THE AGB NEWSLETTER

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Editorial

Dear Colleagues,

It is our pleasure to present you the 203$^{\rm rd}$ issue of the AGB Newsletter, because it contains so many interesting findings about our beloved stars – evolution in front of our eyes, resolved views, dust production in globular clusters, clues from chemical elements like zinc and zirconium, and what about cement in space?

Unfortunately, we also report on the departure of two dear colleagues, who will be sadly missed but fondly remembered.

Have a look at the announcement at the end of the newsletter, for a workshop on high angular resolution studies – very timely indeed.

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

Editorially Yours,
Jacco van Loon, Ambra Nanni and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Celestial beauty is served by a sharp eye and open mind

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)

Olivier Chesneau (1972–2014)

It is with great sadness that we have to report Olivier Chesneau's passing, after a two-year illness. At age 41, he was an associate astronomer in the Lagrange laboratory at Observatoire de la Côte d'Azur in Nice, France. Olivier Chesneau died in Nice on 17 May, 2014.

Olivier was born on 28 October 1972, in Angers, France. He began his astronomy career at the University of Strasbourg, where he obtained a masters degree. He completed his PhD degree in 2001 at Université de Nice–Sophia Antipolis and Université de Montréal using observations conducted at the Calern station of the Observatoire de la Côte d'Azur. His thesis project used polarimetric and high angular resolution observations to study the mass loss of hot stars. Following this he was a postdoc in the VLTI/MIDI group at MPIA in Heidelberg, before obtaining a tenured staff position in Nice in 2004. Hands-on, high angular resolution observations of stars remained his trademark throughout his career.

Optical interferometry suited his talent perfectly. Olivier had an unparalleled ability to turn observations into results and subsequently papers. This productivity combined with the open field provided by a new technique. An explosion of papers followed. By the time he obtained his PhD, he already had 18 papers out with others in press. Thirteen of these paper contained the word 'interferometry' in the title. Close to 10% of all VLTI papers published to date involve Olivier.

Olivier Chesneau's pioneering work uncovered disks around a large variety of astrophysical objects: AGNs, young stars, evolved massive stars, planetary nebulæ, and novæ. The most unexpected may have been the disk around Sakurai's Object, a discovery which was confirmed by Hinkle and Joyce only in the last month of his life. This confirmation delighted Olivier. As he wrote in an email shortly before his death 'This work indeed was a fight [...] sometimes people have the feeling that we 'elaborate' too much and over-interpret. It is always difficult to deal with partial data, but this is in the core of our astronomer work...'. He made the VLTI into a disk-machine. His results were widely publicized through press releases from ESO and CNRS–INSU. Olivier was awarded the 2012 Michelson Prize of the International Astronomical Union and the Mount Wilson Institute for major contributions in stellar astrophysics made with long-baseline interferometry.

Olivier was involved with many projects. Notably he contributed to the ESO VLTI through his involvement in the MIDI instrument and through many observing programs with AMBER. He contributed also to the VEGA instrument at the CHARA interferometer at Mount Wilson, providing much insight in the astrophysical analysis of complex interferometric data. With the MATISSE consortium, he was preparing the second-generation instrumentation for the VLTI that will feed future international research. He was also working in the Jean-Mariotti Center (JMMC) as PI of the Calibration Group. He organized the VLTI school in Porquerolles in April 2010, was a co-organizer of the interferometry school in Barcelonnette in Fall 2013, and of the 2012 Week of the French Society for Astronomy and Astrophysics. Olivier was also the science council chairman of the CNRS–INSU committee on high angular resolution astronomy (ASHRA), and part of the VLT SPHERE GTO program that was devoted to "Other Science", i.e. topics not directly related to exoplanet and protoplanetary disk observations.

Even in hospital, Olivier was still passionately working with collaborators in Nice and worldwide. Several papers were written there, including the discovery of the largest yellow hypergiant star in the Milky Way. He submitted a Letter to Astronomy and Astrophysics a few days before his untimely death and initiated new work that illness precluded him from completing.

Throughout his career, Olivier shared his passion for astronomy and knowledge by teaching astronomy, supervising, helping and mentoring many young students, postdocs and scientists. Everyone who knew Olivier will remember his rich human qualities, his expert scientific abilities, and his continuous and infectious passion for scientific research. Followers of the "Methode Chesneau" – enthusiasm, curiosity, and passion – will without doubt perpetuate his pioneering science.

During these hard times for friends and relatives of Olivier, our thoughts especially go to his spouse, Martine, to their two children, to his parents and to all his relatives.

The email address pour_olivier@oca.eu has been set-up to gather condolences, messages or photographs, that will be compiled in a book to be given to his family. According to his wish, a call for donations will be organized to finance medical research.

We have lost a star.

Eric Lagadec, Orsola de Marco, Albert Zijlstra

Patrick Huggins (1948–2014)

Dear Colleagues,

It is with great sadness that we report the death of Prof. Patrick Huggins of New York University. Patrick passed away on January 30, 2014 after a long illness. We lost an exceptional scientist and, for many of us, an exceptional friend. We also recall his great generosity and kindness, his marvelous British sense of humor and especially high scientific standards.

Patrick was born in 1948 in the UK and attended Cambridge University, receiving his Ph.D. in 1975 on the atmospheres of M-giants and the evolution of *s*-process abundances in the ISM.

In 1975 he became a postdoc with Tom Phillips at Queen Mary College (London University) and later at Bell Labs. This was a time of rapid development of mm and sub-mm radio astronomy, and Patrick and Tom with their many collaborators took full advantage of the new observational possibilities to study interstellar and circumstellar gas. They were among the first to exploit the CO(2–1) and CO(3–2) transitions for the study of a wide range of molecular clouds. Later they extended this work to other molecules such as HCN, HNC, HCO^+ and the ^{18}O isotope of water. They were also the first to detect CO in the Large Magellenic Cloud and among the first to use the CO(2–1) line to map the extended envelopes of Betelgeuse and IRC $+10°216$. This last work was Patrick's introduction to a long term career interest in the circumstellar envelopes of evolved stars.

Much of Patrick's research with Tom Phillips was done with a number of other exceptional individuals mainly from Cal Tech: Peter Wannier, Gill Knapp, Mike Werner, Nick Scoville, Bob Leighton, Al Wootten, Tom Kuiper and Fred Lo. A good example is the much quoted 1982 ApJ paper by Knapp, Phillips, Leighton, Lo, Wannier, Wootten and Huggins on mass-loss observations from 17 evolved stars using the the CO(2–1) line. In discussing this period, one must recall another well cited paper by Phillips and Huggins in the 1981 ApJ on the detection of the C I fine structure line at 492 GHz with the Kuiper Airborne Observatory.

In 1980 Patrick Huggins joined the Physics Department Faculty at NYU. He not only continued his research with Phillips on CO observations of molecular clouds, but almost at once entered into several new fields. He played a key role in a program that lasted more than a decade that used the IUE to measure the ultraviolet properties of active galactic nuclei, in collaboration with Bregman, Glassgold and Kinney, who was Patrick's student. At the same time, he continued CO measurements of circumstellar envelopes, and he collaborated with Glassgold on a series of theoretical papers dealing with photodissociation and chemistry of the envelopes, especially α Orionis. Together with Gary Mamon, they developed a modern theory of line self-shielding and applied it in a well cited 1988 ApJ paper to the photodissociation of CO in circumstellar envelopes.

In 1986 Patrick and his student Austin Healy began to observe the molecular envelopes of planetary nebulæ. In 1991 he was joined by Rafæl Bachiller, Pierre Cox and Thierry Forveille in extending these observations to many different post-AGB systems. For the next twenty years they published at least one journal article each year, often with the help of collaborators such as J.-P. Maillard, A. Omont, K. Young, S. Guilloteau and others. The papers shed new light on the many fascinating properties of post-AGB systems such as their chemistry and structure, including globules, jets and tori. Of particular interest was Patrick's thoughtful 2007 ApJ article, "Jets and Tori in Proto-Planetary Nebulæ", where he deduced that jets and tori are formed nearly simultaneously, with the tori in some cases occurring a few hundred years earlier.

Motivated by the fact that optical wavelengths were able to provide images with better resolution and signal to noise ratio than current radio maps, Patrick engaged Mauron to use this technique to improve on images of IRC +10°216 obtained by Crabtree, McLaren and Christian (published in 1987 in a conference proceedings). With new and better CFHT images of 10°216 (the first made by Crabtree), Mauron and Huggins were able to definitively confirm the presence of complex, multiple shell structure in this archetype AGB star. Mauron and Huggins went on to image other AGB stars and also to investigate the presence or absence of globules in AGB and protoplanetary winds.

Starting in 1980, Patrick Huggins developed his immensely productive career as a faculty member of the NYU Physics Department, where for twenty years he was the only astronomer. He was an excellent teacher, and a research mentor to many undergraduates. He designed, created, and taught a course for undergraduates in Observational Astronomy and even set up a rooftop observatory on the top of a nearby NYU building (in downtown Manhattan) for that purpose. Patrick was a supportive mentor to young scientists, and he was adept at forming productive collaborations with people inside and outside the university. He continued to be active during the last decade, even after he became seriously ill. One of his last publications was "ALMA Observations of the Coldest Place in the Universe: The Boomerang Nebula" (Sahai et al. 2013, ApJ, 777, 92).

Speaking for his many colleagues including ourselves, we will always remember Patrick for his high standards, his kindness, wit and modesty. It was a great privilege to have known and worked with him.

The NYU Physics Department held a memorial service for Patrick on March 12, 2014. His family has designated the Lymphoma Research Foundation (lymphoma.org) for memorials.

Nicolas Mauron, CNRS and Montpellier University, France
Al Glassgold, UC Berkeley, USA

Iron and neutron-capture element abundance variations in the globular cluster M 2 (NGC 7089)

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We present CN and CH indices and Ca II triplet metallicities for 34 giant stars and chemical abundances for 33 elements in 14 giants in the globular cluster M 2. Assuming the program stars are cluster members, our analysis reveals (i) an extreme variation in CN and CH line strengths, (ii) a metallicity dispersion with a dominant peak at [Fe/H] ≈ -1.7 and smaller peaks at -1.5 and -1.0, (iii) star-to-star abundance variations and correlations for the light elements O, Na, Al and Si and (iv) a large (and possibly bimodal) distribution in the abundances of all elements produced mainly via the *s*-process in solar system material. Following Roederer et al. (2011), we define two groups of stars, "$r + s$" and "*r*-only", and subtract the average abundances of the latter from the former group to obtain a "*s*-process residual". This *s*-process residual is remarkably similar to that found in M 22 and in M 4 despite the range in metallicity covered by these three systems. With recent studies identifying a double subgiant branch in M 2 and a dispersion in Sr and Ba abundances, our spectroscopic analysis confirms that this globular cluster has experienced a complex formation history with similarities to M 22, NGC 1851 and ω Centauri.

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Binary central stars of planetary nebulæ with long orbits: the radial velocity orbit of BD +33°2642 (PN G 052.7+50.7) and the orbital motion of HD 112313 (PN LoTr 5)

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We study the impact of binary interaction processes on the evolution of low- and intermediate-mass stars using long-term monitoring of their radial velocity. Here we report on our results on the central stars of two planetary nebulæ (PNe): the well-studied spectrophotometric standard BD +33°2642 (central star of PN G 052.7+50.7) and HD 112313 (central star of PN LoTr 5), the optical light of which is dominated by a rapidly rotating G star. We report on the first detection of orbital motion in these two objects. For BD +33°2642 we sampled 1.5 cycles of the 1105 ± 24 day orbital period. For HD 112313, a full period is not yet covered, despite our 1807 days of monitoring. The radial-velocity amplitude shows that it is unlikely that the orbital plane is co-planar with the one defined by the nebular waist of the bipolar nebula. To our knowledge, these are the first detections of orbits in PNe that are in a range from several weeks to a few years. The orbits of these systems have a low probability of occurrence according to recent population synthesis calculations.

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A 3D radiative transfer framework: XI. multi-level NLTE

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Multi-level non-local thermodynamic equilibrium (NLTE) radiation transfer calculations have become standard throughout the stellar atmospheres community and are applied to all types of stars as well as dynamical systems such as novae and supernovae. Nevertheless even today spherically symmetric 1D calculations with full physics are computationally intensive. We show that full physics NLTE calculations can be done with fully 3 dimensional (3D) radiative transfer.

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Do cement nanoparticles exist in space?

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The calcium-silicate-hydrate is used to model properties of cement on Earth. We study cementitious nanoparticles and propose these structures as components of cosmic dust grains. Quantum density functional theory methods are applied for the calculation of infrared spectra of $Ca_4Si_4O_{14}H_4$, $Ca_6Si_3O_{13}H_2$, and $Ca_{12}Si_6O_{26}H_4$ clusters. We find bands distributed over the near, mid and far-infrared region. A specific calcium-silicate-hydrate spectral feature at 14 μm, together with the bands at 10 and 18 μm which exist for other silicates as well, could be used for a detection of cosmic cement. We compare calculated bands with the 14 μm features in the spectra of HD 45677, HD 44179, and IRC $+10°420$ which were observed by Infrared Space Observatory and classified as remaining. High abundance of oxygen atoms in cementitious nanoparticles could partially explain observed depletion of this element from the interstellar medium into dust grains.

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An empirical mass-loss law for Population II giants from the *Spitzer*-IRAC survey of Galactic globular clusters

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Aims: The main aim of the present work is to derive an empirical mass-loss (ML) law for Population II stars in first and second ascent red giant branches.
Methods: We used the *Spitzer* InfraRed Array Camera (IRAC) photometry obtained in the 3.6–8 μm range of a carefully chosen sample of 15 Galactic globular clusters spanning the entire metallicity range and sampling the vast zoology of horizontal branch (HB) morphologies. We complemented the IRAC photometry with near-infrared data to build suitable color–magnitude and color–color diagrams and identify mass-losing giant stars.
Results: We find that while the majority of stars show colors typical of cool giants, some stars show an excess of mid-infrared light that is larger than expected from their photospheric emission and that is plausibly due to dust formation

in mass flowing from them. For these stars, we estimate dust and total (gas + dust) ML rates and timescales. We finally calibrate an empirical ML law for Population II red and asymptotic giant branch stars with varying metallicity. We find that at a given red giant branch luminosity only a fraction of the stars are losing mass. From this, we conclude that ML is episodic and is active only a fraction of the time, which we define as the duty cycle. The fraction of mass-losing stars increases by increasing the stellar luminosity and metallicity. The ML rate, as estimated from reasonable assumptions for the gas-to-dust ratio and expansion velocity, depends on metallicity and slowly increases with decreasing metallicity. In contrast, the duty cycle increases with increasing metallicity, with the net result that total ML increases moderately with increasing metallicity, about 0.1 $M_\odot$ every dex in [Fe/H]. For Population II asymptotic giant branch stars, we estimate a total ML of ≤ 0.1 $M_\odot$, nearly constant with varying metallicity.

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The rapid evolution of the exciting star of the Stingray nebula

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Context: SAO 244567, the exciting star of the Stingray nebula, is rapidly evolving. Previous analyses suggested that it has heated up from an effective temperature of about 21 kK in 1971 to over 50 kK in the 1990s. Canonical post-asymptotic giant branch evolution suggests a relatively high mass while previous analyses indicate a low-mass star.
Aims: A comprehensive model-atmosphere analysis of UV and optical spectra taken during 1988–2006 should reveal the detailed temporal evolution of its atmospheric parameters and provide explanations for the unusually fast evolution.
Methods: Fitting line profiles from static and expanding non-LTE model atmospheres to the observed spectra allowed us to study the temporal change of effective temperature, surface gravity, mass-loss rate, and terminal wind velocity. In addition, we determined the chemical composition of the atmosphere.
Results: We find that the central star has steadily increased its effective temperature from 38 kK in 1988 to a peak value of 60 kK in 2002. During the same time, the star was contracting, as concluded from an increase in surface gravity from $\log g = 4.8$ to 6.0 and a drop in luminosity. Simultaneously, the mass-loss rate declined from $\log(\dot{M}/\mathrm{M}_\odot\ \mathrm{yr}^{-1}) = -9.0$ to -11.6 and the terminal wind velocity increased from $v_\infty = 1800$ km s^{-1} to 2800 km s^{-1}. Since around 2002, the star stopped heating and has cooled down again to 55 kK by 2006. It has a largely solar surface composition with the exception of slightly subsolar carbon, phosphorus, and sulfur. The results are discussed by considering different evolutionary scenarios.
Conclusions: The position of SAO 244567 in the $\log T_{\mathrm{eff}}$–$\log g$ plane places the star in the region of sdO stars. By comparison with stellar-evolution calculations, we confirm that SAO 244567 must be a low-mass star ($M < 0.55$ $M_\odot$). However, the slow evolution of the respective stellar evolutionary models is in strong contrast to the observed fast evolution and the young planetary nebula with a kinematical age of only about 1000 years. We speculate that the star could be a late He-shell flash object. Alternatively, it could be the outcome of close-binary evolution. Then SAO 244567 would be a low-mass (0.354 $M_\odot$) helium pre-white dwarf after the common-envelope phase, during which the planetary nebula was ejected.

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Dusty shells surrounding the carbon variables S Scuti and RT Capricorni

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For the Mass-loss of Evolved StarS (MESS) programme, the unprecedented spatial resolution of the PACS photometer on board the *Herschel* space observatory was employed to map the dusty environments of asymptotic giant branch (AGB) and red supergiant (RSG) stars. Among the morphologically heterogeneous sample, a small fraction of targets is enclosed by spherically symmetric detached envelopes. Based on observations in the 70 μm and 160 μm wavelength bands, we investigated the surroundings of the two carbon semiregular variables S Sct and RT Cap, which both show evidence for a history of highly variable mass-loss. S Sct exhibits a bright, spherically symmetric detached shell, $138''$ in diameter and co-spatial with an already known CO structure. Moreover, weak emission is detected at the outskirts, where the morphology seems indicative of a mild shaping by interaction of the wind with the interstellar medium, which is also supported by the stellar space motion. Two shells are found around RT Cap that were not known so far in either dust emission or from molecular line observations. The inner shell with a diameter of $188''$ shows an almost immaculate spherical symmetry, while the outer $\sim 5'$ structure is more irregularly shaped. MoD, a modification of the DUSTY radiative transfer code, was used to model the detached shells. Dust temperatures, shell dust masses, and mass-loss rates are derived for both targets.

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Zinc abundances of planetary nebulæ

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Zinc is a useful surrogate element for measuring Fe/H as, unlike iron, it is not depleted in the gas phase media. Zn/H and O/Zn ratios have been derived using the [Zn IV] emission line at 3.625 μm for a sample of nine Galactic planetary nebulæ, seven of which are based upon new observations using the VLT. Based on photoionization models, O/O^{++} is the most reliable ionisation correction factor for zinc that can readily be determined from optical emission lines, with an estimated accuracy of 10% or better for all targets in our sample. The majority of the sample is found to be sub-solar in [Zn/H]. [O/Zn] in half of the sample is found to be consistent with Solar within uncertainties, whereas the remaining half are enhanced in [O/Zn]. [Zn/H] and [O/Zn] as functions of Galactocentric distance have been investigated and there is little evidence to support a trend in either case.

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First versus second generation planet formation in post common envelope binary (PCEB) planetary systems

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We examine planets orbiting post-common envelope binaries (PCEBs) from the perspective of angular momentum evolution, and conclude that the planets are more likely to be first generation (FG) planets than second generation (SG)

planets. FG planets were born together with the parent stars, while SG planets form later from a SG proto-planetary disk formed by mass loss from the evolved primary star during its red giant branch (RGB) phase or asymptotic giant branch (AGB) phase. We find that in some systems the SG scenario requires that more than twenty percent of the SG proto-planetary disk mass ends in planets. Although we cannot rule out SG planet formation in these systems, this fraction of mass that ends in planets is much higher than the value commonly used in planet formation theories. On the other hand, we find that for each of the systems we can build a progenitor system composed of a main-sequence binary system orbited by the appropriate planets. This can be done if the secondary star was in a resonance with the inner planet. To account for the progenitor properties we suggest that in cases where the secondary star has a mass of ~ 0.1–$0.2\ M_\odot$, it was formed in the same way planets are formed, i.e., from a disk.

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The planetary nebula nature and properties of IRAS 18197−1118

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IRAS 18197−1118 is a stellar-like object that has been classified as a planetary nebula from its radio continuum emission and high [S III]λ9532 to Paschen 9 line intensity ratio, as derived from direct images. We present intermediate- and high-resolution, optical spectroscopy, VLA 8.46-GHz radio continuum data, and narrow-band optical images of IRAS 18197−1118 aimed at confirming its planetary nebula nature, and analyzing its properties. The optical spectrum shows that IRAS 18197−1118 is a medium-excitation planetary nebula suffering a high extinction ($c_{\mathrm{H}\beta} \simeq 3.37$). The optical images do not resolve the object but the 8.46-GHz image reveals an elliptical shell of $\simeq 2.7 \times 1.6$ arcsec^2 in size, a compact central nebular region, and possible bipolar jet-like features, indicating several ejection events. The existence of a compact central nebula makes IRAS 18197−1118 singular because this kind of structure is observed in a few PNe only. An expansion velocity $\simeq 20$ km s^{-1} and a systemic velocity (LSR) $\simeq +95$ km s^{-1} are obtained for the object. An electron density of $\simeq 3.4 \times 10^4$ cm^{-3} and an ionized mass of $\simeq 2.1 \times 10^{-2}\ M_\odot$ are deduced from the 8.46-GHz radio continuum data for an estimated statistical distance of 6 kpc. Helium abundance is high but nitrogen is not enriched, which is not consistently reproduced by evolutionary models, suggesting different abundances in the elliptical shell and central region. The properties of IRAS 18197−1118 indicate a relatively young planetary nebula, favor a distance of $\gtrsim$6 kpc, and strongly suggest that it is an inner-disc planetary nebula.

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On helium-dominated stellar evolution: the mysterious role of the O(He)-type stars

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About a quarter of all post-asymptotic giant branch (AGB) stars are hydrogen-deficient. Stellar evolutionary models explain the carbon-dominated H-deficient stars by a (very) late thermal pulse scenario where the hydrogen-rich envelope is mixed with the helium-rich intershell layer. Depending on the particular time at which the final flash occurs, the entire hydrogen envelope may be burned. In contrast, helium-dominated post-AGB stars and their evolution are yet not understood. A small group of very hot, helium-dominated stars is formed by O(He)-type stars. We performed a detailed spectral analysis of ultraviolet and optical spectra of four O(He) stars by means of state-of-the-art non-LTE model-atmosphere techniques. We determined effective temperatures, surface gravities, and the abundances of H, He, C, N, O, F, Ne, Si, P, S, Ar, and Fe. By deriving upper limits for the mass-loss rates of the O(He) stars, we found that they do not exhibit enhanced mass-loss. The comparison with evolutionary models shows that the status of the O(He) stars remains uncertain. Their abundances match predictions of a double helium white dwarf merger scenario, suggesting that they might be the progeny of the compact and of the luminous helium-rich sdO-type stars. The existence of planetary nebulae that do not show helium enrichment around every other O(He) star, precludes a merger origin for these stars. These stars must have formed in a different way, for instance via enhanced mass-loss during their post-AGB evolution or a merger within a common-envelope (CE) of a CO–WD and a red giant or AGB star. A helium-dominated stellar evolutionary sequence exists, that may be fed by different types of mergers or CE scenarios. It appears likely, that all these pass through the O(He) phase just before they become white dwarfs.

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An interferometric study of the post-AGB binary 89 Herculis. II. Radiative transfer models of the circumbinary disk

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Context: The presence of stable disks around post asymptotic giant branch (post-AGB) binaries is a widespread phenomenon. Also the presence of (molecular) outflows is now commonly inferred in these systems. Aims. In the first paper of this series, a surprisingly large fraction of optical light was found to be resolved in the 89 Her post-AGB binary system. The data showed that this flux arises from close to the central binary. Scattering off the inner rim of the circumbinary disk, or scattering in a dusty outflow were suggested as two possible origins. With detailed dust radiative transfer models of the circumbinary disk we aim to discriminate between the two proposed configurations.
Methods: By including *Herschel*/SPIRE photometry, we extend the spectral energy distribution (SED) such that it now fully covers UV to sub-mm wavelengths. The MCMax Monte Carlo radiative transfer code is used to create a large grid of disk models. Our models include a self-consistent treatment of dust settling as well as of scattering. A Si-rich composition with two additional opacity sources, metallic Fe or amorphous C, are tested. The SED is fit together with archival mid-IR (MIDI) visibilities as well as the optical and near-IR visibilities of Paper I, to constrain the structure of the disk and in particular of its inner rim.
Results: The near-IR visibility data require a smooth inner rim, here obtained with a two-power-law parameterization of the radial surface density distribution. A model can be found that fits all the IR photometric and interferometric data well, with either of the two continuum opacity sources. Our best-fit passive models are characterized by a significant amount of mm-sized grains, which are settled to the midplane of the disk. Not a single disk model fits our data at optical wavelengths though, the reason being the opposing constraints imposed by the optical and near-IR interferometric data.
Conclusions: A geometry in which a passive, dusty, and puffed-up circumbinary disk is present, can reproduce all the IR but not the optical observations of 89 Her. Another dusty, outflow or halo, component therefore needs to be added to the system.

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The ^{13}C-pocket structure in AGB models: constraints from zirconium isotope abundances in single mainstream SiC grains

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We present post-process AGB nucleosynthesis models with different ^{13}C-pocket internal structures to better explain zirconium isotope measurements in mainstream presolar SiC grains by Nicolussi et al. (1997) and Barzyk et al. (2007). We show that higher-than-solar ^{92}Zr/^{94}Zr ratios can be predicted by adopting a ^{13}C-pocket with a flat ^{13}C profile, instead of the previous decreasing-with-depth ^{13}C profile. The improved agreement between grain data for zirconium isotopes and AGB models provides additional support for a recent proposal of a flat ^{13}C profile based on barium isotopes in mainstream SiC grains by Liu et al. (2014).

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What sodium absorption lines tell us about type Ia supernovæ

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We propose that the sodium responsible for the variable Na I D absorption lines in some type Ia supernovæ (SN Ia) originate from dust residing at ~ 1 pc from the supernovæ. In this Na-from-dust absorption (NaDA) model the process by which the SN Ia peak luminosity releases sodium from dust at ~ 1 pc from the SN is similar to the processes by which solar radiation releases sodium from comet dust when comets approach a distance of ~ 1 au from the Sun. The dust grains are not sublimated but rather stay intact, and release sodium by photon-stimulated desorption (PSD; or photo-sputtering). We apply the NaDA model to SN 2006X and SN 2007le, and find it to comply better with the observed time variability of the Na I D absorption lines than the Na recombination model. The mass in the dusty shell of the NaDA model is much too high to be accounted for in the single-degenerate scenario for SN Ia. Therefore, the presence of variable Na I D lines in some SN Ia further weakens the already very problematic single-degenerate scenario for SN Ia.

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The Dawes Review 2: Nucleosynthesis and stellar yields of low and intermediate-mass single stars

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The chemical evolution of the Universe is governed by the chemical yields from stars, which in turn is determined primarily by the initial stellar mass. Even stars as low as 0.9 $M_\odot$ can, at low metallicity, contribute to the chemical

evolution of elements. Stars less massive than about 10 $M_\odot$ experience recurrent mixing events that can significantly change the surface composition of the envelope, with observed enrichments in carbon, nitrogen, fluorine, and heavy elements synthesized by the slow neutron capture process (the *s*-process). Low and intermediate mass stars release their nucleosynthesis products through stellar outflows or winds, in contrast to massive stars that explode as core-collapse supernovæ. Here we review the stellar evolution and nucleosynthesis for single stars up to ~ 10 $M_\odot$ from the main sequence through to the tip of the asymptotic giant branch (AGB). We include a discussion of the main uncertainties that affect theoretical calculations and review the latest observational data, which are used to constrain uncertain details of the stellar models. We finish with a review of the stellar yields available for stars less massive than about 10 $M_\odot$ and discuss efforts by various groups to address these issues and provide homogeneous yields for low and intermediate-mass stars covering a broad range of metallicities.

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The evolving spectrum of the planetary nebula Hen 2-260

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Aims: We analysed the planetary nebula Hen 2-260 using optical spectroscopy and photometry. We compared our observations with the data from literature to search for evolutionary changes. We also searched for photomertic variability of the central star.
Methods: The object Hen 2-260 was observed with the SAAO 1.0m telescope (photometry) and the SALT telescope (low resolution spectroscopy). We also used archival high resolution Very Large Telescope spectra and *Hubble* Space Telescope imaging. The nebular line fluxes were modelled with the Cloudy photoionization code to derive the stellar and nebular parameters.
Results: The planetary nebula shows a complex structure and possibly a bipolar outflow. The nebula is relatively dense and young. The central star is just starting O^+ ionization ($T_{\rm eff} \approx 30,000$ K). Comparison of our observations with literature data indicates a 50% increase of the [O III] 5007Å line flux between 2001 and 2012. We interpret it as the result of the progression of the ionization of O^+. The central star evolves to higher temperatures at a rate of 45 ± 7 K yr^{-1}. The heating rate is consistent with a final mass of $0.626^{+0.003}_{-0.005}$ $M_\odot$ or $0.645^{+0.008}_{-0.008}$ $M_\odot$ for two different sets of post-AGB evolutionary tracks from literature. The photometric monitoring of Hen 2-260 revealed variations on a timescale of hours or days. There is no direct indication for central star binarity in the spectrum nor for a strong stellar wind. The variability may be caused by pulsations of the star.
Conclusions: The temperature evolution of the central star can be traced using spectroscopic observations of the surrounding planetary nebula spanning a timescale of roughly a decade. This allows us to precisely determine the stellar mass, since the pace of the temperature evolution depends critically on the core mass. The method is independent of the absolute age of the nebula. The kinematical age of the nebula is consistent with the age obtained from the evolutionary track. The final mass of the central star is close to the mass distribution peak for central stars of planetary nebulæ found in other studies. The object belongs to a group of young central stars of planetary nebulæ showing photometric variability.

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Kinematic study of planetary nebulæ in NGC 6822

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Context: The kinematics of planetary nebulæ in external galaxies and in our own is a clue for understanding the behavior of the low and intermediate mass stars and their relation with other components of the galaxies.
Aims: By measuring precise radial velocities of planetary nebulae (which belong to the intermediate-age population), H II regions, and A-type supergiant stars (which are members of the young population) in NGC 6822, we aim to determine whether both types of population share the kinematics of the disk of H I found in this galaxy.
Methods: Spectroscopic data for six planetary nebulae were obtained with the high spectral-resolution spectrograph Magellan Inamori Kyocera Échelle (MIKE) on the Magellan telescope at Las Campanas Observatory. Data for another three PNe and one H II region were obtained from the SPM Catalog of Extragalactic Planetary Nebulæ, which employed the Manchester Échelle Spectrometer attached to the 2.1-m telescope at the Observatorio Astronómico Nacional, México. An additional PN and one H II region were observed with this same telescope-spectrograph in 2013. Thus, in total we have high-quality data for 10 of the 26 PNe detected in this galaxy. In the wavelength calibrated spectra, the heliocentric radial velocities were measured with a precision better than 5–6 km s^{-1}. Data for two additional H II regions and two A-type supergiant stars were collected from the literature. The heliocentric radial velocities of the different objects were compared to the velocities of the H I disk at the same position.
Results: From the analysis of radial velocities we found that H II regions and A-type supergiants do share the kinematics of the H I disk at the same position, as expected for these young objects. In contrast, most planetary nebula velocities differ significantly (more than 12 km s^{-1}) from that of the H I at the same position. The kinematics of planetary nebulæ is different from the young population kinematics and is more similar to the behavior shown by carbon stars, which are intermediate-age members of the stellar spheroid existing in this galaxy. Our results confirm that there are at least two very different kinematical systems in NGC 6822.

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Pulsations of pre-white dwarfs with hydrogen-dominated atmospheres

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We carried out a fully non-adiabatic analysis for nonradial oscillations of pre-white dwarfs evolved from the post-Asymptotic Giant Branch (AGB) with hydrogen-dominated envelopes. It is shown that nuclear reactions in the hydrogen burning-shell excite low-degree g-modes in the period range of about 40–200 s for the pre-white dwarf models with $T_{\rm eff} = 40,000$ K − 300,000 K. It is also shown that the amount of hydrogen has a significant influence on the instability domain of such pre-white dwarfs in the Hertzsprung–Russell (H–R) diagram. Thus, the thickness of hydrogen-dominated envelopes may be well constrained by observing the presence of the g-mode oscillations.

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Accurate water maser positions from HOPS

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We report on high spatial resolution water maser observations, using the Australia Telescope Compact Array, towards water maser sites previously identified in the H_2O southern Galactic Plane Survey (HOPS). Of the 540 masers identified in the single-dish observations of Walsh et al. (2011), we detect emission in all but 31 fields. We report on 2790 spectral features (maser spots), with brightnesses ranging from 0.06Jy to 576Jy and with velocities ranging from -238.5 to $+300.5$ km s^{-1}. These spectral features are grouped into 631 maser sites. We have compared the positions of these sites to the literature to associate the sites with astrophysical objects. We identify 433 (69 per cent) with star formation, 121 (19 per cent) with evolved stars and 77 (12 per cent) as unknown. We find that maser sites associated with evolved stars tend to have more maser spots and have smaller angular sizes than those associated with star formation. We present evidence that maser sites associated with evolved stars show an increased likelihood of having a velocity range between 15 and 35 km s^{-1} compared to other maser sites. Of the 31 non-detections, we conclude they were not detected due to intrinsic variability and confirm previous results showing that such variable masers tend to be weaker and have simpler spectra with fewer peaks.

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The ^{12}CO/^{13}CO ratio in AGB stars of different chemical type – Connection to the ^{12}C/^{13}C ratio and the evolution along the AGB

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The aim of this paper is to investigate the evolution of the ^{12}C/^{13}C ratio along the AGB through the circumstellar ^{12}CO/^{13}CO abundance ratio. This is the first time a sample including a significant number of M- and S-type stars is analysed together with a carbon-star sample of equal size, making it possible to investigate trends among the different types and establish evolutionary effects. The circumstellar ^{12}CO/^{13}CO abundance ratios are estimated through a detailed radiative transfer analysis of single-dish radio line emission observations. Several different transitions have been observed for each source to ensure that a large extent of the circumstellar envelope is probed and the radiative transfer model is well constrained. The radiative transfer model is based on the Monte Carlo method and has been benchmarked against a set of similar codes. It assumes that the radiation field is non-local and solves the statistical equilibrium equations in full non-LTE. The energy balance equation, determining the gas temperature distribution, is solved self-consistently, and the effects of thermal dust radiation (as estimated from the spectral energy distribution) are taken into account. First, the ^{12}CO radiative transfer is solved, assuming an abundance (dependent on the chemical type of the star), to give the physical parameters of the gas, i.e. mass-loss rate, $\dot{M}$, gas expansion velocity, $\upsilon_{\rm e}$, and gas temperature distribution. Then, the ^{13}CO radiative transfer is solved using the results of the ^{12}CO model giving the ^{13}CO abundance. Finally, the ^{12}CO/^{13}CO abundance ratio is calculated. The circumstellar ^{12}CO/^{13}CO abundance ratio differs between the three spectral types. This is consistent with what is expected from stellar evolutionary models assuming that the spectral types constitute an evolutionary sequence; however, this is the first time this has been shown observationally for a relatively large sample covering all three spectral types. The median value of the ^{13}CO abundance in the inner circumstellar envelope is 1.6×10^{-5}, 2.3×10^{-5}, and 3.0×10^{-5} for the M-type, S-type, and

carbon stars of the sample, respectively, corresponding to ^{12}CO/^{13}CO abundance ratios of 13, 26, and 34, respectively. The spread in the ^{13}CO abundance, quantified by the ratio between the 90$^{\rm th}$ and 10$^{\rm th}$ percentile, is 4, 3, and 15 for the M-type, S-type, and carbon stars, respectively. Interestingly, the abundance ratio spread of the carbon stars is much larger than for the M- and S-type stars, even when excluding J-type carbon stars, in line with what could be expected from evolution on the AGB. We find no correlation between the isotopologue ratio and the mass-loss rate, as would be expected if both increase as the star evolves.

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Angular momentum transport within evolved low-mass stars

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Asteroseismology of 1.0–2.0 $M_\odot$ red giants by the *Kepler* satellite has enabled the first definitive measurements of interior rotation in both first ascent red giant branch (RGB) stars and those on the Helium burning clump. The inferred rotation rates are 10–30 days for the $\approx 0.2\ M_\odot$ He degenerate cores on the RGB and 30–100 days for the He burning core in a clump star. Using the MESA code we calculate state-of-the-art stellar evolution models of low mass rotating stars from the zero-age main sequence to the cooling white dwarf (WD) stage. We include transport of angular momentum due to rotationally induced instabilities and circulations, as well as magnetic fields in radiative zones (generated by the Tayler–Spruit dynamo). We find that all models fail to predict core rotation as slow as observed on the RGB and during core He burning, implying that an unmodeled angular momentum transport process must be operating on the early RGB of low mass stars. Later evolution of the star from the He burning clump to the cooling WD phase appears to be at nearly constant core angular momentum. We also incorporate the adiabatic pulsation code, ADIPLS, to explicitly highlight this shortfall when applied to a specific *Kepler* asteroseismic target, KIC 8366239.

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Conference Papers

Monitoring evolved stars for binarity with the HERMES spectrograph

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Binarity is often invoked to explain peculiarities that cannot be explained by the standard theory of stellar evolution. Detecting orbital motion via the Doppler effect is the best method to test binarity when direct imaging is not possible. However, when the orbital period exceeds the length of a typical observing run, monitoring often becomes problematic. Placing a high-throughput spectrograph on a small semi-robotic telescope allowed us to carry out a radial-velocity survey of various types of peculiar evolved stars. In this review, we highlight some findings after the first four years of observations. Thus, we detect eccentric binaries among hot subdwarf B stars, barium, S stars, and post-AGB stars with disks, which are not predicted by the standard binary interaction theory. In post-AGB disk objects, in addition, we find signs of the on-going mass transfer to the companion, and an intriguing line splitting, which we attribute to the scattered light of the primary.

Oral contribution, published in "Setting a New Standard in the Analysis of Binary Stars", Leuven, Belgium (September 2013), EDP Sciences
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AGB stars and the plate archives heritage

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We report on the characterization of a number of AGB candidate stars identified with objective-prism plates of the Byurakan Observatory. Digitized photographic sky survey plates and recent CCD photometry have been used to improve the selection and distinguish variable and non-variable stars. Some comparisons among published catalog magnitudes are also made. Slit spectroscopy from the Asiago and Loiano Observatories allowed a firm spectral classification, separating C-Type, N-Type and normal M giants. Color–color plots using WISE, AKARI and 2MASS J-band data allow an efficient discrimination of spectral types, which can be used for the definition of larger statistical samples.

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Review Paper

A PIONIER view on mass-transferring red giants

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Symbiotic stars display absorption lines of a cool red giant together with emission lines of a nebula ionised by a hotter star, indicative of an active binary star system in which mass transfer is occurring. PIONIER at the VLT has been used to combine the light of four telescopes at a time to study in unprecedented detail how mass is transferred in symbiotic stars. The results of a mini-survey of symbiotic stars with PIONIER are summarised and some tentative general results about the role of Roche lobe overflow are presented.

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and from http://www.eso.org/sci/publications/messenger/

Announcement of the ESO Workshop: Astronomy at high angular resolution – a cross-disciplinary approach

We are pleased to announce the ESO Workshop on "Astronomy at high angular resolution", to be held on 24–28 November 2014 at ESO Garching, Germany.

Recent years have seen a huge development in high-resolution astronomical techniques, which are critical to progress in many different areas of astronomy. These techniques can be divided in direct methods (adaptive optics, lucky imaging), interferometry (including speckle imaging and spectro-astrometry), and reconstruction methods (astrotomography). This workshop aims at bringing together the different communities working on these fields and increase the synergies between them. It is indeed often necessary to combine all these techniques together in order to have a coherent and comprehensive idea of all the processes at work in a given astronomical environment.

During the workshop, experts in their fields will first introduce the major techniques described above, their use, achievements and limitations. The following sessions will be organised by science topic, with an astrophysical review of the field challenges, observational results through different techniques and technical talks describing the progress on the methods. A link to future developments in terms of instrumentation is also foreseen. There will be ample time for contributing talks and discussions, and space for posters.

Some of the themes to be covered by the meeting will be

- Methods and techniques: lucky imaging, speckle imaging, adaptive optics, spectro-astrometry, interferometry, Astrotomography (Eclipse Mapping, Spot Mapping, Spectral Mapping, Echo Mapping, Spectral Disentangling, Doppler Tomography and Modulated Doppler Tomography, Roche Tomography, Zeeman-Doppler Mapping, Interferometric-Doppler imaging)
- Planets, discs and brown dwarfs: interferometry study of young stellar discs, astrotomography of planets, AO imaging of planets and discs, brown dwarf Zeeman Doppler imaging
- Stars: Stellar interferometry, aperture masking imaging, hot and cool stars, Doppler imaging, spectro-astrometry, mass loss
- Binaries: disentangling of stellar spectra, Roche tomography, Stokes imaging
- Large scale phenomena: AGN reverberation mapping, AGN interferometry
- Instrumentation: current and future instrumentation

The abstract submission deadline is 22 August and registration deadline 24 October 2014.

More detailed information is available at http://www.eso.org/hires2014 or by e-mail to hires2014@eso.org

See also http://www.eso.org/hires2014