THE AGB NEWSLETTER

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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 160$^{\rm th}$ issue of the AGB Newsletter. Enjoy it!

Notwithstanding the economic recession, there still are jobs for astronomers! There is a Ph.D. studentship offered to work with Isabelle Cherchneff in Switzerland, and there are three post-doctoral fellowships offered to work on the planned HERMES spectrograph surveys in Australia.

ALMA is growing fast and the call for early-science observations is imminent. Various workshops are being organised to prepare the community for this, one of which takes place in Manchester in December. There is a special AGB (and "related" objects) meeting associated with it as well.

The next issue is planned to be distributed on the 1$^{\rm st}$ of December 2010.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

What should we make sure ALMA does to advance our understanding of AGB stars?

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

Refereed Journal Papers

The UK infrared Telescope M 33 monitoring project. I. Variable red giant stars in the central square kiloparsec

Atefeh Javadi[1,2]*, Jacco Th. van Loon*[2] *and Mohammad Taghi Mirtorabi*[1]

[1]Physics Department, Alzahra University, Vanak, Tehran, Iran

[2]Astrophysics Group, Lennard-Jones Laboratories, Keele University, Staffordshire ST5 5BG, UK

We have conducted a near-infrared monitoring campaign at the UK InfraRed Telescope (UKIRT), of the Local Group spiral galaxy M 33 (Triangulum). The main aim was to identify stars in the very final stages of their evolution, and for which the luminosity is more directly related to the birth mass than the more numerous less-evolved giant stars that continue to increase in luminosity. The most extensive dataset was obtained in the K-band with the UIST instrument for the central $4' \times 4'$ (1 kpc^2) – this contains the nuclear star cluster and inner disc. These data, taken during the period 2003–2007, were complemented by J- and H-band images. Photometry was obtained for 18,398 stars in this region; of these, 812 stars were found to be variable, most of which are Asymptotic Giant Branch (AGB) stars. Our data were matched to optical catalogues of variable stars and carbon stars, and to mid-infrared photometry from the *Spitzer* Space Telescope. In this first of a series of papers, we present the methodology of the variability survey and the photometric catalogue – which is made publicly available at the Centre de Données astronomiques de Strasbourg (CDS) – and discuss the properties of the variable stars. Most dusty AGB stars had not been previously identified in optical variability surveys, and our survey is also more complete for these types of stars than the *Spitzer* survey.

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The SAGE-Spec *Spitzer* Legacy program: The life-cycle of dust and gas in the Large Magellanic Cloud. Point source classification I.

Paul M. Woods[1]*, J.M. Oliveira*[2]*, F. Kemper*[1]*, J.Th. van Loon*[2]*, B.A. Sargent*[3]*, M. Matsuura*[4,5]*, R. Szczerba*[6]*, K. Volk*[3]*, A.A. Zijlstra*[1]*, G.C. Sloan*[7]*, E. Lagadec*[8,1]*, I. McDonald*[1]*, O. Jones*[1]*, V. Gorjian*[9]*, K.E. Kraemer*[10]*, C. Gielen*[11]*, M. Meixner*[3]*, R.D. Blum*[12]*, M. Sewiło*[3]*, D. Riebel*[13]*, B. Shiao*[3]*, C.-H.R. Chen*[14]*, M.L. Boyer*[3]*, R. Indebetouw*[14,15] *and the SAGE-Spec team*

[1]Jodrell Bank Centre for Astrophysics, Manchester, UK
[2]Keele University, UK
[3]Space Telescope Science Institute, USA
[4]University College London, UK
[5]Mullard Space Science Laboratory, UK
[6]N. Copernicus Astronomical Center, Poland
[7]Cornell University, USA
[8]ESO, Germany
[9]JPL/Caltech, USA
[10]US Air Force Research Laboratory, USA
[11]Katholieke Universiteit Leuven, Belgium
[12]NOAO, USA
[13]Johns Hopkins University, USA
[14]University of Virginia, USA
[15]NRAO, USA

We present the classification of 197 point sources observed with the *Infrared Spectrograph* in the SAGE-Spec Legacy program on the *Spitzer Space Telescope*. We introduce a decision-tree method of object classification based on infrared

spectral features, continuum and spectral energy distribution shape, bolometric luminosity, cluster membership, and variability information, which is used to classify the SAGE-Spec sample of point sources. The decision tree has a broad application to mid-infrared spectroscopic surveys, where supporting photometry and variability information are available. We use these classifications to make deductions about the stellar populations of the Large Magellanic Cloud and the success of photometric classification methods. We find 90 asymptotic giant branch (AGB) stars, 29 young stellar objects, 23 post-AGB objects, 19 red supergiants, eight stellar photospheres, seven background galaxies, seven planetary nebulae, two H II regions and 12 other objects, seven of which remain unclassified.

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Hot Bottom Burning in the envelope of SAGB stars

Paolo Ventura[1] *and Francesca D'Antona*[1]

[1]Observatory of Rome, Italy

We investigate the physical and chemical evolution of population II stars with initial masses in the range 6.5–8 $M_{\odot}$, which undergo an off centre carbon ignition under partially degenerate conditions, followed by a series of thermal pulses, and supported energetically by a CNO burning shell, above a O–Ne degenerate core. In agreement with the results by other research groups, we find that the O–Ne core is formed via the formation of a convective flame that proceeds to the centre of the star. The evolution which follows is strongly determined by the description of the mass loss mechanism. Use of the traditional formalism with the super-wind phase favours a long evolution with many thermal pulses, and the achievement of an advanced nucleosynthesis, due the large temperatures reached by the bottom of the external mantle. Use of a mass loss recipe with a strong dependence on the luminosity favours an early consumption of the stellar envelope, so that the extent of the nucleosynthesis, and thus the chemical composition of the ejecta, is less extreme. The implications for the multiple populations in globular clusters are discussed. If the "extreme" populations present in the most massive clusters are a result of direct formation from the super-AGB ejecta, their abundances may constitute a powerful way of calibrating the mass loss rate of this phase. This calibration will also provide informations on the fraction of super-AGBs exploding as single e-capture supernova, leaving a neutron star remnant in the cluster.

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Seismic diagnostics of red giants: First comparison with stellar models

Josefina Montalbán[1]*, Andrea Miglio*[1]*, Arlette Noels*[1]*, Richard Scuflaire*[1] *and Paolo Ventura*[2]

[1]Institut d'Astrophysique et Géophysique, Universté de Liège, Belgium

[2]Osservatorio Astronomico di Roma–INAF, Italy

The clear detection with *CoRoT* and *KEPLER* of radial and non-radial solar-like oscillations in many red giants paves the way for seismic inferences on the structure of such stars. We present an overview of the properties of the adiabatic frequencies and frequency separations of radial and non-radial oscillation modes for an extended grid of models.We highlight how their detection allows a deeper insight into the internal structure and evolutionary state of red giants. In particular, we find that the properties of dipole modes constitute a promising seismic diagnostic tool of the evolutionary state of red giant stars.We compare our theoretical predictions with the first 34 days of *KEPLER* data and predict the frequency diagram expected for red giants in the *CoRoT* exofield in the galactic center direction.

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and from http://iopscience.iop.org/2041-8205/721/2/L182/

The ubiquity of the rapid neutron-capture process

Ian U. Roederer[1], *John J. Cowan*[2], *Amanda I. Karakas*[3,4], *Karl-Ludwig Kratz*[5], *Maria Lugaro*[4], *Jennifer Simmerer*[6], *Khalil Farouqi*[7] *and Chris Sneden*[8]

[1]Carnegie Observatories, USA

[2]Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, USA

[3]Research School of Astronomy & Astrophysics, The Australian National University, Mount Stromlo Observatory, Australia

[4]Centre for Stellar and Planetary Astrophysics, School of Mathematical Sciences, Monash University, Australia

[5]Max-Planck-Institut für Chemie, Otto-Hahn-Institut, Germany

[6]Department of Physics and Astronomy, University of Utah, USA

[7]Zentrum für Astronomie der Universität Heidelberg, Germany

[8]Department of Astronomy, University of Texas at Austin, USA

To better characterize the abundance patterns produced by the r-process, we have derived new abundances or upper limits for the heavy elements zinc (Zn, $Z = 30$), yttrium (Y, $Z = 39$), lanthanum (La, $Z = 57$), europium (Eu, $Z = 63$), and lead (Pb, $Z = 82$). Our sample of 161 metal-poor stars includes new measurements from 88 high resolution and high signal-to-noise spectra obtained with the Tull Spectrograph on the 2.7m Smith Telescope at McDonald Observatory, and other abundances are adopted from the literature. We use models of the s-process in AGB stars to characterize the high Pb/Eu ratios produced in the s-process at low metallicity, and our new observations then allow us to identify a sample of stars with no detectable s-process material. In these stars, we find no significant increase in the Pb/Eu ratios with increasing metallicity. This suggests that s-process material was not widely dispersed until the overall Galactic metallicity grew considerably, perhaps even as high as [Fe/H] = −1.4, in contrast with earlier studies that suggested a much lower mean metallicity. We identify a dispersion of at least 0.5 dex in [La/Eu] in metal-poor stars with [Eu/Fe] < +0.6 attributable to the r-process, suggesting that there is no unique "pure" r-process elemental ratio among pairs of rare earth elements. We confirm earlier detections of an anti-correlation between Y/Eu and Eu/Fe bookended by stars strongly enriched in the r-process (e.g., CS 22892−052) and those with deficiencies of the heavy elements (e.g., HD 122563). We can reproduce the range of Y/Eu ratios using simulations of high-entropy neutrino winds of core-collapse supernovae that include charged-particle and neutron-capture components of r-process nucleosynthesis. The heavy element abundance patterns in most metal-poor stars do not resemble that of CS 22892−052, but the presence of heavy elements such as Ba in nearly all metal-poor stars without s-process enrichment suggests that the r-process is a common phenomenon.

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Integral field spectroscopy of H_2 and CO emission in IRAS 18276−1431: evidence for ongoing post-AGB mass loss

T.M. Gledhill[1], *K.P. Forde*[1], *K.T.E. Lowe*[1] *and M.D. Smith*[2]

[1]Science and Technology Research Institute, University of Hertfordshire, College Lane, Hatfield AL10 9AB, UK

[2]Centre for Astrophysics and Planetary Science, School of Physical Sciences, University of Kent, Canterbury CT2 7NR, UK

We present *K*-band integral field spectroscopy of the bipolar post-AGB object IRAS 18276−1431 (OH 17.7−2.0) using *SINFONI* on the *VLT*. This allows us to image both the continuum and molecular features in this object from 1.95–2.45 μm with a spatial resolution down to 70 mas and a spectral resolution of $\sim$ 5000. We detect a range of H_2 ro-vibrational emission lines which are consistent with shock excitation in regions of dense ($\sim 10^7$ cm^{-3}) gas with shock velocities in the range 25–30 km s^{-1}. The distribution of H_2 emission in the bipolar lobes suggests that a fast wind is impinging on material in the cavity walls and tips. H_2 emission is also seen along a line of sight close to the obscured star as well as in the equatorial region to either side of the stellar position which has the appearance of a ring with radius 0.3″. This latter feature may be radially cospatial with the boundary between the AGB and post-AGB winds. The first overtone ^{12}CO bandheads are observed longward of 2.29 μm with the v = 2 − 0 bandhead prominently in emission. The CO emission has the same spatial distribution as the *K*-band continuum and therefore originates from an unresolved central source close to the star. We interpret this as evidence for ongoing mass loss in

this object. This conclusion is further supported by a rising K-band continuum indicating the presence of warm dust close to the star, possibly down to the condensation radius. The red-shifted scattered peak of the CO bandhead is used to estimate a dust velocity along the bipolar axis of 95 km s^{-1} for the collimated wind. This places a lower limit of $\sim$ 125 yr on the age of the bipolar cavities, meaning that the collimated fast wind turned on very soon after the cessation of AGB mass loss.

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Light-element abundance variations at low metallicity: the globular cluster NGC 5466

M. Shetrone[1], S.L. Martell[2], R. Wilkerson[3], J. Adams[4], M.H. Siegel[5], G.H. Smith[6] and H.E. Bond[7]

[1]McDonald Observatory, UT Austin, USA
[2]University of Heidelberg, Germany
[3]Baylor University, USA
[4]UT Austin, USA
[5]Penn State, USA
[6]UCO/Lick Observatory, UC Santa Cruz, USA
[7]STScI, USA

We present low-resolution ($R \sim 850$) spectra for 67 asymptotic giant branch, horizontal branch and red giant branch (RGB) stars in the low-metallicity globular cluster NGC 5466, taken with the VIRUS-P integral-field spectrograph at the 2.7-m Harlan J. Smith telescope at McDonald Observatory. Sixty-six stars are confirmed, and one rejected, as cluster members based on radial velocity, which we measure to an accuracy of 16 km s^{-1} via template-matching techniques. CN and CH bandstrengths have been measured for 29 RGB and AGB stars in NGC 5466, and the bandstrength indices measured from VIRUS-P data show close agreement with those measured from Keck/LRIS spectra previously taken of five of our target stars. We also determine carbon abundances from comparisons with synthetic spectra. The RGB stars in our data set cover a range in absolute V magnitude from +2 to −3, which permits us to study the rate of carbon depletion on the giant branch as well as the point of its onset. The data show a clear decline in carbon abundance with rising luminosity above the luminosity function "bump" on the giant branch, and also a subdued range in CN bandstrength, suggesting ongoing internal mixing in individual stars but minor or no primordial star-to-star variation in light-element abundances.

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Distinguishing post-AGB impostors in a sample of pre-main sequence star

Rodrigo G. Vieira[1], Jane Gregorio-Hetem[1], Annibal Hetem Jr.[2], Grażyna Stazyńska[3] and Ryszard Szczerba[4]

[1]Universidade de São Paulo, IAG, Rua do Matão, 1226, 05508-900, São Paulo, SP, Brazil
[2]Universidade Federal do ABC, CECS, Rua Santa Adélia, 166, 09210-170 Santo André, SP, Brazil
[3]Observatoire de Meudon, LUTH, 5 Place Jules Janssen, 92190, Meudon, France
[4]N. Copernicus Astronomical Center, Rabiańska 8, 87-100, Toruń, Poland

A sample of 27 sources, catalogued as pre-main sequence stars by the Pico dos Dias Survey (PDS), is analyzed to investigate a possible contamination by post-AGB stars. The far-infrared excess, due to dust present in the circumstellar envelope, is typical for both categories: young stars and objects that have already left the main sequence and are suffering a severe mass-loss. The presence of two known post-AGB stars in our sample inspired us to seek for

other very likely or possible post-AGB objects among PDS sources previously suggested to be Herbig Ae/Be stars, by revisiting the observational database of this sample. In a comparative study with well known post-AGBs, several characteristics were evaluated: (i) parameters related to the circumstellar emission; (ii) spatial distribution to verify the background contribution from dark clouds; (iii) spectral features, and (iv) optical and infrared colors. These characteristics suggest that 7 objects of the studied sample are very likely post-AGBs, 5 are possible post-AGBs, 8 are unlikely post-AGBs, and the nature of 7 objects remains unclear.

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Observing and modeling the dynamic atmosphere of the low mass-loss C-star R Sculptoris at high angular resolution

Stephane Sacuto[1], *Bernhard Aringer*[2], *Josef Hron*[1], *Walter Nowotny*[1], *Claudia Paladini*[1], *Tijl Verhoelst*[3] *and Susanne Höfner*[4]

[1]University of Vienna, Department of Astronomy, Vienna, Austria
[2]INAF–OAPD, Padova, Italy
[3]Instituut voor Sterrenkunde, K.U. Leuven, Belgium
[4]Department of Physics & Astronomy, Uppsala University, Uppsala, Sweden

We study the circumstellar environment of the carbon-rich star R Scl using the near- and mid-infrared high spatial resolution observations from the ESO–VLTI instruments VINCI and MIDI. These observations aim at increasing our knowledge of the dynamic processes in play within the very close circumstellar environment where the mass loss of AGB stars is initiated. Data are interpreted using a self-consistent dynamic model. Interferometric observations do not show any significant variability effect at the 16 m baseline between phases 0.17 and 0.23 in the K band, and for both the 15 m baseline between phases 0.66 and 0.97 and the 31 m baseline between phases 0.90 and 0.97 in the N band. We find fairly good agreement between the dynamic model and the spectrophotometric data from 0.4 to 25 μm. The model agrees well with the time-dependent flux data at 8.5 μm, whereas it is too faint at 11.3 and 12.5 μm. The VINCI visibilities are reproduced well, meaning that the extension of the model is suitable in the K-band. In the mid-infrared, the model has the proper extension to reveal molecular structures of C_2H_2 and HCN located above the stellar photosphere. However, the windless model used is not able to reproduce the more extended and dense dusty environment. Among the different explanations for the discrepancy between the model and the measurements, the strong nonequilibrium process of dust formation is one of the most probable. The complete dynamic coupling of gas and dust and the approximation of grain opacities with the small-particle limit in the dynamic calculation could also contribute to the difference between the model and the data.

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V605 Aquilae: a born again star, a nova or both?

Herbert.H.B.Lau[1,2], *Orsola De Marco*[3] *and X-W Liu*[2,4]

[1]CSPA, Monash University, Australia
[2]KIAA, PKU, China
[3]Dept. of Physics & Astronomy, Macquarie University, Australia
[4]Dept. of Astronomy, Peking University, China

V605 Aquilae is today widely assumed to have been the result of a final helium shell flash occurring on a single post-asymptotic giant branch star. The fact that the outbursting star is in the middle of an old planetary nebula and that the ejecta associated with the outburst is hydrogen deficient supports this diagnosis. However, the material ejected

during that outburst is also extremely neon rich, suggesting that it derives from an oxygen–neon–magnesium star, as is the case in the so-called neon novae. We have therefore attempted to construct a scenario that explains all the observations of the nebula and its central star, including the ejecta abundances. We find two scenarios that have the potential to explain the observations, although neither is a perfect match. The first scenario invokes the merger of a main sequence star and a massive oxygen–neon–magnesium white dwarf. The second invokes an oxygen–neon–magnesium classical nova that takes place shortly after a final helium shell flash. The main drawback of the first scenario is the inability to determine whether the ejecta would have the observed composition and whether a merger could result in the observed hydrogen-deficient stellar abundances observed in the star today. The second scenario is basedon better understood physics, but, through a population synthesis technique, we determine that its frequency of occurrence should be very low and possibly lower than what is implied by the number of observed systems. While we could not envisage a scenario that naturally explains this object, this is the second final flash star which, upon closer scrutiny, is found to have hydrogen-deficient ejecta with abnormally high neon abundances. These findings are in stark contrast with the predictions of the final helium shell flash and beg for an alternative explanation.

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The formation of high-field magnetic white dwarfs from common envelopes

J. Nordhaus[1]*, S. Wellons*[1]*, D.S. Spiegel*[1]*, B.D. Metzger*[1] *and E.G. Blackman*[2]

[1]Department of Astrophysical Sciences, Princeton University, Princeton, NJ 08544, U.S.A.
[2]Department of Physics and Astronomy, University of Rochester, Rochester, NY 14627, U.S.A.

The origin of highly-magnetized white dwarfs has remained a mystery since their initial discovery. Recent observations indicate that the formation of high-field magnetic white dwarfs is intimately related to strong binary interactions during post-main-sequence phases of stellar evolution. If a low-mass companion, such as a planet, brown dwarf, or low-mass star is engulfed by a post-main-sequence giant, the hydrodynamic drag in the envelope of the giant leads to a reduction of the companion's orbit. Sufficiently low-mass companions in-spiral until they are shredded by the strong gravitational tides near the white dwarf core. Subsequent formation of a super-Eddington accretion disk from the disrupted companion inside a common envelope can dramatically amplify magnetic fields via a dynamo. Here, we show that these disk-generated fields are sufficiently strong to explain the observed range of magnetic field strengths for isolated, high-field magnetic white dwarfs. A higher-mass binary analogue may also contribute to the origin of magnetar fields.

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A *Spitzer*/IRS spectral study of a sample of galactic carbon-rich proto-planetary nebulae

Yong Zhang[1]*, Sun Kwok* [1] *and Bruce J. Hrivnak*[2]

[1]University of Hong Kong, China
[2]Valparaiso University, USA

Recent infrared spectroscopic observations have shown that proto-planetary nebulae (PPNs) are sites of active synthesis of organic compounds in the late stages of stellar evolution. This paper presents a study of *Spitzer*/IRS spectra for a sample of carbon-rich PPNs, all except one of which show the unidentified 21 micron emission feature. The strengths of the aromatic infrared band (AIB), 21 μm, and 30 μm features are obtained by decomposition of the spectra. The observed variations in the strengths and peak wavelengths of the features support the model that the newly synthesized

organic compounds gradually change from aliphatic to aromatic characteristics as stars evolve from PPNs to planetary nebulae.

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Discrete source survey of 6 GHz OH emission from PNe & pPNe and first 6 GHz images of K 3-35

J.-F. Desmurs[1], *A. Baudry*[2], *P. Sivagnanam*[3], *C. Henkel*[4], *A.M.S. Richards*[5] *and I. Bains*[6]

[1]Observatorio Astronómico Nacional, Alfonso XII 3, E-28014 Madrid, Spain
[2]LAB – Observatoire Aquitain des Sciences de l'Univers, BP 89, 33271 Floirac, France
[3]GEPI, Observatoire de Paris, France
[4]MPIfR, Bonn, Germany
[5]Jodrell Bank Centre for Astrophysics, School of Physics and Astronomy, University of Manchester, UK
[6]Swinburne University of Technology, Victoria, Australia

The aim of this study is to investigate the physical properties of molecular envelopes of planetary nebulae in their earliest stages of evolution. Using the 100m telescope at Effelsberg, we have undertaken a high sensitivity discrete source survey for the first excited state of OH maser emission ($J = 5/2$, $^2\Pi_{3/2}$ at 6 GHz) in the direction of planetary and proto-planetary nebulae exhibiting 18cm OH emission (main and/or satellite lines), and we further validate our detections using the Nançay radio telescope at 1.6–1.7 GHz and MERLIN interferometer at 1.6–1.7 and 6 GHz. Two sources have been detected at 6035 MHz (5 cm), both of them are young (or very young) planetary nebulae. The first one is a confirmation of the detection of a weak 6035 MHz line in Vy 2-2. The second one is a new detection, in K 3-35, which was already known to be an exceptional late-type star because it exhibits 1720 MHz OH emission. The detection of 6035 MHz OH maser emission is confirmed by subsequent observations made with the MERLIN interferometer. These lines are very rarely found in evolved stars. The 1612 MHz masers surround but are offset from the 1720 and 6035 MHz masers which in turn lie close to a compact 22 GHz continuum source embedded in the optical nebula.

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The evolution of luminosity, colour and the mass-to-luminosity ratio of Galactic open clusters: comparison of discrete vs. continuous IMF models

A.E. Piskunov[1,2,3], *N.V. Kharchenko*[1,3,4], *E. Schilbach*[3], *S. Röser*[3], *R.-D. Scholz*[1] *and H. Zinnecker*[1]

[1]Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D–14482 Potsdam, Germany
[2]Institute of Astronomy of the Russian Acad. Sci., 48 Pyatnitskaya Str., 109017 Moscow, Russia
[3]Astronomisches Rechen-Institut, Mönchhofstraße 12-14, Zentrum für Astronomie der Universität Heidelberg, D–69120 Heidelberg, Germany
[4]Main Astronomical Observatory, 27 Academica Zabolotnogo Str., 03680 Kiev, Ukraine

Context: We found in previous studies that standard Simple Stellar Population (SSP) models are unable to describe or explain the colours of Galactic open clusters both in the visible and in the NIR spectral range. The reason for this disagreement is the continuous nature of the stellar IMF in clusters which is the underlying assumption in the SSP models. In reality, the Galactic open clusters are scarcely populated with the brightest stars responsible for integrated fluxes. *Aims*: In this study, we aim at constructing discrete SSP-models which are able to adequately describe the observed magnitude-, colour-, and mass-to-luminosity-ratio-age relations of open clusters by including a number of rarely considered effects. *Methods*: We construct a numerical SSP-model, with an underlying Salpeter

IMF, valid within an upper $m_{\rm u}$ and lower $m_{\rm l}$ stellar mass range, and with total masses $M_{\rm c} = 10^2 \ldots 10^4$ $M_\odot$ typical of open clusters. We assume that the mass loss from a cluster is provided by mass loss from evolved stars and by the dynamical evaporation of low-mass members due to two-body relaxation. The data for the latter process were scaled to the models from high-resolution N-body calculations. We also investigate how a change of the $m_{\rm l}$-limit influences *magnitudes* and colours of clusters of a given mass and derive a necessary condition for a luminosity and colour flash. *Results*: The discreteness of the IMF leads to bursts in magnitude and colour of model clusters at moments when red supergiants or giants appear and then die. The amplitude of the burst depends on the cluster mass and on the spectral range; it is strongly increased in the NIR compared to optical passbands. In the discrete case variations of the parameter $m_{\rm l}$ are able to substantially change the magnitude-age and M/L-age relations. For the colours, the lowering of $m_{\rm l}$ considerably amplifies the discreteness effect. The influence of dynamical mass loss on colour and magnitude is weak, although it provides a change of the slopes of the considered relations, improving their agreement with observations. For the Galactic open clusters we determined luminosity and tidal mass independent of each other. The derived mass-to-luminosity ratio *shows, on average, an increase with cluster age in the optical*, but gradually declines with age in the NIR. The observed flash statistics can be used to constrain $m_{\rm l}$ in open clusters.

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Photochemistry in the inner layers of clumpy circumstellar envelopes: formation of water in C-rich objects and of C-bearing molecules in O-rich objects

Marcelino Agúndez[1], *José Cernicharo*[2] *and Michel Guélin*[3]

[1]LUTH, Observatoire de Paris-Meudon, 5 Place Jules Janssen, 92190 Meudon, France

[2]Departamento de Astrofísica, Centro de Astrobiología, CSIC-INTA, Ctra. de Torrejón a Ajalvir km 4, Torrejón de Ardoz, 28850 Madrid, Spain

[3]Institut de Radioastronomie Millimétrique, 300 rue de la Piscine, 38406 Saint Martin d'Héres, France

A mechanism based on the penetration of interstellar ultraviolet photons into the inner layers of clumpy circumstellar envelopes around AGB stars is proposed to explain the non-equilibrium chemistry observed in such objects. We show through a simple modelling approach that in circumstellar envelopes with a certain degree of clumpiness or with moderately low mass loss rates (a few 10^{-7} $M_\odot$ yr^{-1}) a photochemistry can take place in the warm and dense inner layers inducing important changes in the chemical composition. In carbon-rich objects water vapor and ammonia would be formed with abundances of 10^{-8}–10^{-6} relative to H_2, while in oxygen-rich envelopes ammonia and carbon-bearing molecules such as HCN and CS would form with abundances of 10^{-9}–10^{-7} relative to H_2. The proposed mechanism would explain the recent observation of warm water vapor in the carbon-rich envelope IRC +10 216 with the *Herschel* Space Observatory, and predict that water vapour should be detectable in other carbon-rich objects.

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White-dwarf kicks and implications for barium stars

Robert G. Izzard[1,2,4], *Tyl Dermine*[1] *and Ross P. Church*[3,4]

[1]Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, Boulevard du Triomphe, B-1050 Brussels, Belgium

[2]Argelander-Institut für Astronomie, University of Bonn, Auf dem Hügel 71, D-53121 Bonn, Germany

[3]Lund Observatory, Box 43, SE-221 00, Lund, Sweden

[4]Centre for Stellar and Planetary Astrophysics, School of Mathematical Sciences, Monash University, VIC 3800, Australia

The formation mechanism of the barium stars is thought to be well understood. Barium-rich material, lost in a stellar wind from a thermally-pulsing asymptotic-giant-branch star in a binary system, is accreted by its companion main-sequence star. Now, many millions of years later, the primary is an unseen white dwarf and the secondary has

itself evolved into a giant which displays absorption lines of barium in its spectrum and is what we call a barium star. A similar wind-accretion mechanism is also thought to form the low-metallicity CH and carbon-enhanced metal-poor stars. Qualitatively the picture seems clear but quantitatively it is decidedly murky: several key outstanding problems remain which challenge our basic understanding of binary-star physics. Barium stars with orbital periods less than about 4,000 days should "according to theory" be in circular orbits because of tidal dissipation, yet they are often observed to be eccentric. Only one barium-star period longer than 10^4 days has been published although such stars are predicted to exist in large numbers. In this paper we attempt to shed light on these problems. First, we consider the impact of kicking the white dwarf at its birth, a notion which is supported by independent evidence from studies of globular clusters. Second, we increase the amount of orbital angular momentum loss during wind mass transfer, which shrinks barium-star binaries to the required period range. We conclude with a discussion of possible physical mechanisms and implications of a kick, such as the break up of wide barium-star binaries and the limits imposed on our models by observations.

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On the evolution of intra-cluster gas within Galactic globular clusters

William Priestley[1,3]*, Maximilian Ruffert*[2] *and Maurizio Salaris*[1]

[1]Astrophysics Research Institute, Liverpool John Moores University, UK
[2]School of Mathematics and Maxwell Institute, University of Edinburgh, UK
[3]National Astronomical Observatory of Japan, Tokyo, Japan

It has been known since the 1950's that the observed gas content of Galactic globular clusters (GCs) is 2–3 orders of magnitude less than the mass lost by stars between Galactic disk crossings. In this work we address the question: What happens to this stellar gas? Using an Eulerian nested grid code, we present 3D simulations to determine how stellar wind material evolves within the GC environment. We expand upon work done in the 70's and move a single-mass King-model GC through the Galactic halo medium, stripping a 10^5 $M_\odot$ GC of its intra-cluster medium but predicting a detectable medium for a 10^6 $M_\odot$ cluster. We find from new multi-mass King model simulations, the first to incorporate empirical mass-loss formulae, that the single-mass King model underestimates the retention of intra-cluster gas in the cluster. Lastly, we present a simple discretised multi-mass GC model, which yields lower levels of intra-cluster medium compared to the continuous single- and multi-mass King models. Our results show that there is still an issue with the predicted intra-cluster gas content of massive GCs. We conclude that by modelling GC systems more accurately, in particular the stellar structure and description of mass loss, we will be able to work towards resolving this issue and begin to fill in some of the gaps in our understanding of the evolution of globular clusters.

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Evolution and nucleosynthesis of extremely metal-poor and metal-free low- and intermediate-mass stars II. s-process nucleosynthesis during the core He flash

S.W. Campbell[1,2,3]*, M. Lugaro*[3] *and A.I. Karakas*[4,3]

[1]Departament de Física i Enginyeria Nuclear, Universitat Politècnica de Catalunya, EUETIB, Carrer Comte d'Urgell 187, E-08036, Barcelona, Spain
[2]Institut de Ciències de l'Espai (ICE–CSIC), Campus UAB, Fac. Ciències, Torre C5 parell 2, E-08193, Bellaterra, Spain
[3]Centre for Stellar and Planetary Astrophysics, Monash University, Clayton, VIC 3800, Australia
[4]Research School of Astronomy and Astrophysics, Australian National University, Canberra, Australia

Models of primordial and hyper-metal-poor stars with masses similar to the Sun experience an ingestion of protons

into the hot core during the core helium flash phase at the end of their red giant branch evolution. This produces a concurrent secondary flash powered by hydrogen burning that gives rise to further nucleosynthesis in the core. We perform post-process nucleosynthesis calculations on a one-dimensional stellar evolution calculation of a star of 1 $M_\odot$ and metallicity [Fe/H] = −6.5 that suffers a proton ingestion episode. Our network includes 320 nuclear species and 2,366 reactions and treats mixing and burning simultaneously. The mixing and burning of protons into the hot convective core leads to the production of ^{13}C, which then burns via the ^{13}C(α,n)^{16}O reaction releasing a large number of free neutrons. During the first two years of neutron production the neutron poison ^{14}N abundance is low, allowing the prodigious production of heavy elements such as strontium, barium, and lead via slow neutron captures (the s process). These nucleosynthetic products are later mixed to the stellar surface and ejected via stellar winds. We compare our results with observations of the hyper-metal-poor halo star HE 1327−2326, which shows a strong Sr overabundance. Our model provides the possibility of self-consistently explaining the Sr overabundance in HE 1327−2326 together with its C, N, and O overabundances (all within a factor of ~ 4) if the material were heavily diluted, for example, via mass transfer in a wide binary system. The model produces at least 18 times too much Ba than observed, but this may be within the large modelling uncertainties. In this scenario, binary systems of low mass must have formed in the early Universe. If true then this puts constraints on the primordial initial mass function.

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An optical–infrared study of the young multipolar planetary nebula NGC 6644

Chih-Hao Hsia[1], *Sun Kwok*[1], *Yong Zhang*[1], *Nico Koning*[2] *and Kevin Volk*[3]

[1]Department of Physics, University of Hong Kong, Pokfulam Road, Hong Kong, China
[2]Department of Physics & Astronomy, University of Calgary, Calgary, Alberta, Canada
[3]Space Telescope Science Institute, Baltimore, MD 21218, USA

High-resolution *HST* imaging of the compact planetary nebula NGC 6644 has revealed two pairs of bipolar lobes and a central ring lying close to the plane of the sky. From mid-infrared imaging obtained with the *Gemini* Telescope, we have found a dust torus which is oriented nearly perpendicular to one pair of the lobes. We suggest that NGC 6644 is a multipolar nebula and have constructed a 3-D model which allows the visualization of the object from different lines of sight. These results suggest that NGC 6644 may have similar intrinsic structures as other multipolar nebulae and the phenomenon of multipolar nebulosity may be more common than previously believed.

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Circumstellar dust shells around long-period variables. X. Dynamics of envelopes around standard luminous, C-rich AGB stars

C. Dreyer[1], *M. Hegamm*[1] *and E. Sedlmayr*[1]

[1]Technische Universität Berlin, Zentrum für Astronomie und Astrophysik (ZAA), Germany

Long-period variables (LPVs) and Miras are highly evolved stars at the upper region of the asymptotic giant branch. They exhibit a pronounced variability of their luminosity with a more or less well defined period and suffer large mass loss in the form of stellar winds. Due to this extensive mass loss, LPVs and Miras are surrounded by extended circumstellar dust shells (CDSs). The dynamics of these envelopes is the result of a complex interplay via an external excitation by the pulsating central star, dust formation and radiative transfer.
Our study is aimed at an understanding of the dynamics of CDSs around carbon-rich, standard luminous LPVs and Miras. These shells often show multiperiodicity with secondary periods as high as a few 10^4 d superimposed on a

main period which is in the range of approximately 10^2–10^3 d. Such secondary periods may be caused at least in part by the presence of dust.
We consider an excitation of the CDSs by either a harmonic force, provided by the oscillation of the central star, or by a stochastic force with a continuous power spectrum. The resulting numerically computed dynamical behaviour of the shell is analysed with the help of Fourier analysis and stroboscopic maps.
CDSs may be described as multioscillatory systems which are driven by the pulsating stars. A set of normal modes can be identified. The obtained periods of these modes are of the order of some 10^3 d, which is a characteristic timescale for dust nucleation, growth and elemental enrichment in the dust formation zone. Depending on the oscillation period and strength of the central star, the envelope reacts periodically, multi-periodically or irregularly.

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Observational evidence for the shrinking of bright maser spots

A.M.S. Richards[1], *M. Elitzur*[2] *and J.A. Yates*[3]

[1]JBCA, School Physics & Astronomy, Manchester, UK
[2]University of Kentucky, Dept. Physics & Astronomy, USA
[3]Dept. Physics & Astronomy, UCL, UK

The nature of maser emission means that the apparent angular size of an individual maser spot is determined by the amplification process as well as by the instrinsic size of the emitting cloud. Highly sensitive MERLIN radio interferometry images spatially and spectrally resolve water maser clouds around evolved stars. We measured the properties of clouds around the red supergiant S Per and the AGB stars IK Tau, RT Vir, U Her and U Ori, to test maser beaming theory. Spherical clouds are expected to produce an inverse relationship between maser intensity and apparent size, which would not be seen from cylindrical or slab-like regions. We analysed the maser properties, in order to estimate the saturation state, and investigated the variation of observed spot size with intensity and across the spectral line profiles. Circumstellar masers emanate from discrete clouds from about one to 20 AU in diameter depending on the star. Most of the maser features have negative excitation temperatures close to zero and modest optical depths, showing that they are mainly unsaturated. Around S Per and (at most epochs) RT Vir and IK Tau, the maser component size shrinks with increasing intensity. In contrast, the masers around U Ori and U Her tend to increase in size, with a larger scatter. The water masers from S Per, RT Vir and IK Tau are mainly beamed into spots with an observed angular size much smaller than the emitting clouds and smallest of all at the line peaks. This suggests that the masers are amplification-bounded, emanating from approximately spherical clouds. Many of the masers around U Her and U Ori have apparent sizes which are more similar to the emitting clouds and have less or no dependence on intensity, suggesting that these masers are matter-bounded. This is consistent with an origin in flattened clouds and these two stars have shown other behaviour indicating the presence of shocks.

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A model of Mira's cometary head/tail entering the Local Bubble

A. Esquivel[1], *A. C. Raga*[1], *J. Cantó*[2], *A. Rodríguez-González*[1], *D. López-Cámara*[1], *P. F. Velázquez*[1] *and F. De Colle*[3]

[1]ICN-UNAM, México
[2]IA-UNAM, México
[3]UCSC, USA

We model the cometary structure around Mira as the interaction of an AGB wind from Mira A, and a streaming

environment. Our simulations introduce the following new element: we assume that after 200 kyr of evolution in a dense environment Mira entered the Local Bubble (low density coronal gas). As Mira enters the bubble, the head of the comet expands quite rapidly, while the tail remains well collimated for a 100 kyr timescale. The result is a broad-head/narrow-tail structure that resembles the observed morphology of Mira's comet. The simulations were carried out with our new adaptive grid code WALICXE, which is described in detail.

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The shapes of light curves of Mira-type variables

T. Lebzelter[1]

[1]Department of Astronomy, University of Vienna, Austria

Using a sample of 454 mira light curves from the ASAS survey we study the shape of the light variations in this kind of variable stars. Opposite to earlier studies, we choose a general approach to identify any deviation from a sinusoidal light change. We find that about 30% of the studied light curves show a significant deviation from the sinusoidal reference shape. Among these stars two characteristic light curve shapes of comparable frequency could be identified. Some hint for a connection between atmospheric chemistry and light curve shape was found, but beside that no or only very weak relations between light curve shape and other stellar parameters seem to exist.

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Mn, Cu, and Zn abundances in barium stars and their correlations with neutron capture elements

Dinah Moreira Allen[1,2] *and Gustavo F. Porto de Mello*[1,2]

[1]Universidade de São Paulo, Instituto de Astronomia, Geofísica e Ciéncias Atmosféricas, Brasil
[2]Universidade Federal do Rio de Janeiro, Observatório do Valongo, Brasil

Barium stars are optimal sites for studying the correlations between the neutron-capture elements and other species that may be depleted or enhanced, because they act as neutron seeds or poisons during the operation of the *s*-process. These data are necessary to help constrain the modeling of the neutron-capture paths and explain the *s*-process abundance curve of the solar system. Chemical abundances for a large number of barium stars with different degrees of *s*-process excesses, masses, metallicities, and evolutionary states are a crucial step towards this goal. We present abundances of Mn, Cu, Zn, and various light and heavy elements for a sample of barium and normal giant stars, and present correlations between abundances contributed to different degrees by the weak-*s*, main-*s*, and *r*-processes of neutron capture, between Fe-peak elements and heavy elements. Data from the literature are also considered in order to better study the abundance pattern of peculiar stars. The stellar spectra were observed with FEROS/ESO. The stellar atmospheric parameters of the eight barium giant stars and six normal giants that we analyzed lie in the range $4300 < T_{\rm eff}/{\rm K} < 5300$, $-0.7 < {\rm [Fe/H]} \leq 0.12$ and $1.5 \leq \log g < 2.9$. Carbon and nitrogen abundances were derived by spectral synthesis of the molecular bands of C_2, CH, and CN. For all other elements we used the atomic lines to perform the spectral synthesis. A very large scatter was found mainly for the Mn abundances when data from the literature were considered. We found that [Zn/Fe] correlates well with the heavy element excesses, its abundance clearly increasing as the heavy element excesses increase, a trend not shown by the [Cu/Fe] and [Mn/Fe] ratios. Also, the ratios involving Mn, Cu, and Zn and heavy elements usually show an increasing trend toward higher metallicities. Our results suggest that a larger fraction of the Zn synthesis than of Cu is owed to massive stars, and that the contribution of the main-*s* process to the synthesis of both elements is small. We also conclude that Mn is mostly synthesized by SNe Ia, and that a non-negligible fraction of the synthesis of Mn, Cu, and Zn is owed to the

weak s-process.

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The mass-loss rates of red supergiants and the de Jager prescription

N. Mauron[1] *and E. Josselin*[1]

[1]GRAAL, CNRS and U. of Montpellier, Place Bataillon, 34095 Montpellier, France

Mass loss of red supergiants (RSG) is important for the evolution of massive stars, but is not fully explained. Several empirical prescriptions have been proposed, trying to express the mass-loss rate as a function of fundamental stellar parameters (mass, luminosity, effective temperature). Our goal is to test whether the de Jager et al. (1988) prescription, used in some stellar evolution models, is still valid in view of more recent mass-loss determinations. By considering 40 Galactic RSGs presenting an infrared excess and an IRAS 60-μm flux larger than 2 Jy, and assuming a gas-to-dust mass ratio of 200, it is found that the de Jager rate agrees within a factor 4 with most mass-loss estimates based on the 60-μm signal. It is also in agreement with 6 of the only 8 Galactic RSGs for which mass-loss rates can be measured more directly through observations of the circumstellar gas. The two objects that do not follow the de Jager prescription (by an order of magnitude) are μ Cep and NML Cyg. We have also considered the RSGs of the Magellanic Clouds. Thanks to the works of Groenewegen et al. (2009) and Bonanos et al. (2010), we find that the RSGs of the Small Magellanic Cloud have mass-loss rates consistent with the de Jager rate scaled by $(Z/\mathrm{Z}_\odot)^\alpha$, where Z is the metallicity and α is 0.7. The situation is less clear for the RSGs of the Large Magellanic Cloud. In particular, for $L > 1.6 \times 10^5$ $\mathrm{L}_\odot$, one finds numerous RSGs (except WOH G64) having mass-loss rates significantly smaller than the de Jager rate and indicating that the mass-loss rate would no longer increase with L. Before this odd situation is confirmed through further analysis of LMC RSGs, we suggest to keep the de Jager prescription unchanged at solar metallicity in the stellar evolutionary models and to apply a $(Z/\mathrm{Z}_\odot)^{0.7}$ dependence.

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HE 1015−2050: Discovery of a hydrogen-deficient carbon star at high Galactic latitude

Aruna Goswami[1]*, Drisya Karinkuzhi*[1] *and N.S. Shantikumar*[1]

[1]Indian Institute of Astrophysics, Bangalore, India

Medium resolution spectral analysis of candidate Faint High Latitude Carbon (FHLC) stars from Hamburg/ESO survey has given us the potential to discover objects of rare types. Two primary spectral characteristics of R Coronae Borealis (RCB) stars are hydrogen deficiency and weaker CN bands relative to C_2 bands. They are also characterized by their characteristic location in the J–H, H–K plane with respect to cool carbon stars. From a spectral analysis of a sample of 243 candidate FHLC stars, we have discovered a hydrogen-deficient carbon (HdC) star HE 1015−2050, at high Galactic latitude. A differential analysis of its spectrum with that of the spectrum of U Aquarii (U Aqr), a well-known cool HdC star of RCB type, provides sufficient evidence to put this object in a group same as that of U Aqr. Further, it is shown that HE 1015−2050 does not belong to any of the C-star groups CH, C-R, C-N or C-J. Cool RCB stars form a group of relatively rare astrophysical objects; approximately 51 are known in the Galaxy and some 18 in the Large Magellanic Clouds (LMC) and five in Small Magellanic Cloud (SMC). The present discovery adds a new member to this rare group. Although its spectral characteristics and its location in the J–H vs. H–K plane places HE 1015−2050 in the same group to which U Aqr belongs, extended photometric observations would be useful to learn if there is any sudden decline in brightness, this being a characteristic property of HdC stars of RCB type.

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Central stars of Planetary Nebulae: New spectral classifications and catalogue

Walter A. Weidmann[1] *and Roberto Gamen*[2]

[1]Observatorio Astronómico Córdoba, Universidad Nacional de Córdoba, Argentina

[2]Instituto de Astrofísica de La Plata, CCT La Plata – CONICET, Universidad Nacional de La Plata, Argentina

Context: There are more than 3000 true and probable known Galactic Planetary Nebulae (PNe), but only for 13% of them there is central star spectroscopic information available. *Aims:* To contribute to the knowledge of central stars of planetary nebulae and star evolution. *Methods:* We undertook a spectroscopic survey of central stars of PNe in low resolution and compiled a large list of central stars for which information was dispersed in the literature. *Results:* We complete a catalogue of 492 true and probable CSPN and we provide a preliminary spectral classification for 45 central star of PNe, This made it possible to update the proportion of CSPN with atmosphere poor in hydrogen with regard to the whole in at least 30% and contribute with statistical information that allow to infer the origin of H-poor stars.

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Conference Papers

Relaxing the small particle approximation for dust-grain opacities in carbon-star wind models

Lars Mattsson[1,2] *and Susanne Höfner*[1]

[1]Dept. of Astronomy & Space Physics, Uppsala University, Sweden

[2]Dark Cosmology Centre, NBI, University of Copenhegen, Denmark

We have computed wind models with time-dependent dust formation and grain-size dependent opacities, where (1) the problem is simplified by assuming a fixed dust-grain size, and where (2) the radiation pressure efficiency is approximated using grain sizes based on various means of the actual grain size distribution. It is shown that in critical cases, the effect of grain sizes can be significant. For well-developed winds, however, the effects on the mass-loss rate and the wind speed are small.

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Available from arXiv:1010.0117

Symmetric vs. asymmetric planetary nebulae: morphology and chemical abundances

W.J. Maciel[1] *and R.D.D. Costa*[1]

[1]Astronomy Department, University of São Paulo, Brasil

We analyse a large sample of galactic planetary nebulae based on their chemical composition and morphology. A recent morphological classification system is adopted, and several elements are considered, namely He, N, O, S, Ar, Ne, and C in order to investigate the correlations involving these elements and the different PN types. Special emphasis is given to the differences between symmetric (round or elliptical) nebulae and those that present some degree of asymmetry (bipolars or bipolar core objects). The results are compared with previous findings both for PN in the Galaxy and in

the Magellanic Clouds.

Oral contribution, published in "Asymmetrical Planetary Nebulae V", eds. A.A. Zijlstra et al., Ebrary online publication
Available from arXiv:1009.5634
and from http://www.astro.iag.usp.br/∼maciel

Two populations of companions around white dwarfs: The effect of tides and tidal engulfment

J. Nordhaus[1]

[1]Dept. of Astrophysical Sciences, Princeton University, Princeton, NJ 08544, U.S.A.

During post-main-sequence evolution, radial expansion of the primary star, accompanied by intense winds, can significantly alter the binary orbit via tidal dissipation and mass loss. The fate of a given binary system is determined by the initial masses of the primary and companion, the initial orbit (taken to be circular), the Reimers mass-loss parameter, and the tidal prescription employed. For a range of these parameters, we determine whether the orbit expands due to mass loss or decays due to tidal torques. Where a common envelope (CE) phase ensues, we estimate the final orbital separation based on the energy required to unbind the envelope. These calculations predict period gaps for planetary and brown dwarf companions to white dwarfs. In particular, the lower end of the gap is the longest period at which companions survive their CE phase while the upper end of the gap is the shortest period at which a CE phase is avoided. For binary systems with 1 $M_\odot$ progenitors, we predict no Jupiter-mass companions with periods $\lesssim$270 days. For binary systems consisting of a 1 $M_\odot$ progenitor with a 10 Jupiter-mass companion, we predict a close, post-CE population with periods $\lesssim$0.1 days and a far population with periods $\gtrsim$380 days. These results are consistent with the detection of a ∼50 M_J brown dwarf in a ∼0.08 day orbit around the white dwarf WD 0137−349 and the tentative detection of a ∼2 M_J planet in a ∼4 year orbit around the white dwarf GD 66.

Oral contribution, published in "Asymmetric Planetary Nebulae V"; eds. A.A. Zijlstra, I. McDonald & E. Lagadec
Available from arXiv:1007.4799

Chemical abundances in metal-poor giants: limitations imposed by the use of classical 1D stellar atmosphere models

V. Dobrovolskas[1]*, A. Kučinskas*[2,1]*, H.-G. Ludwig*[3]*, E. Caffau*[3,4]*, J. Klevas*[2] *and D. Prakapavičius*[2]

[1]Vilnius University Astronomical Observatory, Lithuania

[2]Institute of Theoretical Physics and Astronomy of Vilnius University, Lithuania

[3]Landessternwarte Königstuhl, Heidelberg, Germany

[4]GEPI, Observatoire de Paris, CNRS, Université Paris Diderot, France

In this work we have used 3D hydrodynamical (CO^{5}BOLD) and 1D hydrostatic (LHD) stellar atmosphere models to study the importance of convection and horizontal temperature inhomogeneities in stellar abundance work related to late-type giants. We have found that for a number of key elements, such as Fe, Mg, Ca, Ti, Mn, Ni, Zn, Ba, Eu, differences in abundances predicted by 3D and 1D models are typically minor (< 0.1 dex) at solar metallicity. However, at [M/H] $= -3$ they become increasingly large and reach to $-0.6 \ldots -1.6$ dex. In case of neutral atoms and fixed metallicity, the largest abundance differences were obtained for the spectral lines with lowest excitation potential, while for ionized species the largest 3D–1D abundance differences were found for lines of highest excitation potential. We have found that large abundance differences at low metallicity are caused by large horizontal temperature fluctuations and lower mean temperature in the outer layers of the 3D hydrodynamical model compared with its 1D counterpart.

Poster contribution, published in "Proceedings of Science"
Available from arXiv:1010.2507

Wolf–Rayet central stars of planetary nebulae: their evolution and properties

Kyle DePew[1], *David J. Frew*[1], *Quentin A. Parker*[1,2] *and Orsola De Marco*[1]

[1]Department of Physics & Astronomy, Macquarie University, Sydney, NSW 2109, Australia

[2]Australian Astronomical Observatory, Epping, NSW 1719, Australia

Over the past decade, the number of planetary nebula central stars (CSPN) known to exhibit the Wolf–Rayet (WR) phenomenon has grown substantially. Many of these discoveries have resulted from the Macquarie/AAO/Strasbourg Hα (MASH) PN Survey. While WR CSPN constitute a relatively rare stellar type ($\gtrsim$10% of CS), there are indications that the proportion of PNe harbouring them may increase as spectroscopy of more central stars is carried out. In addition, with new and better distances from the Hα surface brightness-radius relationship of Frew (2008), we can attempt a dynamical age sequence which may provide insight into the evolution of these stars.

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Available from arXiv:1010.1063

3D hydrodynamical CO^{5}BOLD model atmospheres of late-type giants: chemical abundances from molecular lines

A. Ivanauskas[1,2], *A. Kučinskas*[2,1], *H.-G. Ludwig*[3] *and E. Caffau*[3]

[1]Vilnius University Astronomical Observatory, M.K. Čiurlionio 29, Vilnius LT-10222, Lithuania

[2]Vilnius University Institute of Theoretical Physics and Astronomy, A. Goštauto 12, Vilnius, Lithuania

[3]ZAH Landessternwarte Königstuhl, D-69117, Heidelberg, Germany

We investigate the influence of convection on the formation of molecular spectral lines in the atmospheres of late-type giants. For this purpose we use the 3D hydrodynamical CO^{5}BOLD and classical 1D LHD stellar atmosphere codes and synthesize a number of fictitious lines belonging to a number of astrophysically relevant molecules, C_2, CH, CN, CO, NH, OH. We find that differences between the abundances obtained from molecular lines using the 3D and 1D model atmospheres are generally small at [M/H] = 0.0, but they quickly increase at sub-solar metallicities where for certain molecules they may reach −2.0 dex. The 3D–1D abundance differences show a significant dependence on the spectral line parameters, such as wavelength and excitation potential. Our comparison, therefore, reveals a complex interplay between the spectral line formation and convection that can not be properly accounted for with the classical 1D model atmospheres.

Poster contribution, published in "Proceedings of Science"
Available from arXiv:1010.1722

Modelling H_2 infrared emission of the Helix nebula cometary knots

I. Aleman[1,2], *A.A. Zijlstra*[1], *M. Matsuura*[3,4], *R. Gruenwald*[2] *and R. Kimura*[2]

[1]Jodrell Bank Centre for Astrophysics, The Alan Turing Building, School of Physics and Astronomy, The University of Manchester, Oxford Rd., Manchester, M13 9PL, UK

[2]IAG-USP, Universidade de São Paulo, Cidade Universitária, Rua do Matão 1226, São Paulo, SP, 05508-090, Brazil

[3]UCL-Institute of Origins, Astrophysics Group, Department of Physics and Astronomy, University College London, Gower Street, London, WC1E 6BT, UK

[4]UCL-Institute of Origins, Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Dorking, Surrey, RH5 6NT, UK

In the present work, we use a photoionisation code to study the H_2 emission of the Helix nebula (NGC 7293) cometary knots, particularly that produced in the interface H^+/H^0 of the knot, where a significant fraction of the H_2 1–0 S(1)

emission seems to be produced. Our results show that the production of molecular hydrogen in such region may explain several characteristics of the observed emission, particularly the high excitation temperature of the H_2 infrared lines.

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Available from arXiv:1010.4049

Review Papers

Drawing parallels between planetaries and novae

A. Evans[1]

[1]Astrophysics Group, Keele University, UK

We present a brief overview of classical nova eruptions. There is a number of similarites between the evolution and environments of novae and planetaries, and observing and understanding the evolution of nova eruptions may give clues to the formation and evolution of planetary nebulae.

Published in "Asymmetric Planetary Nebulae V"

Radioactivities in low- and intermediate-mass stars

Maria Lugaro[1] *and Alessandro Chieffi*[2]

[1]Monash University, Victoria 3800, Australia
[2]I.N.A.F., 00133 Roma, Italy

Energy in stars is provided by nuclear reactions, which, in many cases, produce radioactive nuclei. When stable nuclei are irradiated by a flux of protons or neutrons, capture reactions push stable matter out of stability into the regime of unstable species. The ongoing production of radioactive nuclei in the deep interior of the Sun via proton-capture reactions is recorded by neutrinos emitted during radioactive decay and detected on Earth. Radioactive nuclei that have relatively long half lives may also be detected in stars via spectroscopic observations and in stardust recovered from primitive meteorites via laboratory analysis. The vast majority of these stardust grains originated from Asymptotic Giant Branch (AGB) stars. This is the final phase in the evolution of stars initially less massive than ~ 10 $M_\odot$, during which nuclear energy is produced by alternate hydrogen and helium burning in shells above the core. The long-lived radioactive nucleus ^{26}Al is produced in massive AGB stars ($> 4{:}5$ $M_\odot$), where the base of the convective envelope reaches high temperatures. Several other long-lived radioactive nuclei, including ^{60}Fe, ^{87}Rb, and ^{99}Tc, are produced in AGB stars when matter is exposed to a significant neutron flux leading to the synthesis of elements heavier than iron. Here, neutron captures occur on a timescale that is typically slower than beta-decay timescales, resulting slow neutron captures (the s-process). However, when radioactive nuclei with half lives greater than a few days are produced they may either decay or capture a neutron, thus branching up the path of neutron captures and defining the final s-process abundance distribution. This nucleosynthesis in AGB stars could produce some long-living radioactive nuclei in relative abundances that resemble those observed in the early solar system.

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Available from arXiv:1010.1304

Observations of dusty torii and compact disks around evolved stars: the high spatial resolution IR view

Olivier Chesneau[1]

[1]Observatoire de la Côte d'Azur, France

The recent high angular resolution observations have shown that the transition between a globally symmetrical giant and a source surrounded by a spatially complex environment occurs relatively early, as soon as the external layers of the stars are not tightly bound to the core of the star anymore. In this review, the emphasis will be put on the delineating the differences between the torus and disk classification through the presentation of many examples of near-IR and mid-IR high angular resolution observations. These examples cover the disks discovered in the core of some bipolar nebulae, post-AGB disks, the dusty environment around born-again stars and recent novae, and also the disks encountered around more massive evolved sources. We discuss the broad range of circumstances and time scales for which bipolar nebulae with disks are observed.

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The formation of Polycyclic Aromatic Hydrocarbons in evolved circumstellar environments

Isabelle Cherchneff[1]

[1]Basel university, Switzerland

The formation of Polycyclic Aromatic Hydrocarbons in the circumstellar outflows of evolved stars is reviewed, with an emphasis on carbon stars on the Asymptotic Giant Branch. Evidence for PAHs present in their winds is provided by meteoritic studies and recent observations of the Unidentified Infrared bands. We detail the chemical processes leading to the closure of the first aromatic ring as well as the growth mechanisms leading to amorphous carbon grains. Existing studies on PAH formation in evolved stellar envelopes are reviewed and new results for the modelling of the inner wind of the archetype carbon star IRC +10 216 are presented. Benzene, C_6H_6, forms close to the star, as well as water, H_2O, as a result of non-equilibrium chemistry induced by the periodic passage of shocks. The growth process of aromatic rings may thus resemble that active in sooting flames due to the presence of radicals like hydroxyl, OH. Finally, we discuss possible formation processes for PAHs and aromatic compounds in the hydrogen-rich R CrB star, V854 Cen, and their implication for the carriers of the Red Emission and the Diffuse Interstellar Bands.

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Job Adverts

Basel university, Switzerland
PhD scholarship

Applications are invited for a PhD scholarship in Astrophysics with Dr. I. Cherchneff at the Physics Department, the University of Basel. The position will focus on studying the dust formation processes in Red Giant and Supergiant stars at various metallicities to assess mass loss from stars in our local and far universe. Such a study is multidisciplinary (physics, chemistry and astronomy) and will be theoretical but exposure to observations will be provided through various international collaborations. The astrochemistry group in Basel is small but has an excellent international reputation in the study of dust in evolved stellar environments.

Eligible candidates must have:
An undergraduate and MSc degree in Physics or Astrophysics with excellent grades,
Programming skills,
Good communication skills (both oral and written) in English.

Please visit http://phys-merger.physik.unibas.ch/users/group/ for further information about the group. The scholarship duration is 3 years with a starting date as soon as possible. Interested candidates should send a letter of motivation, a CV, a list of grades for their MSc, a short statement of past research experience, and two references to Dr. Isabelle Cherchneff (isabelle.cherchneff@unibas.ch) prior to 28.11.2010

Macquarie University (Australia) HERMES Super Science Fellowships

The Department of Physics and Astronomy at Macquarie University seeks to appoint THREE (3) highly-motivated Super Science Fellows to carry out research related to the HERMES project. HERMES is an innovative new multi-object high-resolution spectrograph being built for the Anglo-Australian Telescope, specifically designed for conducting large stellar surveys, which will observe more than 1 million stars in the Galactic disk and Magellanic Clouds in order to test current theories of galaxy formation and stellar astrophysics (see http://www.aao.gov.au/HERMES). The Super Science Fellows will work with Dr. Daniel Zucker and the other members of the HERMES Super Science team (Freeman, Bland-Hawthorn, Lattanzio, De Silva), as well as with collaborators at the Australian Astronomical Observatory, Australian National University, the University of Sydney, Monash University and other universities and institutes around the world. The Fellows will lay the groundwork for, and exploit the data flowing from, the massive Galactic Archaeology and Magellanic Cloud surveys planned for HERMES. These surveys will obtain detailed elemental abundances and precision radial velocities for over a million stars, yielding a dataset uniquely suited to a wide range of astrophysical research, and directly complementary to major projects such as ESA's Gaia mission. Macquarie University, a dynamic research and teaching institution, is located on a park-like campus in suburban Sydney, Australia, in close proximity to the headquarters of the Australian Astronomical Observatory (AAO) and the Australia Telescope National Facility (ATNF). The Astronomy and Astrophysics group at Macquarie has undergone a rapid expansion in the past 5 years, now comprising over 35 faculty, postdoctoral researchers and students, making it one of the largest and most active astronomy groups within Australia. In order to enhance collaboration between the participating institutions, the Fellows will have the opportunity to visit the AAO, ANU, Monash, and the University of Sydney for up to a year.

The Fellowships are full-time, fixed-term 3 year positions, available from 1 July 2011, with research funds of AUD$25,000 per year per fellow attached to the project. There are also two PhD scholarships associated with the project, and Fellows will have the opportunity to co-supervise these students. Applicants should have a PhD in a relevant field (e.g., astronomy or physics), usually awarded not more than 3 years before the nominal start date for the Fellowships (1 July 2011); a demonstrated track record of ongoing research and publication, with an emphasis on observational or theoretical astronomy; the ability to carry out independent research and the ability or capacity to develop research collaborations; the ability or capacity to attract and supervise research students, and to obtain competitive funding; the ability to work independently and as a member of a team; and excellent written, verbal and interpersonal communication skills.

Applications must be submitted through the Macquarie University jobs website: http://www.mq.edu.au/jobs , Reference No. 00V8B.

Candidates should include a CV, list of publications, contact details for three referees, and a one to two page statement about their research interests and how these would contribute to the HERMES project. Applications must be received by 15 December 2010.

The positions have an annual salary package from AUD$91,916 per annum, including (Level B) base salary from AUD$77,670 to AUD$92,103, plus 17% employer's superannuation contribution and annual leave loading. Relocation assistance will be provided in accordance with the Macquarie University Relocation Guidelines.

See also http://www.aao.gov.au/HERMES (HERMES project) http://www.mq.edu.au/jobs (HERMES Super Science Fellowships)

Announcements

ALMA Community Day and Proposal Preparation Workshop 14–16 December 2010

The first call for ALMA Early Science is expected to be in early 2011. The UK ALMA Regional Centre is holding an ALMA Community Day on 14 December 2010. Leonardo Testi and Robert Laing (European ALMA scientists) will give an update on ALMA status and Paola Caselli, Derek Ward-Thompson, Jane Greaves, Elias Brinks and Matt Jarvis will kick off discussions on Galactic and extra-galactic science. This is followed on 15 December by a workshop on proposal preparation and simulations, to prepare for early science. On 15–16 December there will be space for break-out collaborations to plan specific projects with expert advice at hand. There will also be a workshop on evolved stars on 16 December.

See also http://www.alma.ac.uk/events/preparing-for-early-science

AGB discussion meeting on ALMA early science proposals: December 16

A one-day discussion meeting will be held in Manchester on December 16, to prepare for ALMA early science proposals, and to start to define collaborations for the various proposals. The ALMA call for early science proposals is expected in early 2011.

Topics covered are: AGB stars; post-AGB stars; Planetary and proto-planetary nebulae; Red supergiants; Disks around evolved stars; Evolved binary systems (e.g. symbiotic stars).

The AGB discussion meeting will be held in conjunction with, but is independent of, the UK ALMA Community Day and Early Science Proposal Planning workshop on December 14–15. You are welcome to attend all events, or come to the AGB meeting alone.

More information is available from the website, or contact Albert Zijlstra at a.zijlstra@manchester.ac.uk

See also http://iapetus.jb.man.ac.uk/Meetings/AGB_ALMA.html