higher than for field giants of similar metallicity. We also found that NGC 5822-2 and 201 have, respectively, luminosities of 140 $L_\odot$ and 76 $L_\odot$, which is much lower than a luminosity of an asymptotic giant branch star. We conclude that NGC 5822-2 and NGC 5822-201 are two new barium stars first identified in the open cluster NGC 5822. The mass-transfer hypothesis is the best scenario to explain the observed overabundances.

Accepted for publication in The Astronomical Journal

Adaptive optics imaging of VY Canis Majoris at 2–5 μm with LBT/LMIRCam

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We present adaptive optics images of the extreme red supergiant VY Canis Majoris in the K_s, L' and M bands (2.15 to 4.8 μm) made with LMIRCam on the Large Binocular Telescope (LBT). The peculiar "Southwest Clump" previously imaged from 1 to 2.2 μm appears prominently in all three filters. We rule out thermal emission as a source of its brightness, which we attribute to scattering alone. We model its brightness as optically thick scattering from silicate dust grains using typical size distributions. We find a lower limit mass of approximately 5×10^{-3} $M_\odot$ in this single feature. The presence of the Clump as a distinct feature with no apparent counterpart on the other side of the star is suggestive of an ejection event from a localized region of the star and is consistent with VY CMa's history of asymmetric high mass loss events.

Submitted to Astronomical Journal

Available from arXiv:1305.6912

Precise radial velocities of giant stars. V. A brown dwarf and a planet orbiting the K giant stars τ Gem and 91 Aqr

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For more than a decade we have used Doppler spectroscopy to acquire high-precision radial velocity measurements of K giant stars. All data for this survey were taken at Lick Observatory. Our survey includes 373 G and K giants. Radial velocity data showing periodic variations were fitted with Keplerian orbits using a χ^2 minimization technique. We report the presence of two substellar companions to the K giant stars τ Gem and 91 Aqr. The brown dwarf orbiting τ Gem has an orbital period of 305.5 ± 0.1 days, a minimum mass of 20.6 $M_{\rm Jup}$, and an eccentricity of 0.031 ± 0.009. The planet orbiting 91 Aqr has an orbital period of 181.4 ± 0.1 days, a minimum mass of 3.2 $M_{\rm Jup}$, and an eccentricity of 0.027 ± 0.026. Both companions have exceptionally circular orbits for their orbital distance, as compared to all previously discovered planetary companions.

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Probing the fast outflow in IRAS 15452−5459 with ATCA observations of OH, H_2O, and SiO masers

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Maser lines of OH, H_2O, and SiO are commonly observed in O-rich AGB stars, but their presence after the end of the

Asymptotic Giant Branch (AGB) phase is linked to non-spherical mass-loss processes. IRAS 15452−5459 is a post-AGB star with an hourglass nebula whose maser lines are quite peculiar. We observed all of the three maser species with the Australia Telescope Compact Array with angular resolutions of 6″, 0.″6, 0.″3, and 1.″7 at 18 cm, 13 mm, 7 mm, and 3 mm, respectively. While double peaks are routinely seen in OH and water masers and interpreted as due to expanding envelopes, only very few sources display SiO lines with a similar spectral profile. Our observations confirm the detection of the double peak of SiO at 86 GHz; the same spectral shape is seen in the lower-J maser at 43 GHz. A double peak is also detected in the water line, which covers the same velocity range as the SiO masers. Thermally excited lines of SiO are detected at 7 and 3 mm and span the same velocity range as the maser lines of this species. Although observations at higher angular resolution are desirable to further investigate the spatial distributions of the maser spots, the current data allow us to conclude that the SiO masers are distributed in an hourglass shape and are likely due to the sputtering of dust grains caused by shock propagation. The complex OH profile would instead be due to emission from the fast outflow and an orthogonal structure.

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Available from arXiv:1306.1729

High angular resolution stellar imaging with occultations from the *Cassini* spacecraft I: Observational technique

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We present novel observations utilising the *Cassini* spacecraft to conduct an observing campaign for stellar astronomy from a vantage point in the outer solar system. By exploiting occultation events in which Mira passed behind the Saturnian ring plane as viewed by *Cassini*, parametric imaging data were recovered spanning the near-infrared. From this, spatial information at extremely high angular resolution was recovered enabling a study of the stellar atmospheric extension across a spectral bandpass spanning the 1–5 μm spectral region in the near-infrared. The resulting measurements of the angular diameter of Mira were found to be consistent with existing observations of its variation in size with wavelength. The present study illustrates the validity of the technique; more detailed exploration of the stellar physics obtained by this novel experiment will be the subject of forthcoming papers.

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The deceleration of nebular shells in evolved planetary nebulæ

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We have selected a group of 100 evolved planetary nebulæ (PNe) and study their kinematics based upon spatially-resolved, long-slit, échelle spectroscopy. The data have been drawn from the San Pedro Mártir Kinematic Catalogue of PNe (López et al. 2012). The aim is to characterize in detail the global kinematics of PNe at advanced stages of evolution with the largest sample of homogenous data used to date for this purpose. The results reveal two groups that share kinematics, morphology, and photo-ionization characteristics of the nebular shell and central star luminosities at the different late stages under study. The typical ow velocities we measure are usually larger than seen in earlier evolutionary stages, with the largest velocities occurring in objects with very weak or absent [N II] 6584 line emission, by all indications the least evolved objects in our sample. The most evolved objects expand more slowly. This apparent deceleration during the final stage of PNe evolution is predicted by hydrodynamical models, but other explanations are also possible. These results provide a template for comparison with the predictions of theoretical models.

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Proper-motion measurements of the Cygnus Egg Nebula: The presence of fast equatorial outflows

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We present the results of differential proper-motion analyses of the Egg Nebula (RAFGL 2688, V1610 Cyg) based on the archived two-epoch optical data taken with the *Hubble* Space Telescope. First, we determined that the polarization characteristics of the Egg Nebula is influenced by the higher optical depth of the central regions of the nebula (i.e., the "dustsphere" of about 1000 au radius), causing the nebula illuminated in two steps – the direct starlight is first channeled into bipolar cavities and then scattered off to the rest of the nebula. We then measured the amount of motion of local structures and the signature concentric arcs by determining their relative shifts over the 7.25 yr interval. Based on our analysis, which does not rely on the single-scattering assumption, we concluded that the lobes have been excavated by a linear expansion along the bipolar axis for the past 400 yr, while the concentric arcs have been generated continuously and moving out radially at about 10 km s^{-1} for the past 5,500 yr, and there appears to be a colatitudinally-increasing trend in the radial expansion velocity field of the concentric arcs. There exist numerical investigations into the mass-loss modulation by the central binary system, which predict such a colatitudinally-increasing expansion velocity field in the spiral-shock trails of the mass-loss ejecta. Therefore, the Egg Nebula may represent a rare edge-on case of the binary-modulated circumstellar environs, corroborating the previous theoretical predictions.

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Infrared spectroscopy of fullerene C_{60}/anthracene adducts

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Recent *Spitzer* Space Telescope observations of several astrophysical environments such as Planetary Nebulæ, Reflection Nebulæ, and R Coronæ Borealis stars show the simultaneous presence of mid-infrared features attributed to neutral fullerene molecules (i.e., C_{60}) and polycyclic aromatic hydrocarbons (PAHs). If C_{60} fullerenes and PAHs coexist in fullerene-rich space environments, then C_{60} may easily form adducts with a number of different PAH molecules; at least with catacondensed PAHs. Here we present the laboratory infrared spectra ($\sim$ 2–25 μm) of C_{60} fullerene and anthracene Dies–Alder mono- and bis-adducts as produced by sonochemical synthesis. We find that C_{60}/anthracene Diels–Alder adducts display spectral features strikingly similar to those from C_{60} (and C_{70}) fullerenes and other unidentified infrared emission features. Thus, fullerene-adducts – if formed under astrophysical conditions and stable/abundant enough – may contribute to the infrared emission features observed in fullerene-containing circumstellar/interstellar environments.

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Hot bottom burning and s-process nucleosynthesis in massive AGB stars at the beginning of the thermally-pulsing phase

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We report the first spectroscopic identification of massive Galactic asymptotic giant branch (AGB) stars at the beginning of the thermal pulse (TP) phase. These stars are the most Li-rich massive AGBs found to date, super Li-rich AGBs with $\log E(\mathrm{Li}) \sim 3$–4. The high Li overabundances are accompanied by weak or no s-process element (i.e. Rb and Zr) enhancements. A comparison of our observations with the most recent hot bottom burning (HBB) and s-process nucleosynthesis models confirms that HBB is strongly activated during the first TPs but the ^{22}Ne neutron source needs many more TP and third dredge-up episodes to produce enough Rb at the stellar surface. We also show that the short-lived element Tc, usually used as an indicator of AGB genuineness, is not detected in massive AGBs which is in agreement with the theoretical predictions when the ^{22}Ne neutron source dominates the s-process nucleosynthesis.

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Rapid angular expansion of the ionized core of CRL 618

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During the transition from the AGB to the planetary nebula phase the circumstellar envelopes of most of low and intermediate mass stars experience a dramatic change in morphology. CRL 618 is an object that exhibits characteristics of both AGB and post-AGB star. It also displays a spectacular array of bipolar lobes with a dense equatorial region, which makes it an excellent object to study the development of asymmetries in evolved stars. In the recent decades, an elliptical compact H II region located in the center of the nebula has been seen to be increasing in size and flux. This seems to be due to the ionization of the circumstellar envelope by the central star, and it would be indicating the beginning of the planetary nebula phase for CRL 618. To determine the physical conditions under which the onset of the ionization the circumstellar envelope of CRL 618 took place and the subsequent propagation of the ionization front. We analyzed interferometric radio continuum data at ~ 5 and 22 GHz from observations carried out at seven epochs with the VLA. We traced the increase of the flux of the ionized region over a period of ~ 26 years. We measured the dimensions of the H II region directly from the brightness distribution images to determine the increase of its size over time. For one of the epochs we analyzed observations at six frequencies from which we estimated the electron density distribution. We carried out model calculations of the spectral energy distribution at two different epochs to corroborate our observational results. We found that the radio continuum flux and the size of the ionized region have been increasing monotonically in the last three decades. The size of the major axis of the H II region shows a dependence with frequency, which has been interpreted as a result of a gradient of the electron density in this direction. The growth of the H II region is due to the expansion of an ionized wind whose mass-loss rate increased continuously for a period of ~ 100 years until a few decades ago, when the mass-loss rate experienced a sudden decline. Our results indicate that the beginning of the ionization of the circumstellar envelope began around 1971, which marks the start of the planetary nebula phase of CRL 618.

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Nebular emission and the Lyman continuum photon escape fraction in CALIFA early-type galaxies

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We use deep integral field spectroscopy data from the CALIFA survey to study the warm interstellar medium (WIM) of 32 nearby early-type galaxies (ETGs). We propose a tentative subdivision of our sample ETGs into two groups, according to their Hα equivalent width (EW) and Lyman continuum (LyC) photon escape fraction (PLF). Type I ETGs show nearly constant EWs and a $PLF \sim 0$, suggesting that photoionization by post-AGB stars is the main driver of their faint extranuclear nebular emission. Type II ETGs are characterized by very low, outwardly increasing EWs, and a PLF as large as ~ 0.9 in their centers. Such properties point to a low, and inwardly decreasing WIM density and/or volume filling factor. We argue that, because of extensive LyC photon leakage, emission-line luminosities and EWs are reduced in type II ETG nuclei by at least one order of magnitude. Consequently, the line weakness of these ETGs is by itself no compelling evidence for their containing merely "weak" (sub-Eddington accreting) active galactic nuclei (AGN). In fact, LyC photon escape, which has heretofore not been considered, may constitute a key element in understanding why many ETGs with prominent signatures of AGN activity in radio continuum and/or X-ray wavelengths show only faint emission lines and weak signatures of AGN activity in their optical spectra. The LyC photon escape, in conjunction with dilution of nuclear EWs by line-of-sight integration through a triaxial stellar host, can systematically impede detection of AGN in gas-poor galaxy spheroids through optical emission-line spectroscopy. We further find that type I and II ETGs differ little (~ 0.4 dex) in their mean BPT line ratios, which in both cases are characteristic of LINERs. This potentially hints at a degeneracy of the projected, luminosity-weighted BPT ratios for the specific 3D properties of the WIM in ETGs. (abridged)

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Characterization of the red giant HR 2585 using the CHARA array

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We present the fundamental parameters of HR 2582, a high-mass red giant star whose evolutionary state is a mystery. We used the CHARA Array interferometer to directly measure the star's limb-darkened angular diameter (1.006 ± 0.020 mas) and combined our measurement with parallax and photometry from the literature to calculate its physical radius (35.76 ± 5.31 R$_\odot$), luminosity (517.8 ± 17.5 L$_\odot$), bolometric flux ($(14.8 \pm 0.5) \times 10^{-8}$ erg s^{-1} cm^{-2}) and effective temperature (4577 ± 60 K). We then determined the star's mass (5.6 ± 1.7 M$_\odot$) using our new values with stellar oscillation results from Baudin et al. Finally, using the Yonsei–Yale evolutionary models, we estimated HR 2582's age to be 165^{+20}_{-15} Myr. While our measurements do not provide the precision required to definitively state where the star is in its evolution, it remains an excellent test case for evaluating stellar interior models.

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Measuring nebular temperatures: the effect of new collision strengths with equilibrium and κ-distributed electron energies

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In this paper we develop tools for observers to use when analysing nebular spectra for temperatures and metallicities, with two goals: to present a new, simple method to calculate equilibrium electron temperatures for collisionally excited line flux ratios, using the latest atomic data; and to adapt current methods to include the effects of possible non-equilibrium κ electron energy distributions. Adopting recent collision strength data for [O III], [S III], [O II], [S II], and [N II], we find that existing methods based on older atomic data seriously overestimate the electron temperatures, even when considering purely Maxwellian statistics. If κ distributions exist in H II regions and planetary nebulæ as they do in solar system plasmas, it is important to investigate the observational consequences. This paper continues our previous work on the κ distribution (Nicholls et al. 2012). We present simple formulaic methods that allow observers to (a) measure equilibrium electron temperatures and atomic abundances using the latest atomic data, and (b) to apply simple corrections to existing equilibrium analysis techniques to allow for possible non-equilibrium effects. These tools should lead to better consistency in temperature and abundance measurements, and a clearer understanding of the physics of H II regions and planetary nebulæ.

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A long-term VLBA monitoring campaign of the $v = 1$, $J = 1$–0 SiO masers toward TX Cam. I. Morphology and shock waves

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We present the latest and final version of the movie of the SiO masers toward the Mira variable TX Cam. The new version consists of 112 frames (78 successfully reduced epochs) with data covering almost three complete stellar cycles between 24$^{\rm th}$ May 1997 and 25$^{\rm th}$ January 2002, observed with the VLBA. In this paper we examine the global morphology, kinematics and variability of the masering zone. The morphology of the emission is confined in a structure that usually resembles a ring or an ellipse, with occasional deviations due to localised phenomena. The ring appears to be contracting and expanding, although for the first cycle contraction is not observed. The width and outer boundary of the masering zone follow the stellar pulsation. Our data seem to be consistent with a shock being created once per stellar cycle at maximum that propagates with a velocity of ~ 7 km s^{-1} . The difference in velocities along different axes strongly suggests that the outflow in TX Cam is bipolar. The contribution of projection is examined and our results are compared with the latest theoretical model.

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OH/IR stars and their superwinds as observed by the *Herschel* Space Observatory

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Aims: In order to study the history of mass loss in extreme OH/IR stars, we observed a number of these objects using CO as a tracer of the density and temperature structure of their circumstellar envelopes.
Methods: Combining CO observations from the *Herschel* Space Observatory with those from the ground, we trace mass-loss rates as a function of radius in five extreme OH/IR stars. Using radiative transfer modelling, we modelled the dusty envelope as well as the CO emission. The high-rotational transitions of CO indicate that they originate in a dense superwind region close to the star while the lower transitions tend to come from a more tenuous outer wind which is a result of the mass loss since the early AGB phase.
Results: The models of the circumstellar envelopes around these stars suggest that they have entered a superwind phase in the past 200–500 years. The low $^{18}O/^{17}O$ (~ 0.1 compared to the solar abundance ratio of ~ 5) and $^{12}C/^{13}C$ (3–30 cf. the solar value of 89) ratios derived from our study support the idea that these objects have undergone hot-bottom burning and hence that they are massive $M \geq 5$ $M_\odot$ AGB stars.

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The atmospheric structure and fundamental parameters of the red supergiants AH Scorpii, UY Scuti, and KW Sagittarii

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Aims: We present the atmospheric structure and the fundamental properties of the red supergiants (RSGs) AH Sco, UY Sct, and KW Sgr based on VLTI/AMBER observations.
Methods: We carried out spectro-interferometric observations of AH Sco, UY Sct, and KW Sgr in the near-infrared K band (1.92–2.47 μm) with the VLTI/AMBER instrument with spatial and spectral resolutions of 3 milliarcsec and 1500, respectively, and compared the data to a new grid of hydrostatic PHOENIX model atmospheres.
Results: In our visibility data, we observe molecular layers of water and CO in extended atmospheres. For a uniform disk modeling, we observe size increases at the water band centered at 1.9 μm of 10% to 25% and at the CO bandheads at 2.3–2.5 μm of 20%–35% with respect to the near-continuum bandpass at around 2.20 μm. Our near-infrared spectra of AH Sco, UY Sct, and KW Sgr are well reproduced by the PHOENIX model atmospheres. The continuum visibility values are consistent with a limb-darkened disk as predicted by the PHOENIX models. However, the model visibilities do not predict the large observed extensions of the molecular layers. Comparing the continuum visibility values to PHOENIX models, we estimate the Rosseland-mean photospheric angular diameters of AH Sco, UY Sct, and KW Sgr to be 5.81 ± 0.15 mas, 5.48 ± 0.10 mas, and 3.91 ± 0.25 mas, respectively. Together with the distance and the spectro-photometry, we calculate radii of 1411 ± 124 $R_\odot$ for AH Sco, 1708 ± 192 $R_\odot$ for UY Sct, and 1009 ± 142 $R_\odot$ for KW Sgr and effective temperatures of 3682 ± 190 K for AH Sco, 3365 ± 134 K for UY Sct, and 3720 ± 183 K for KW Sgr.
Conclusions: AH Sco, UY Sct, and KW Sgr exhibit extended atmospheric layers of H_2O and CO. The PHOENIX atmosphere models predict the spectra and the continuum visibility values, but cannot reproduce the large extensions of the molecular layers. This indicates that the opacities of the molecular bands are included, but that the model atmospheres are too compact compared to the observations. The observed extended layers may be levitated by

processes such as pulsation or convection, which are not included in the hydrostatic atmospheric models. The location of the targets in the HR-diagram is confirmed to be close to, and possibly slightly to the right of, the Hayashi limit of recent evolutionary tracks corresponding to masses between about 20 $M_\odot$ and 40 $M_\odot$.

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Advanced burning stages and fate of 8–10 $M_\odot$ stars

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The stellar mass range $8 \lesssim M/M_\odot \lesssim 12$ corresponds to the most massive AGB stars and the most numerous massive stars. It is host to a variety of supernova progenitors and is therefore very important for galactic chemical evolution and stellar population studies. In this paper, we study the transition from super-AGB star to massive star and find that a propagating neon–oxygen burning shell is common to both the most massive electron capture supernova (EC-SN) progenitors and the lowest mass iron-core collapse supernova (FeCCSN) progenitors. Of the models that ignite neon burning off-center, the 9.5 $M_\odot$ star would evolve to an FeCCSN after the neon-burning shell propagates to the center, as in previous studies. The neon-burning shell in the 8.8 $M_\odot$ model, however, fails to reach the center as the URCA process and an extended (0.6 $M_\odot$) region of low Y_e (0.48) in the outer part of the core begin to dominate the late evolution; the model evolves to an EC-SN. This is the first study to follow the most massive EC-SN progenitors to collapse, representing an evolutionary path to EC-SN in addition to that from SAGB stars undergoing thermal pulses. We also present models of an 8.75 $M_\odot$ super-AGB star through its entire thermal pulse phase until electron captures on ^{20}Ne begin at its center and of a 12 $M_\odot$ star up to the iron core collapse. We discuss key uncertainties and how the different pathways to collapse affect the pre-supernova structure. Finally, we compare our results to the observed neutron star mass distribution.

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Period–mass-loss rate relation of Miras with and without technetium

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Aims: We report the discovery that Mira variables with and without absorption lines of the element technetium (Tc) occupy two different regions in a diagram of near- to mid-infrared colour versus pulsation period. Tc is an indicator of a recent or ongoing mixing event called the third dredge-up (3DUP), and the near- to mid-IR colour, such as the

(K–[22]) colour where [22] is the 22 μm band of the WISE space observatory, is an indicator of the dust mass-loss rate of a star.
Methods: We collected data from the literature about the Tc content, pulsation period, and near- and mid-infrared magnitudes of more than 190 variable stars on the asymptotic giant branch (AGB) to which Miras belong. The sample is naturally biased towards optical AGB stars, which have low to intermediate (dust) mass-loss rates.
Results: We show that a clear relation between dust mass-loss rate and pulsation period exists if a distinction is made between Tc-poor and Tc-rich Miras. Surprisingly, at a given period, Tc-poor Miras are redder in (K–[22]) than are Tc-rich Miras; i.e. they have higher mass-loss rates than the Tc-rich Miras. A few stars deviate from this trend; physical explanations are given for these exceptions, such as binarity or high mass.
Conclusions: We put forward two hypotheses to explain this dichotomy and conclude that the two sequences formed by Tc-poor and Tc-rich Miras are probably due to the different masses of the two groups. The pulsation period has a strong correlation with the dust-mass loss rate, indicating that the pulsations are indeed triggering a dust-driven wind. The location in the (K–[22]) vs. period diagram can be used to distinguish between pre- and post-3DUP Miras, which we apply to a sample of Galactic bulge AGB stars. We find that 3DUP is probably not common in AGB stars in the inner bulge.

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The discrepant kinematics of ORLs and CELs in NGC 7009 as a function of ionization structure

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We present spatially- and velocity-resolved echelle spectroscopy for NGC 7009 obtained with the UVES spectrograph at the European Southern Observatory's Very Large Telescope. Our objective is to analyze the kinematics of emission lines excited by recombination and collisions with electrons to determine whether similarities or differences could be useful in elucidating the well-known abundance discrepancy derived from them. We construct position-velocity maps for recombination, fluorescence, charge transfer, and collisionally-excited lines. We find a plasma component emitting in the C II, N II, O II, and Ne II recombination lines whose kinematics are discrepant: They are incompatible with the ionization structure derived from all other evidence and the kinematics derived from all of these lines are unexpectedly very similar. We find direct evidence for a recombination contribution to [N II] 5755. Once taken into account, the electron temperatures from [N II], [O III], and [Ne III] agree at a given position and velocity. The electron densities derived from [O II] and [Ar IV] are consistent with direct imaging and the distribution of hydrogen emission. The kinematics of the C II, N II, O II, and Ne II lines does not coincide with the kinematics of the [O III] and [Ne III] forbidden emission, indicating that there is an additional plasma component to the recombination emission that arises from a different volume from that giving rise to the forbidden emission from the parent ions within NGC 7009. Thus, the chemical abundances derived from either type of line are correct only for the plasma component from which they arise. Apart from [N II] 5755, we find no anomaly with the forbidden lines usually used to determine chemical abundances in ionized nebulæ, so the abundances derived from them should be reliable for the medium from which they arise.

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Spatio-kinematic modelling of Abell 65, a double-shelled planetary nebula with a binary central star

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We present the first detailed spatio-kinematical analysis and modelling of the planetary nebula Abell 65, which is known to host a post-common envelope, binary, central star system. As such, this object is of great interest in studying the link between nebular morphology and central star binarity.

[O III]5007Å and Hα+[N II]6584Å longslit spectra and imagery of Abell 65 were obtained with the Manchester Échelle Spectrometer on the 2.1-m telescope at the San Pedro Martir Observatory (MES-SPM). Further [O III]5007Å longslit spectra were obtained with the Ultraviolet and Visual Échelle Spectrograph on the Very Large Telescope (VLT-UVES). These data were used to develop a spatio-kinematical model for the [O III]5007Å emission from Abell 65. A "best-fit" model was found by comparing synthetic spectra and images rendered from the model to the data. The model comprises an outer shell and an inner shell, with kinematical ages of 15000 ± 5000 yr kpc^{-1} and 8000 ± 3000 yr kpc^{-1}, respectively. Both shells have peanut-shaped bipolar structures with symmetry axes at inclinations of $55° \pm 10°$ (to the line-of-sight) for the outer shell and $68° \pm 10°$ for the inner shell. The near-alignment between the nebular shells and the binary orbital inclination (of $68° \pm 2°$) is strongly indicative that the binary is responsible for shaping the nebula. Abell 65 is one of a growing number of planetary nebulæ (seven to date, including Abell 65 itself) for which observations and modelling support the shaping influence of a central binary.

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Fundamental parameters of 16 late-type stars derived from their angular diameter measured with VLTI/AMBER

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Thanks to their large angular dimension and brightness, red giants and supergiants are privileged targets for optical long-baseline interferometers. Sixteen red giants and supergiants have been observed with the VLTI/AMBER facility over a two-years period, at medium spectral resolution ($R = 1500$) in the K band. The limb-darkened angular diameters are derived from fits of stellar atmospheric models on the visibility and the triple product data. The angular diameters do not show any significant temporal variation, except for one target: TX Psc, which shows a variation of 4% using visibility data. For the eight targets previously measured by Long-Baseline Interferometry (LBI) in the same spectral range, the difference between our diameters and the literature values is less than 5%, except for TX Psc, which shows a difference of 11%. For the 8 other targets, the present angular diameters are the first measured from LBI. Angular diameters are then used to determine several fundamental stellar parameters, and to locate these targets in the Hertzsprung–Russell Diagram (HRD). Except for the enigmatic Tc-poor low-mass carbon star W Ori, the location of Tc-rich stars in the HRD matches remarkably well the thermally-pulsating AGB, as it is predicted by the stellar-evolution models. For pulsating stars with periods available, we compute the pulsation constant and locate the stars along the various sequences in the Period–Luminosity diagram. We confirm the increase in mass along the pulsation sequences, as predicted by the theory, except for W Ori which, despite being less massive, appears to have a longer period than T Cet along the first overtone sequence.

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Evolution of Thermally Pulsing Asymptotic Giant Branch stars II. Dust production at varying metallicity

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We present the dust ejecta of the new stellar models for the Thermally Pulsing Asymptotic Giant Branch (TP-AGB) phase computed with the COLIBRI code. We use a formalism of dust growth coupled with a stationary wind for both M and C-stars. In the original version of this formalism, the most efficient destruction process of silicate dust in M-giants is chemisputtering by H_2 molecules. For these stars we find that dust grains can only form at relatively large radial distances ($r \sim 5R_\star$), where they cannot be efficiently accelerated, in agreement with other investigations. In the light of recent laboratory results, we also consider the alternative case that the condensation temperature of silicates is determined only by the competition between growth and free evaporation processes (i.e. no chemisputtering). With this latter approach we obtain dust condensation temperatures that are significantly higher (up to $T_{\rm cond} \sim 1400$ K) than those found when chemisputtering is included ($T_{\rm cond} \sim 900$ K), and in better agreement with condensation experiments. As a consequence, silicate grains can remain stable in inner regions of the circumstellar envelopes ($r \sim 2R_\star$), where they can rapidly grow and can be efficiently accelerated. With this modification, our models nicely reproduce the observed trend between terminal velocities and mass-loss rates of Galactic M-giants. For C-stars the formalismis based on the homogeneous growth scheme where the key role is played by the carbon over oxygen excess. The models reproduce fairly well the terminal velocities of Galactic stars and there is no need to invoke changes in the standard assumptions. At decreasing metallicity the carbon excess becomes more pronounced and the efficiency of dust formation increases. This trend could be in tension with recent observational evidence in favour of a decreasing efficiency, at decreasing metallicity. If confirmed by more observational data, it would indicate that either the amount of the carbon excess, determined by the complex interplay between mass loss, third dredge-up and hot bottom burning, or the homogeneous growth scheme should be revised. Finally, we analyze the differences in the total dust production of M-stars that arise from the use of the two approaches (i.e. with or without chemisputtering). We find that, in spite of the differences in the expected dust stratification, for a given set of TP-AGB models, the ejecta are only weakly sensitive to the specific assumption. This work also shows that the properties of TP-AGB circumstellar envelopes are important diagnostic tools that may be profitably added to the traditional calibrators for setting further constraints on this complex phase of stellar evolution.

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On the carbonaceous carriers of IR plateau and continuum emission

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This study explores the molecular origins of plateaus and continuum underlying IR and FIR bands emitted by compact nebulæ, especially proto-planetary nebulæ. Computational organic chemistry codes are used to deliver the vibrational integrated band intensities of various large, typical carbonaceous structures. These spectra are composed of a rather continuous distribution of weak modes from which emerge the fingerprints. The 6 to 18-μm region is interspersed with

a great many weak lines, to which the plateaus are assigned. Similarly, the far IR spectrum is ascribed to the phonon (skeletal) spectrum which is readily identified beyond 18 μm.
The absorptivities and absorption cross-sections per interstellar H atom deduced from these spectra are comparable with those of laboratory dust analogs and astronomical measurements, respectively. Moreover, the 5–35 μm spectra of two typical proto-planetary nebula were reasonably well simulated with combinations of molecules containing functional groups which carry the 21- and 30-μm bands, and molecules devoid of these but carrying strong phonon spectra.
These results may help understand the emergence of plateaus, the origin of continua underlying FIR bands, as well as the composition of circumstellar dust.

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Discovery of an ultramassive pulsating white dwarf

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We announce the discovery of the most massive pulsating hydrogen-atmosphere white dwarf (WD) ever discovered, GD 518. Model atmosphere fits to the optical spectrum of this star show it is a $12,030 \pm 210$ K WD with a $\log g = 9.08 \pm 0.06$, which corresponds to a mass of 1.20 ± 0.03 $M_{\odot}$. Stellar evolution models indicate that the progenitor of such a high-mass WD endured a stable carbon- burning phase, producing an oxygen–neon-core WD. The discovery of pulsations in GD 518 thus offers the first opportunity to probe the interior of a WD with a possible oxygen-neon core. Such a massive WD should also be significantly crystallized at this temperature. The star exhibits multi- periodic luminosity variations at timescales ranging from roughly 425–595 s and amplitudes up to 0.7%, consistent in period and amplitude with the observed variability of typical ZZ Ceti stars, which exhibit non-radial g-mode pulsations driven by a hydrogen partial ionization zone. Successfully unraveling both the total mass and core composition of GD 518 provides a unique opportunity to investigate intermediate-mass stellar evolution, and can possibly place an upper limit to the mass of a carbon–oxygen-core WD, which in turn constrains Type Ia supernovæ progenitor systems.

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Luminosities of carbon-rich asymptotic giant branch stars in the Milky Way

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Context: Stars evolving along the asymptotic giant branch can become carbon-rich in the final part of their evolution. They replenish the inter-stellar medium with nuclear processed material via strong radiative stellar winds. The determination of the luminosity function of these stars, even if far from being conclusive, is extremely important for testing the reliability of theoretical models. In particular, strong constraints on the mixing treatment and the mass-loss rate can be derived. Aims. We present an updated luminosity function of Galactic carbon stars (LFGCS) obtained from a re-analysis of available data already published in previous papers.
Methods: Starting from available near- and mid-infrared photometric data, we re-determined the selection criteria. Moreover, we took advantage of updated distance estimates and period–luminosity relations and we adopted a new

formulation for the computation of bolometric corrections (BCs). This led us to collect an improved sample of carbon-rich sources from which we constructed an updated luminosity function.
Results: The LFGCS peaks at magnitudes around −4.9, confirming the results obtained in a previous work. Nevertheless, the luminosity function presents two symmetrical tails instead of the larger high-luminosity tail characterizing the former luminosity function.
Conclusions: The derived LFCGS matches the indications from recent theoretical evolutionary asymptotic giant branch models, thus confirming the validity of the choices of mixing treatment and mass-loss history. Moreover, we compare our new luminosity function with its counterpart in the Large Magellanic Cloud finding that the two distributions are very similar for dust-enshrouded sources, as expected from stellar evolutionary models. Finally, we derive a new fitting formula aimed to better determine BCs for C-stars.

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Conference Papers

Weak and extended H_2 emission in NGC 6369

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NGC 6369 is a double-shell PN with a filamentary outer shell or envelope and faint bipolar extensions. We have used ground- and space-based narrowband optical and near-IR images, broadband mid-IR images, optical long-slit échelle spectra, and mid-IR spectra to investigate its physical structure. The observations confirm a bipolar structure for the inner shell of NGC 6369, but they also reveal evidence for H_2 and strong polycyclic aromatic hydrocarbons (PAHs) emission from a photo-dissociation region (PDR) with molecular inclusions located outside the bright inner shell.

Poster contribution, published in IAU Symp. 283: "Planetary Nebulæ: An Eye to the Future", Volume 7, July 2011, E3
Available from arXiv:1305.4211

A new look at the symbiotic star RW Hydræ

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We present new estimates of the basic stellar parameters of the non-eruptive, eclipsing symbiotic system, RW Hydræ. A set of photometric and spectroscopic data was used to model this object simultaneously from the light and radial velocity curves. With new spectroscopic data we were able to improve previous results known from the literature and derive physical parameters of the system: $q = 4.2$, $M_1 = 0.8$ $M_\odot$, $M_2 = 3.4$ $M_\odot$, $R_1 = 0.2$ $R_\odot$, $R_2 = 145$ $R_\odot$, $a = 350$ $R_\odot$, and $i = 75°$.

Oral contribution, published in "Stella Novæ: Past and Future Decades", eds. P.A. Woudt & V.A.R.M. Ribeiro, ASPCS
Available from arXiv:1306.5191

Announcements

The Betelgeuse Workshop 2012
"The physics of Red Supergiants: recent advances and open questions"
Observatoire de Paris, France, 26–29 November 2012

Mass loss from evolved massive stars is a major contributor to the chemical enrichment of the interstellar medium, the Galaxy, and ultimately the Universe. To assemble a clear view of their cosmic impact, it is essential to understand their physics, from the photosphere to the interstellar medium. The violent convective motions, low surface gravity, and high luminosity combine to trigger an intense stellar wind, complex chemistry and dust formation. Thanks to its proximity and brightness, Betelgeuse is a particularly important fiducial star to study in details the physical phenomena at play in red supergiants. Impressive progress has been made recently on our understanding of Betelgeuse and other evolved massive stars, thanks to new observations from ESO's VLT, *Herschel*, NRAO's VLA and other facilities. Considerable advances also came from theory and numerical simulations. The goal of the Betelgeuse workshop was to present a coherent panorama of these results, and discuss possible future research axes in this field. The proceedings reflect these discussions, and therefore cover a broad range of topics, from numerical simulations to observations. They are directed towards researchers and graduate students.

The proceedings are published in the European Astronomical Society Publications Series (volume 60). The electronic versions of the papers are available on: http://www.eas-journal.org/action/displayIssue?iid=8926372

See also: http://betelgeuse.sciencesconf.org/

The editors, Pierre Kervella, Thibaut Le Bertre and Guy Perrin

IAUS 302 – Full program and registration deadline

The program of IAUS 302 is now available online!
http://iaus302.sciencesconf.org/program

The full list of abstracts (including posters) can be found here: http://iaus302.sciencesconf.org/browse/session

The deadline for registration is on July 21! To join us in Biarritz at the end of August, we invite you to proceed to the registration page: http://iaus302.sciencesconf.org/registration/index

The SOC and LOC of IAUS 302

See also http://iaus302.sciencesconf.org