THE AGB NEWSLETTER

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Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

# *Editorial*

Dear Colleagues,

It is our pleasure to present you the 219$^{\text{th}}$ issue of the AGB Newsletter.

We start the newsletter with an obituary of Ernst Zinner, kindly written by Gerald Wasserburg. Some additional material is available from the AGB Newsletter website, under the "view" option.

Please see the announcements, of a new IAU Commission on stellar Evolution which we encourage all of you will join; a conference on supernova remnants in Greece in 2016; an IAU Symposium on planetary nebulæ in China, also in 2016; and a Ph.D. position in Sweden.

Last month's *Food for Thought* – "What is the difference between convection and turbulence?" – provoked the following response from Elizabeth Griffin: "My instant reaction (rather than considered explanation) is that it's a question of the dominant plane of activity. Put unscientifically, convection is mostly up and down, whereas turbulence is quite a lot of sideways too." Thank you Elizabeth! You are all welcome to continue sharing your thoughts on this topic via e-mail to the astro.agbnews@keele.ac.uk, which would be addressed in forthcoming editorials of the newsletter.

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

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

# *Food for Thought*

This month's thought-provoking statement is:

*We owe our lives to AGB stars*

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

# ERNST K. ZINNER

**Born January 30th 1937**
**Steyr, Austria**

**Died July 30th 2015**
**St.Louis Missouri, USA**

The death of Ernst Kunibert Zinner brings great sadness to the astronomical community. He pioneered the isotopic and chemical study of grains formed in ejecta from very diverse stars that exploded before the Solar System formed. The identification of the chemical compounds, which he found in grains of circumstellar condensates, and their isotopic compositions has permitted great advances in our understanding of stellar nucleosynthesis. Ernst Zinner was Research Professor at Washington University, where he was supported by research grants from NASA and from the NSF.

These measurements and their interpretation have been the focus of interest both to observers and to theoreticians throughout the world. In particular, the community of scientists interested in the structure and evolution of red giants and AGB stars are greatly indebted to him for his remarkable contributions. His work presented direct evidence of the nuclear processes in stars and new insights into the dynamics of stellar evolution. Most stellar models are really one-dimensional. While some theoretical studies (David Dearborn 1992) inferred the possibility of deep transport mechanisms, which might provide nuclear signatures of possible dynamics, the data that Zinner presented clearly showed some dynamical processes that must occur and exposed their nature. Further, these studies further provided a link between the small variations (~1%) in isotopic composition previously found in meteorites and the samples of individual different stars that contributed to it. These small isotopic shifts resulted from nucleosynthetic processes that affected even heavy mass elements such as Ti, Nd and Sm. The results Zinner found in dust from circumstellar condensates (CIRCONs) showed enormous isotopic shifts. Some extinct nuclei had been found from studies of meteorites to have been present in the early Solar System. For example $^{26}$Al (with a half life of 720,000 yr), was inferred to have an initial abundance of $^{26}Al/^{27}Al=5x10^{-5}$ in the very early Solar System. This was a dominant heat source for planetesimals and came from some stellar source. Zinner found that $^{26}$Al had a high abundance in many circumstellar condensates indicating that it can be produced in some AGB stars at a level of $^{26}Al/^{27}Al=0.1$. Some grains he found were from supernovae, but the large majority of the stellar condensates found (C & carbides) were AGB products. The discovery of a presolar oxide grain from an AGB star with a large (100%) enrichment in $^{17}O/^{16}O$ and high ratio of $^{26}Al/^{27}Al$ (Ian Hutcheon et al. 1994) led to extensive research by Larry Nittler, a student of Zinner's, and gave a treasure of oxide grains that revealed broader issues of stellar dynamics. It also attracted theoretical investigations on circulation in AGB stars.

Zinner's work caused a rejuvenation of studies of the "s" process in low mass stars and invigorated efforts to connect these new observations to the earlier theories by B$^2$FH (Margaret Burbidge, Geoffrey Burbidge, William Fowler and Fred Hoyle, 1957) and Alastair Cameron. These earlier works were directed toward understanding the bulk Solar inventory (so called "Cosmic" Abundances). The efforts of Roberto Gallino and Maurizio Busso (University of Torino) in seeking explanations for the data on CIRCONs were the beginning of a new attack on nucleosynthesis in low mass stars. Zinner's results showed that the general nuclear processes studied earlier were sound but that each star had its own "initial" composition when it formed out of the local ISM. It became clear that the bulk Solar isotopic abundances were a kind of grand average with considerable variations from star to star. This leaves us with uncertainty in the initial composition of a given star. Even an exact model of all the nuclear reactions and stellar evolution in a model star, still leaves us with an uncertainty in the detailed initial state.

It may be of interest to review developments that led to the remarkable work by Zinner. The study of meteorites, known to represent objects formed in the early Solar system, led to a search for evidence of pre-Solar isotopic effects. David Black and Robert Pepin (1969) found wide variations in the isotopic composition of Ne by differential heating of a bulk meteorite. David Black (1972) then discovered that one of the Ne components was essentially pure $^{22}$Ne and inferred that this was the result of grains from an RGB star incorporated in the meteorite. In seeking to find these "carrier" grains, massive efforts were carried forward in which the bulk meteorite sample was dissolved in acids leaving a very fine grained sludge. This sludge was then found to carry the pure $^{22}$Ne that was in the bulk meteorite (Peter Eberhardt, 1974). The studies on micron scale grains were made possible by the development of secondary ion mass spectrometry (SIMS) at high mass resolution with a focused beam and with imaging capabilities that were developed by G. Slodzian and R. Castaing with the CAMECA Co. With the advent of this instrument, it then became possible to measure the isotopic composition of these small particles. The acquisition of a CAMCA 3F ion probe at Washington University with the samples provided by Edward Anders from the University of Chicago with the close aid of Sachiko Amari and Roy Lewis, then gave Zinner the opportunity to breach this formidable barrier of analysis of micrometer-sized particles. The result was a plethora of data on carbon grains and carbides that opened the door. Amari then joined Zinner's research group at Washington University and was actively involved in the research. Zinner and his students, research fellows and colleagues then laid out the feast of data on the debris of a large number of stars that had each individually contributed to the mix that is our Solar system and exposed actual details of earlier stellar processes that have intrigued and excited us. Ernst Zinner had a remarkable skill in using and applying SIMS along with careful sample preparation and an ongoing positive enthusiasm for doing science and discovery. Seeing the results of Zinner's virtuoso artistic performance with various generations of SIMS instruments was always a great stimulus and joy. The range of isotopic effects, which reflected nuclear processes, made us think more carefully about what was going on in a star. The microscopic structures of chemical compounds in a CIRCON grain caused us to think carefully about what happens in the blown off envelopes of stars (Thomas Bernatowicz et al., 1991). Zinner interacted with theoreticians and modelers who were interpreting his experimental results and was a member of both the experimental and theoretical communities of astrophysicists and cosmochemists.

In all of this work, he was always a kind and thoughtful mentor and friend to all who had the good fortune to be associated with him. He had a host of students and postdoctoral fellows who then went off and played leadership roles in the field (such as Larry Nittler, Peter Hoppe and many others – see attached publication list). The scientific contributions made by Ernst K. Zinner continued even after he was found to have Mantle Cell Lymphoma in 1996. His son Max G. Zinner was then seven years old. Ernst battled with this disease over 19 years with treatments that required frequent and painful procedures. With the uncompromising support of his wife Brigitte Wopenka and Max, he maintained a remarkable sense of equanimity and grace and continued doing outstanding science until his death. Ernst Zinner took his scientific work as a source of personal joy that gave him a focus and personal satisfaction of infinite value. This joy was always evident in meeting Ernst or reading the annual Zinner-Wopenka family letter sent out to friends every year.

Gerald J. Wasserburg
Caltech

*Attachments are available from the AGB Newsletter site under the "view" option, and include: Zinner's CV, publication list and his last two papers.*

# *Refereed Journal Papers*

## Optical spectroscopy of $\alpha$ Persei white dwarfs

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As part of an investigation into the high mass end of the initial mass-final mass relation we performed a search for new white dwarf members of the nearby (172.4 pc), young (80–90 Myr) $\alpha$ Persei open star cluster. The photometric and astrometric search using the UKIRT Infrared Deep Sky Survey and SuperCOSMOS sky surveys discovered 14 new white dwarf candidates. We have obtained medium resolution optical spectra of the brightest 11 candidates using the *William Herschel* Telescope and confirmed that while 7 are DA white dwarfs, 3 are DB white dwarfs and one is an sdOB star, only three have cooling ages within the cluster age, and from their position on the initial mass–final mass relation, it is likely none are cluster members. This result is disappointing, as recent work on the cluster mass function suggests that there should be at least one white dwarf member, even at this young age. It may be that any white dwarf members of $\alpha$ Per are hidden within binary systems, as is the case in the Hyades cluster, however the lack of high mass stars within the cluster also makes this seem unlikely. One alternative is that a significant level of detection incompleteness in the legacy optical image survey data at this Galactic latitude has caused some white dwarf members to be overlooked. If this is the case, Gaia will find them.

**Published in MNRAS**
*Available from* arXiv:1506.01861

## ALMA reveals sunburn: CO dissociation around AGB stars in the globular cluster 47 Tucanæ

*Iain McDonald[1], Albert Zijlstra[1], Eric Lagadec[3,4], Greg Sloan[3], Martha Boyer[2], Mikako Matsuura[5,6], Rowan Smith[1], Christina Smith[1], Jeremy Yates[5], Jacco van Loon[7], Olivia Jones[1,8], Sofia Ramstedt[9], Adam Avison[1], Kay Justtanont[10], Hans Olofsson[10], Joris Blommaert[11], Steven Goldman[7] and Martin Groenewegen[12]*

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ALMA observations show a non-detection of carbon monoxide around the four most luminous asymptotic giant branch

(AGB) stars in the globular cluster 47 Tucanæ. Stellar evolution models and star counts show that the mass-loss rates from these stars should be $\sim 1.2$–$3.5 \times 10^{-7}$ $M_\odot$ yr$^{-1}$. We would naively expect such stars to be detectable at this distance (4.5 kpc). By modelling the ultraviolet radiation field from post-AGB stars and white dwarfs in 47 Tuc, we conclude CO should be dissociated abnormally close to the stars. We estimate that the CO envelopes will be truncated at a few hundred stellar radii from their host stars and that the line intensities are about two orders of magnitude below our current detection limits. The truncation of CO envelopes should be important for AGB stars in dense clusters. Observing the CO (3–2) and higher transitions and targeting stars far from the centres of clusters should result in the detections needed to measure the outflow velocities from these stars.

**Accepted for publication in MNRAS**
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# Line strengths of rovibrational and rotational transitions in the $X^2\Pi$ ground state of OH

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A new line list including positions and absolute transition strengths (in the form of Einstein A values and oscillator strengths) has been produced for the OH ground $X^2\Pi$ state rovibrational (Meinel system) and pure rotational transitions. All possible transitions are included with v′ and v″ up to 13, and J up to between 9.5 and 59.5, depending on the band. An updated fit to determine molecular constants has been performed, which includes some new rotational data and a simultaneous fitting of all molecular constants. The absolute transition strengths are based on a new dipole moment function, which is a combination of two high level ab initio calculations. The calculations show good agreement with an experimental $v = 1$ lifetime, experimental $\mu_v$ values, and $\Delta v = 2$ line intensity ratios from an observed spectrum. To achieve this good agreement, an alteration in the method of converting matrix elements from Hund's case (b) to (a) was made. Partitions sums have been calculated using the new energy levels, for the temperature range 5–6000 K, which extends the previously available (in HITRAN) 70–3000 K range. The resulting absolute transition strengths have been used to calculate O abundances in the Sun, Arcturus, and two red giants in the Galactic open and globular clusters M 67 and M 71. Literature data based mainly on [O I] lines are available for the Sun and Arcturus, and excellent agreement is found.

**Accepted for publication in Journal of Quantitative Spectroscopy and Radiative Transfer**
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*and from* http://dx.doi.org/10.1016/j.jqsrt.2015.07.021

# Improved spectral descriptions of planetary nebulæ central stars

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*Context:* At least 492 central stars of Galactic planetary nebulæ (CSPNs) have been assigned spectral types. Since

many CSPNs are faint, these classification efforts are frequently made at low spectral resolution. However, the stellar Balmer absorption lines are contaminated with nebular emission; therefore in many cases a low-resolution spectrum does not enable the determination of the H abundance in the CSPN photosphere. Whether or not the photosphere is H deficient is arguably the most important fact we should expect to extract from the CSPN spectrum, and should be the basis for an adequate spectral classification system.
*Aims:* Our purpose is to provide accurate spectral classifications and contribute to the knowledge of central stars of planetary nebulæ and stellar evolution.
*Methods:* We have obtained and studied higher quality spectra of CSPNs described in the literature as weak emission-line star (WELS). We provide descriptions of 19 CSPN spectra. These stars had been previously classified at low spectral resolution. We used medium-resolution spectra taken with the Gemini Multi-Object Spectrograph (GMOS). We provide spectral types in the Morgan–Keenan (MK) system whenever possible.
*Results:* Twelve stars in our sample appear to have normal H rich photospheric abundances, and five stars remain unclassified. The rest (two) are most probably H deficient. Of all central stars described by other authors as WELS, we find that at least 26% of them are, in fact, H rich O stars, and at least 3% are H deficient. This supports the suggestion that the denomination WELS should not be taken as a spectral type, because, as a WELS is based on low-resolution spectra, it cannot provide enough information about the photospheric H abundance.

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# Cold gas in hot star clusters: the wind from the red supergiant W26 in Westerlund 1

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The massive red supergiant W26 in Westerlund 1 is one of a growing number of red supergiants shown to have winds that are ionized from the outside in. The fate of this dense wind material is important for models of second generation star formation in massive star clusters. Mackey et al. (2014) showed that external photoionization can stall the wind of red supergiants and accumulate mass in a dense static shell. We use spherically symmetric radiation-hydrodynamic simulations of an externally photoionized wind to predict the brightness distribution of H$\alpha$ and [N II] emission arising from photoionized winds both with and without a dense shell. We analyse spectra of the H$\alpha$ and [N II] emission lines in the circumstellar environment around W26 and compare them with simulations to investigate whether W26 has a wind that is confined by external photoionization. Simulations of slow winds that are decelerated into a dense shell show strongly limb-brightened line emission, with line radial velocities that are independent of the wind speed. Faster winds ($> 22$ km s$^{-1}$) do not form a dense shell, have less limb-brightening, and the line radial velocity is a good tracer of the wind speed. The brightness of the [N II] and H$\alpha$ lines as a function of distance from W26 agrees reasonably well with observations when only the line flux is considered. The radial velocity of the simulated winds disagrees with observations, however: the brightest observed emission is blueshifted by 25 km s$^{-1}$ relative to the radial velocity of the star, whereas a spherically symmetric wind has the brightest emission at zero radial velocity because of limb brightening. Our results show that the bright nebula surrounding W26 must be asymmetric, and we suggest that it is confined by external ram pressure from the extreme wind of the nearby supergiant W9. We obtain a lower limit on the nitrogen abundance within the nebula of 2.35 times solar. The line ratio strongly favours photoionization over shock ionization, and so even if the observed nebula is pressure confined there should still be an ionization front and a photoionization-confined shell closer to the star that is not resolved by the current observations, which could be tested with better spectral resolution and spatial coverage.

**Accepted for publication in Astronomy & Astrophysics**
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*and from* http://dx.doi.org/10.1051/0004-6361/201526159

# Oxygen rich cool stars in the Cepheus region. New observations. III

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We present moderate resolution CCD spectra and $R$ photometry for seven KP2001 stars. We revised the spectral classification of the stars in the range $\lambda \sim$ 3900–8500 Å. On the bases of light curves of the NSVS (Northern Sky Variability Survey) database we classify KP2001-18 as a semi regular and KP2001-176 as Mira type variables. For all observed objects NSVS phase-dependence light curve analysis and variability type classification was performed with the VStar Software. Using period–luminosity relation we computed MK magnitudes and the distances to variables.

**Accepted for publication in Astrofizika (Astrophysics)**
*Available from* arXiv:1509.01828

# Numerical radiative transfer with state-of-the-art iterative methods made easy

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This article presents an on-line tool and its accompanying software resources for the numerical solution of basic radiation transfer out of local thermodynamic equilibrium (LTE). State-of-the-art stationary iterative methods such as Accelerated Λ-Iteration and Gauss–Seidel schemes, using a short characteristics-based formal solver are used. We also comment on typical numerical experiments associated to the basic non-LTE radiation problem. These resources are intended for the largest use and benefit, in support to more classical radiation transfer lectures usually given at the Master level.

**Accepted for publication in Eur. J. Phys.**
*Available from* arXiv:1509.01158
*and from* http://rttools.irap.omp.eu/

# Collision strengths and transition probabilities for Co II infrared forbidden lines

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We calculate collision strengths and their thermally-averaged Maxwellian values for electron excitation and de-excitation between the fifteen lowest levels of singly-ionised cobalt, $Co^+$, which give rise to emission lines in the near- and mid-infrared. Transition probabilities are also calculated and relative line intensities predicted for conditions typical of supernova ejecta. The diagnostic potential of the 10.52, 15.46 and 14.74 $\mu$m transition lines is briefly discussed.

**Submitted to MNRAS**

# Photometry of the Stingray Nebula (V839 Ara) from 1889–2015 across the ionization of its planetary nebula

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Up until around 1980, the Stingray was an ordinary B1 post-AGB star, but then it suddenly sprouted bright emission lines like in a planetary nebula (PN), and soon after this the *Hubble* Space Telescope (HST) discovered a small PN around the star, so apparently we have caught a star in the act of ionizing a PN. We report here on a well-sampled light curve from 1889 to 2015, with unique coverage of the prior century plus the entire duration of the PN formation plus three decades of its aftermath. Surprisingly, the star anticipated the 1980s' ionization event by declining from $B = 10.30$ in 1889 to $B = 10.76$ in 1980. Starting in 1980, the central star faded fast, at a rate of 0.20 mag yr$^{-1}$, reaching $B = 14.64$ in 1996. This fast fading is apparently caused by the central star shrinking in size. From 1994–2015, the V-band light curve is almost entirely from the flux of two bright [O III] emission lines from the unresolved nebula, and it shows a consistent decline at a rate of 0.090 mag yr$^{-1}$. This steady fading (also seen in the radio and infrared) has a time scale equal to that expected for ordinary recombination within the nebula, immediately after a short-duration ionizing event in the 1980s. We are providing the first direct measure of the rapidly changing luminosity of the central star on both sides of a presumed thermal pulse in 1980, with this providing a strong and critical set of constraints, and these are found to sharply disagree with theoretical models of PN evolution.

**Accepted for publication in The Astrophysical Journal**
*Available from* arXiv:1509.01202

# The dustiest post-main sequence stars in the Magellanic Clouds

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Using observations from the *Herschel* Inventory of The Agents of Galaxy Evolution (HERITAGE) survey of the Magellanic Clouds, we have found thirty five evolved stars and stellar end products that are bright in the far-infrared. These twenty eight (LMC) and seven (SMC) sources were selected from the 529 evolved star candidates in the HERITAGE far-infrared point source catalogs. Our source identification method is based on spectral confirmation, spectral energy distribution characteristics, careful examination of the multiwavelength images and includes constraints on the luminosity, resulting in a thoroughly vetted list of evolved stars. These sources span a wide range in luminosity and hence initial mass. We found thirteen low- to intermediate mass evolved stars, including asymptotic giant branch (AGB) stars, post-AGB stars, planetary nebulae and a symbiotic star. We also identify ten high mass stars, including four of the fifteen known B[e] stars in the Magellanic Clouds, three extreme red supergiants which are highly enshrouded by dust, a Luminous Blue Variable, a Wolf–Rayet star and two supernova remnants. Further, we report the detection of nine probable evolved objects which were previously undescribed in the literature. These sources are likely to be among the dustiest evolved objects in the Magellanic Clouds. The *Herschel* emission may either be due to dust produced by the evolved star or it may arise from swept-up ISM material.

**Accepted for publication in ApJ**
*Available from* arXiv:1508.06999

# Post-AGB stars in the Magellanic Clouds and neutron-capture processes in AGB stars

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We explore modifications to the current scenario for the slow ($s$) neutron capture process in asymptotic giant branch (AGB) stars to account for the Pb deficiency observed in post-AGB stars of low metallicity ([Fe/H] $\simeq -1.2$) and low initial mass ($\simeq$ 1–1.5 $M_\odot$) in the Large and Small Magellanic Clouds. We calculated the stellar evolution and nucleosynthesis for a 1.3 $M_\odot$ star with [Fe/H] $= -1.3$ and tested different amounts and distributions of protons leading to the production of the main neutron source within the $^{13}$C-pocket and proton ingestion scenarios. No $s$-process models can fully reproduce the abundance patterns observed in the post-AGB stars. When the Pb production is lowered the abundances of the elements between Eu and Pb, such as Er, Yb, W, and Hf, are also lowered to below those observed. Neutron-capture processes with neutron densities intermediate between the $s$ and the rapid ($r$) neutron-capture processes may provide a solution to this problem and be a common occurrence in low-mass, low-metallicity AGB stars.

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# Near infrared studies during maximum and early decline of Nova Cephei 2014 and Nova Scorpii 2015

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We present multi-epoch near-infrared photo-spectroscopic observations of Nova Cephei 2014 and Nova Scorpii 2015, discovered in outburst on 2014 March 8.79 UT and 2015 February 11.84 UT respectively. Nova Cep 2014 shows the conventional NIR characteristics of a Fe II class nova characterized by strong C I, H I and O I lines, whereas Nova Sco 2015 is shown to belong to the He/N class with strong He I, H I and O I emission lines. The highlight of the results consists in demonstrating that Nova Sco 2015 is a symbiotic system containing a giant secondary. Leaving aside the T CrB class of recurrent novae, all of which have giant donors, Nova Sco 2015 is shown to be only the third classical nova to be found with a giant secondary. The evidence for the symbiotic nature is three-fold; first is the presence of a strong decelerative shock accompanying the passage of the nova's ejecta through the giant's wind, second is the H$\alpha$ excess seen from the system and third is the spectral energy distribution of the secondary in quiescence typical of a cool late type giant. The evolution of the strength and shape of the emission line profiles shows that the ejecta velocity follows a power law decay with time ($t^{-1.13\pm0.17}$). A Case B recombination analysis of the H I Brackett lines shows that these lines are affected by optical depth effects for both the novæ. Using this analysis we make estimates for both the novæ of the emission measure $n_e^2 L$, the electron density $n_e$ and the mass of the ejecta.

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## A morpho-kinematic and spectroscopic study of the bipolar nebulæ: M 2-9, Mz 3 and Hen 2-104

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*Context:* Complex bipolar shapes can be generated either as a planetary nebula or a symbiotic system. The origin of the material ionised by the white dwarf is very different in these two scenarios, and it complicates the understanding of the morphologies of planetary nebulæ.
*Aims:* The physical properties, structure, and dynamics of the bipolar nebulæ, M 2-9, Mz 3 and Hen 2-104, are investigated in detail with the aim of understanding their nature, shaping mechanisms, and evolutionary history. Both a morpho-kinematic study and a spectroscopic analysis, can be used to more accurately determine the kinematics and nature of each nebula.
*Methods:* Long-slit optical échelle spectra are used to investigate the morpho-kinematics of M 2-9, Mz 3 and Hen 2-104. The morpho-kinematic modelling software SHAPE is used to constrain both the morphology and kinematics of each nebula by means of detailed 3-D models. Near-infrared (NIR) data, as well as optical, spectra are used to separate Galactic symbiotic-type nebulæ from genuine planetary nebulæ by means of a 2MASS J–H/H–$K_s$ diagram and a $\lambda$4363/H$\gamma$ vs. $\lambda$5007/H$\beta$ diagnostic diagram, respectively.
*Results:* The best-fitted 3-D models for M 2-9, Mz 3 and Hen 2-104 provide invaluable kinematical information on the expansion velocity of its nebular components by means of synthetic spectra. The observed spectra match up very well with the synthetic spectra for each model, thus showing that each model is tightly constrained both morphologically and kinematically. Kinematical ages of the different structures of M 2-9 and Mz 3 have also been determined. Both diagnostic diagrams show M 2-9 and Hen 2-104 to fall well within the category of having a symbiotic source, whereas Mz 3 borders the region of symbiotic and young planetary nebulæ in the optical diagram but is located firmly in the symbiotic region of the NIR colour–colour diagram. The optical diagnostic diagram is shown to successfully separate the two types of nebulæ, however, the NIR colour–colour diagram is not as accurate in separating these objects.
*Conclusions:* The morphology, kinematics, and evolutionary history of M 2-9, Mz 3 and Hen 2-104 are better understood using the interactive 3-D modelling tool shape. The expansion velocities of the components for each nebula are better constrained and fitted with a vector field to reveal their direction of motion. The optical and NIR diagnostic diagrams used are important techniques for separating Galactic symbiotic-type nebulæ from genuine planetary nebulæ.

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## Detection of C I line emission from the detached CO shell of the AGB star R Sculptoris

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Stars on the asymptotic giant branch (AGB) lose substantial amounts of matter, to the extent that they are important for the chemical evolution of, and dust production in, the universe. The mass loss is believed to increase gradually with age on the AGB, but it may also occur in the form of bursts, possibly related to the thermal pulsing phenomenon. Detached, geometrically thin, CO shells around carbon stars are good signposts of brief and intense mass ejection. We aim to put further constraints on the physical properties of detached CO shells around AGB stars. The photodissociation of CO and other carbon-bearing species in the shells leads to the possibility of detecting lines from neutral carbon. We have therefore searched for the C I ($^3P_1$–$^3P_0$) line at 492 GHz towards two carbon stars, S Sct and R Scl, with detached CO shells of different ages, ≈ 8000 and 2300 years, respectively. The C I ($^3P_1$–$^3P_0$) line was detected towards R Scl. The line intensity is dominated by emission from the detached shell. The detection is at a level consistent with the neutral carbon coming from the full photodissociation of all species except CO, and with only limited photoionisation of carbon. The best fit to the observed $^{12}$CO and $^{13}$CO line intensities, assuming a

homogeneous shell, is obtained for a shell mass of $\approx 0.002\ M_\odot$, a temperature of $\approx 100$ K, and a CO abundance with respect to $H_2$ of $10^{-3}$. The estimated C I/CO abundance ratio is $\approx 0.3$ for the best-fit model. However, a number of arguments point in the direction of a clumpy medium, and a viable interpretation of the data within such a context is provided.

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# Cool and luminous transients from mass-losing binary stars

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We study transients produced by equatorial disk-like outflows from catastrophically mass-losing binary stars with an asymptotic velocity and energy deposition rate near the inner edge which are proportional to the binary escape velocity $v_{\rm esc}$. As a test case, we present the first smoothed-particle radiation-hydrodynamics calculations of the mass loss from the outer Lagrange point with realistic equation of state and opacities. The resulting spiral stream becomes unbound for binary mass ratios $0.06 \lesssim q \lesssim 0.8$. For synchronous binaries with non-degenerate components, the spiral-stream arms merge at a radius of $\sim 10a$, where $a$ is the binary semi-major axis, and the accompanying shock thermalizes 10–20% of the kinetic power of the outflow.
The mass-losing binary outflows produce luminosities proportional to the mass loss rate $\dot{M}$ and $v_{\rm esc}$, reaching up to $\sim 10^6\ L_\odot$. The effective temperatures depend primarily on $v_{\rm esc}$ and span $500 \lesssim T_{\rm eff} \lesssim 6000$ K. Dust readily forms in the outflow, potentially in a catastrophic global cooling transition. The appearance of the transient is viewing angle-dependent due to vastly different optical depths parallel and perpendicular to the binary plane. The predicted peak luminosities, timescales, and effective temperatures of mass-losing binaries are compatible with those of many of the class of recently-discovered red transients such as V838 Mon and V1309 Sco. We predict a correlation between the peak luminosity and the outflow velocity, which is roughly obeyed by the known red transients. Outflows from mass-losing binaries can produce luminous ($10^5\ L_\odot$) and cool ($T_{\rm eff} \lesssim 1500$ K) transients lasting a year or longer, as has potentially been detected by *Spitzer* surveys of nearby galaxies.

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# 3D PYCLOUDY modelling of bipolar planetary nebulæ: evidence for fast fading of the lobes

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We apply an axially symmetric pseudo-3D photoionization model, PYCLOUDY, to derive the structures of 6 bipolar nebulæ and 2 suggested post-bipolars in a quest to constrain the bipolar planetary nebulæ evolution. HST images and VLT/UVES spectroscopy are used for the modelling. The targets are located in the direction of the Galactic bulge. A 3D model structure is used as input to the photoionization code, so as to fit the HST images. Line profiles of different ions constrain the velocity field. The model and associated velocity fields allow us to derive masses, velocities, and ages. The 3D models find much lower ionized masses than required in 1D models: ionized masses are reduced by

factors of 2–7. The selected bi-lobed planetary nebulæ show a narrow range of ages: the averaged radii and velocities result in values between 1300 and 2000 yr. The lobes are fitted well with velocities linearly increasing with radius. These Hubble-type flows have been found before, and suggest that the lobes form at a defined point in time. The lobes appear to be slightly younger than the main (host) nebulae, by $\sim 500$ yr, they seem to form at an early phase of PN evolution, and fade after 1–2 kyr. We find that 30–35% of bulge PNe pass through a bipolar phase.

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## Dust processing in elliptical galaxies

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We reconsider the origin and processing of dust in elliptical galaxies. We theoretically formulate the evolution of grain size distribution, taking into account dust supply from asymptotic giant branch (AGB) stars and dust destruction by sputtering in the hot interstellar medium (ISM), whose temperature evolution is treated by including two cooling paths: gas emission and dust emission (i.e. gas cooling and dust cooling). With our new full treatment of grain size distribution, we confirm that dust destruction by sputtering is too efficient to explain the observed dust abundance even if AGB stars continue to supply dust grains, and that, except for the case where the initial dust-to-gas ratio in the hot gas is as high as $\sim 0.01$, dust cooling is negligible compared with gas cooling. However, we show that, contrary to previous expectations, cooling does not help to protect the dust; rather, the sputtering efficiency is raised by the gas compression as a result of cooling. We additionally consider grain growth after the gas cools down. Dust growth by the accretion of gas-phase metals in the cold medium increase the dust-to-gas ratio up to $\sim 10^{-3}$ if this process lasts $> 10/(n_{\rm H}/10^3\ {\rm cm}^{-3})$ Myr, where $n_{\rm H}$ is the number density of hydrogen nuclei. We show that the accretion of gas-phase metals is a viable mechanism of increasing the dust abundance in elliptical galaxies to a level consistent with observations, and that the steepness of observed extinction curves is better explained with grain growth by accretion.

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# *Job Advert*

## Ph.D. position in evolved stars

We are offering a Ph.D. position at Onsala Space Observatory, researching the physics and chemistry of evolved stars. The project will make use of instruments such as ALMA, APEX, SMA, and IRAM 30m in the millimeter/sub-millimeter, as well as optical and infrared observations with, e.g., VLT and *Herschel*. The position will focus on the physical and chemical properties of low-mass evolved stars on the AGB, as well as proto-planetary nebulæ. The successful applicant will have the opportunity to influence the details of the research project, with the possibility to combine observations with theoretical modelling. The Ph.D. student will be expected to lead the work in close collaboration with the other members of the group. The research will mainly be done at Onsala Space Observatory, where Chalmers hosts the Swedish National Facility for Radio Astronomy.

For questions please contact
Matthias Maercker (maercker@chalmers.se) or Wouter Vlemmings (wouter.vlemmings@chalmers.se).

*See also* http://www.chalmers.se/en/about-chalmers/vacancies/Pages/default.aspx?rmpage=job&rmjob=3304

## *Announcements*

# Supernova remnants: an odyssey in space after stellar death

This is the 2nd announcement for the upcoming conference:
Supernova Remnants: An Odyssey in Space after Stellar death
June 6–11, 2016
Chania, Crete, Greece

Registration is now open and the deadline for abstract submission is March, 04, 2016. To register, please follow the ”Register” button on the website: http://snr2016.astro.noa.gr

Background and Scientific Rationale

The meeting ”Supernova Remnants: An Odyssey in Space after Stellar death” will explore the exciting recent observational and theoretical progress in the structure, evolution and physics of SNRs. The Institute for Astronomy, Astrophysics, Space Applications & Remote Sensing of the National Observatory of Athens, invites you to the beautiful island of Crete, the home of very well known myths, i.e. Dædalus, as well as Icarus, Theseus and the Minotaur, the birth of Zeus.

The conference will build upon spectral and imaging observations from radio to $\gamma$-ray wavelengths of SNR blast waves, pulsar wind nebulæ and SN ejecta and their interpretation through models and numerical simulations. The goals of the meeting are understanding the evolution of SNRs and their interaction with interstellar gas, elucidating the physical processes that govern shock waves and relativistic plasmas, and inferring characteristics of supernova explosions from SNR observations.

We will focus on narrowing the gap between observations and theories with the help of powerful new instrumentation such as hard X-ray and $\gamma$-ray satellites, large optical telescopes, and sub-mm and low-frequency radio arrays on the one hand, and increasingly detailed and realistic numerical simulations on the other. New understanding of the nature of supernova remnants and processes that occur there offers new insights into the role of SNRs in the structure and evolution of galaxies and the nature of supernova explosions.

Scientific Topics & Session Chairs

- Radiation studies from $\gamma$-rays to radio in Galactic and Extragalactic SNRs (D. Green)
- The search for the binary companions of SN progenitors in SNRs (W. Blair)
- Pulsar winds nebulæ (including Crab flares) (P. Slane)
- Magnetic fields in SNRs and PWNe (R. Kothes)
- Collisionless shock waves in SNRs (A. Decourcelle)
- Jets and Asymmetries in SNe and their Remnants (R. Fesen)
- SNRs as probes and drivers of galaxy structure (A. Rest)
- SNe and SNRs cosmic ray acceleration (T. Bell)
- SN ejecta & abundances, clumpiness (K. Borkowski)
- SNe and SNRs with circumstellar interactions (J. Raymond)

Invited Speakers (confirmed): R. Chevalier (USA – opening plenary talk), J. Vink (Netherlands – summary plenary talk), E. Amato (Italy), C. Badenes (USA), G. Dubner (Argentina), P. Ghavamian (USA), W. Kerzendorf (Germany), S-H. Lee (Japan), M. Lemoine-Goumard (France), I. Leonidaki (Greece), L. Lopez (USA), R. McCray (USA), D.

Milisavljević (USA), D. Patnaude (USA), W. Reich (Germany), S. Reynolds (USA), S. Safi-Harb (Canada), N. Soker (Israel), T. Temim (USA), S. Van Dyk (USA), B. Williams (USA)

Venue & Accommodation

The meeting will take place at the luxury 5⋆ beachside hotel Minoa Palace Luxury Resort & Spa, situated in the cosmopolitan area of Platanias, 12 km west of the picturesque town of Chania and only a 30 min drive from Chania International Airport.

Travel Information

The Star Alliance member airlines are pleased to be appointed as the Official Airline Network for the Astrophysical Conference "Supernova Remnants: An Odyssey in Space after Stellar Death". To obtain the Star Alliance Conventions Plus discounts please visit Conventions Plus online booking tool. Registered Event participants plus one accompanying person traveling to the Event qualify for a discount of up to 20%, depending on fare and class of travel booked.

Avis Rent a Car is pleased to be appointed as the Official Rent a Car company for the Astrophysical conference: "Supernova Remnants: An Odyssey in Space after Stellar Death". To obtain the Avis rent a car discount please visit the online booking tool. Registered Event participants qualify for a discount of 15%.

Scientific Organizing Committee: P. Boumis (co-chair), J. Raymond (co-chair), T. Bell, W. Blair, K. Borkowski, A. Decourchelle, R. Fesen, D. Green, R. Kothes, A. Rest, P. Slane

Local Organizing Committee: P. Boumis (co-chair), A. Bonanos (co-chair), D. Abartzi, S. Akras, I. Alikakos, A. Chiotellis, M. Kopsacheili, M. Kourniotis, I. Leonidaki, A. Liakos, M. Pliatsika, S. Williams

Looking forward to seeing you in Crete!

The LOC co-chairs
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# New IAU Commission G3 "Stellar Evolution"

Dear colleagues

at the recent IAU GA the new IAU structure was officially implemented. I am pleased to say that we have a brand new Commission G3 "Stellar Evolution".

I don't have to tell the readers of this newsletter that stars stand at the centre of modern astrophysics – even if some people may not realise it! On top of this, there is clearly a major revolution happening with unique and game-changing instruments and surveys under way or just starting: HERMES, GALAH, GAIA, *Kepler*, ALMA, VLTI/CHARA, JWST, TESS, *Plato* etc. etc. The list goes on!

To complement this, we find that computing facilities are now at a level where 3D direct numerical simulation of previously impossible phases is becoming viable, even if for restricted cases. We are nevertheless learning about physics previously inaccessible to direct simulation.

If the Commission is to be useful we need people to step up and provide ideas and activities. For example: what do you want from a revised webpage? What activities can we organise to promote and advance our discipline?

In the first instance, please send ideas and comments to any of the people below. We hope to set up a place on the web pages for such discussions.

Please help us to make this Commission useful to us all!

John Lattanzio and the Organizing Committee of CG3


| | | |
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## 1$^{st}$ announcement for the IAU Symposium 323 Planetary nebulæ: multi-wavelength probes of stellar & galactic evolution

Dear Colleague,

This is the 1$^{st}$ announcement for the IAU Symposium 323 – Planetary nebulæ: Multi-wavelength probes of stellar and galactic evolution to be held on October 10–14, 2016, in Beijing, China. The Symposium will encompass all aspects of the impact and importance of planetary nebulæ (PNe) on stellar and galactic evolution. In particular, we expect to cover the following topics:

- New challenges to surveys of PNe in the Local Group
- PNe as a versatile laboratory of dust and molecular studies
- From the asymptotic giant branch to the white dwarf stellar phases
- The connection between binary evolution and the PN phenomena
- Planets around evolved stars and their impact on PN formation
- PNe in nearby galaxies: probing chemical evolution and galactic dynamics
- PNe outside of the local group: Challenges to observing and interpret distant PNe

We also expect discussion on the challenges of new and future instrumentation as applied to the field of PNe.

More information will be posted on the IAU Commission H3 Planetary Nebulæ web page at http://ast.noao.edu/activities/pn-commission/, and on the conference's home page http://162.105.156.249/IAUS323/.

We hope to see a broad participation to this Symposium!

Xiaowei Liu, Letizia Stanghellini, and Amanda Karakas (SOC co-Chairs)

*See also* http://162.105.156.249/IAUS323/