THE AGB NEWSLETTER

An electronic publication dedicated to Asymptotic Giant Branch stars and related phenomena

No. 110 — 1 July 2006

http://www.astro.keele.ac.uk/AGBnews

Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present the 110$^{\rm th}$ issue of the AGB Newsletter, featuring an abundant and rich variety of items. As expected, the Spitzer Space Telescope has started to produce very interesting results on AGB stars, including the intriguing detection of circum- and interstellar dust within the extremely metal-poor globular cluster M 15 (Martha Boyer et al.). Meanwhile, the APEX results are wetting our appetite for when ALMA becomes reality.

Congratulations to Roni Waldman with his PhD thesis on the possibility of helium stars exploding as Supernovae of type I. We also draw your attention to two Research Astronomer job openings at Armagh Observatory, Northern Ireland.

The next issue will be distributed on the 1$^{\rm st}$ of August; the deadline for contributions is the 31$^{\rm st}$ of July.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

AGB stars can form dust even at metallicities less than 1 per cent solar.

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 Diffuse Interstellar Bands: A Major Problem in Astronomical Spectroscopy

Peter J Sarre [1]

[1]School of Chemistry, The University of Nottingham, University Park, Nottingham, United Kingdom NG7 2RD

A critical review of the very long-standing problem of the diffuse interstellar bands is presented with emphasis on spectroscopic aspects of observational, modelling and laboratory-based research. Some research themes and ideas that could be explored theoretically and experimentally are discussed. The article is based on the Journal of Molecular Spectroscopy Review Lecture presented at the 60$^{\rm th}$ Ohio State University International Symposium on Molecular Spectroscopy, June 2005.

Accepted for publication in Journal of Molecular Spectroscopy

VZ Velorum: 116 years of a Mira star

L.L. Kiss[1]

[1]University of Sydney, Australia

Using the Harvard College Observatory Photographic Plate Collection and recent CCD observations by the ASAS project we have reconstructed the light variations of the southern pulsating red giant star VZ Velorum between 1890 and early 2006. Contrary to an early report on its low-amplitude semiregular nature, we found a relatively stable Mira-like light curve with a mean period of 318 days and amplitude up to 7 magnitudes. The latest observations show evidence for a slightly shorter period (312 days). However, the difference does not exceed the intrinsic period jitter often seen in Mira type variables.

Accepted for publication in Journal of the AAVSO
Available from astro-ph/0606018

Hot Flashers and He Dwarfs in Galactic Globulars

M. Castellani[1], *V. Castellani*[1] *and P.G. Prada Moroni*[2,3]

[1]INAF - Osservatorio Astronomico di Roma (Italy)
[2]Dipartimento di Fisica, Università di Pisa (Italy)
[3]INFN, Sezione di Pisa (Italy)

We revisit the evolutionary scenario for Hot Flasher low-mass structures, where mass loss delays the He flash till the initial phases of their White Dwarf cooling sequence. Our aim has been to test the theoretical results vis-a-vis different assumptions about the efficiency of mass loss. To this purpose, we present evolutionary models covering a fine grid of masses, as obtained assuming a single episode of mass loss in a Red Giant model of 0.86 $M_\odot$ with $Z = 0.0015$. We find a reasonable agreement with previous evolutionary investigations, showing that for the given metallicity late Hot Flashers are predicted to cover the mass range $M = 0.4975$ to $M = 0.4845$ $M_\odot$, all models igniting the He-flash with a mass of the H-rich envelope as given by about $M_{\rm e} = 0.00050$. The ignition mechanism is discussed in some details, showing the occurrence of a bifurcation in the evolutionary history of stellar structures at the lower mass limit for He ignition. Below such a critical mass, the structures miss the He ignition, cooling down as a Hot Flasher-Manqué He White Dwarfs We predict that these structures will cool down, reaching the luminosity $\log(L/L_\odot) = -1$ in a time at

the least five times longer than the corresponding cooling time of a normal CO White Dwarf. On very general grounds, one expects that old stellar clusters with a sizeable population of Hot Flasher should likely produce at least a similar amount of slow-cooling He White Dwarfs. According to this result, in a cluster where 20% of Red Giants escape the He burning phase, one expects roughly twice as White Dwarfs than in a normal cluster where all Red Giants undergo their He flash.

Accepted for publication in A&A main journal
Available from astro-ph/0606026

Mass-loss properties of S-stars on the AGB

S. Ramstedt[1], *F. L. Schöier*[1], *H. Olofsson*[1,2] *and A. A. Lundgren*[3]

[1]Stockholm Observatory, AlbaNova University Center, SE-10691 Stockholm, Sweden

[2]Onsala Space Observatory, SE-43992 Onsala, Sweden

[3]European Southern Observatory, Casilla 19001, Santiago 19, Chile

We have used a detailed non-LTE radiative transfer code to model new APEX CO($J = 3 \rightarrow 2$) data, and existing CO radio line data, on a sample of 40 AGB S-stars. The derived mass-loss-rate distribution has a median value of $2 \times 10^{-7}\,\mathrm{M_\odot\,yr^{-1}}$, and resembles values obtained for similar samples of M-stars and carbon stars. Possibly, there is a scarcity of high-mass-loss-rate ($\geq 10^{-5}\,\mathrm{M_\odot\,yr^{-1}}$) S-stars. The distribution of envelope gas expansion velocities is similar to that of the M-stars, the median is 7.5 $\mathrm{km\,s^{-1}}$, while the carbon stars, in general, have higher gas expansion velocities. The mass-loss rate correlates well with the gas expansion velocity, in accordance with results for M-stars and carbon stars.

Accepted for publication in A&A APEX special issue
Available from astro-ph/0605664

alpha-element enhanced opacity tables and low-mass metal-rich stellar models

A. Weiss[1], *M. Salaris*[1,2], *J.W. Ferguson*[1,3] *and D.R. Alexander*[3]

[1]MPA Garching, Germany

[2]JMU Liverpool, UK

[3]Wichita State University, USA

We investigate the influence of both a new generation of low-temperature opacities and of various amounts of alpha-element enhancements on stellar evolution models. New stellar models with two different alpha-element mixtures and two sets of appropriate opacity tables are computed and compared. The influence of the different mixtures as well as that of the improved generation of opacity tables is investigated. It is found that around solar metallicity the new opacity tables have a drastic influence on stellar temperatures, which is mainly an effect of the new low-temperature tables, and not of variations in alpha-element enhancement factors. The latter, however, influence stellar lifetimes via systematic opacity effects at core temperatures. We trace the reason for the low-temperature table changes to errors in the old tables. We conclude that variations in alpha-element abundance ratios affect the main-sequence properties of super-solar metallicity stars significantly. Red giant branch effective temperatures depend only slightly on the specific mixture. Our older low-temperature opacity tables were shown to be erroneous and should no longer be used for stellar models with near- or super-solar metallicity. Corrected tables have already been produced.

Submitted to Astronomy and Astrophysics
Available from astro-ph/0605666

The Dynamical Evolution of Planetary Nebulae After the Fast Wind

G. García-Segura[1], *J. A. López*[1], *W. Steffen*[1], *J. Meaburn*[1,2] *and A. Manchado*[3]

[1]Instituto de Astronomía, Universidad Nacional Autónoma de México, Apdo Postal 877, Ensenada 22800, Baja California, México

[2]Jodrell Bank Observatory, University of Manchester, Macclesfield SK11 9DL, UK

[3]Instituto de Astrofísica de Canarias, C/Vía Láctea, E-38200 La Laguna, Tenerife, Spain

In this paper we explore the dynamics of ionization bounded planetary nebulae after the termination of the fast stellar wind. When the stellar wind becomes negligible, the hot, shocked bubble depressurizes and the thermal pressure of the photoionized region, at the inner edge of the swept-up shell, becomes dominant. At this stage the shell tends to fragment creating clumps with comet-like tails and long, photoionized trails in between, while the photoionized material expands back towards the central stars as a rarefaction wave. Once that the photoionized gas fills the inner cavity, it develops a kinematical pattern of increasing velocity from the center outwards with a typical range of velociti es starting from the systemic velocity to ~ 50 m s^{-1} at the edges. The Helix nebula is a clear example of a planetary nebula at this late evolutionary stage.

Accepted for publication in The Astrophysical Journal Letters
Available from astro-ph/0606205

Stellar Populations and Mass-Loss in M15: A Spitzer Detection of Dust in the Intra-Cluster Medium

Martha L. Boyer[1], *Charles E. Woodward*[1], *Jacco Th. van Loon*[2], *Karl D. Gordon*[3], *A. Evans*[2], *Robert D. Gehrz*[1], *L. Andrew Helton*[1] *and Elisha F. Polomski*[1]

[1]Department of Astronomy, University of Minnesota, USA

[2]Astrophysics Group, School of Physical & Geographical Sciences, Keele University, UK

[3]Steward Observatory, University of Minnesota, USA

We present *Spitzer Space Telescope* IRAC and MIPS observations of the galactic globular cluster M15 (NGC 7078), one of the most metal-poor clusters with a [Fe/H]$= -2.4$. Our *Spitzer* images reveal a population of dusty red giants near the cluster center, a previously detected planetary nebula (PN) designated K648, and a possible detection of the intra-cluster medium (ICM) arising from mass loss episodes from the evolved stellar population. Our analysis suggests $(9 \pm 2) \times 10^{-4}$ M$_\odot$ of dust is present in the core of M15, and this material has accumulated over a period of $\approx 10^6$ yrs, a timescale ten times shorter than the last galactic plane crossing event. We also present *Spitzer* IRS follow up observations of K648, including the detection of the [Ne II] λ12.81 μm line, and discuss abundances derived from infrared fine structure lines.

Accepted for publication in Astronomical Journal
Available from astro-ph/0606236
and from http://ir.astro.umn.edu/∼mboyer/ms_060906.pdf

Analysis of RR Lyrae Stars in the Northern Sky Variability Survey

K. Kinemuchi[1,2], *H. A. Smith*[2], *P. R. Wozniak*[3] *and T. A. McKay*[4]

[1]University of Wyoming, USA

[2]Michigan State University, USA

[3]Los Alamos National Laboratory, USA

[4]University of Michigan, USA

We use data from the Northern Sky Variability Survey (NSVS), obtained from the first generation Robotic Optical Transient Search Experiment (ROTSE-I), to identify and study RR Lyrae variable stars in the solar neighborhood. We

initially identified 1197 RRab (RR0) candidate stars brighter than the ROTSE median magnitude $V = 14$. Periods, amplitudes, and mean V magnitudes are determined for a subset of 1188 RRab stars with well defined light curves. Metallicities are determined for 589 stars by the Fourier parameter method and by the relationship between period, amplitude, and [Fe/H]. We comment upon the difficulties of clearly classifying RRc (RR1) variables in the NSVS dataset. Distances to the RRab stars are calculated using an adopted luminosity-metallicity relation with corrections for interstellar extinction. The 589 RRab stars in our final sample are used to study the properties of the RRab population within 5 kpc of the Sun. The Bailey diagram of period versus amplitude shows that the largest component of this sample belongs to Oosterhoff type I. Metal-rich ([Fe/H]> -1) RRab stars appear to be associated with the Galactic disk. Our metal-rich RRab sample may include a thin disk as well as a thick disk population, although the uncertainties are too large to establish this. There is some evidence among the metal-rich RRab stars for a decline in scale height with increasing [Fe/H], as was found by Layden (1995). The distribution of RRab stars with $-1 <$[Fe/H]< -1.25 indicates that within this metallicity range the RRab stars are a mixture of stars belonging to halo and disk populations.

Accepted for publication in Astronomical Journal
Available from astro-ph/0606092

Spitzer observations of acetylene bands in carbon-rich AGB stars in the Large Magellanic Cloud

M. Matsuura [1,2,3], *P.R. Wood* [4], *G.C. Sloan* [5], *A.A. Zijlstra* [1], *J.Th. van Loon* [6], *M.A.T. Groenewegen* [7], *J.A.D.L. Blommaert* [7], *M.-R.L. Cioni* [8], *M.W. Feast* [9], *H.J. Habing*[10], *S. Hony* [7], *E. Lagadec* [1], *C. Loup* [11], *J.W. Menzies* [12], *L.B.F.M. Waters* [13,7] *and P.A. Whitelock* [9,12]

[1]University of Manchester, England
[2]QUB, Northern Ireland
[3]NAOJ, Japan
[4]ANU, Australia
[5]Cornell University, USA
[6]Keele University, England
[7]KU Leuven, Belgium
[8]University of Edinburgh, Scotland
[9]University of Cape Town, South Africa
[10]Sterrewacht Leiden, The Netherlands
[11]Institut d'Astrophysique de Paris, France
[12]South African Astronomical Observatory, South Africa
[13]Astronomical Institute "Anton Pannekoek", University of Amsterdam, The Netherlands

We investigate the molecular bands in carbon-rich AGB stars in the Large Magellanic Cloud (LMC), using the InfraRed Spectrograph (IRS) on board the Spitzer Space Telescope (SST) over the 5–38 μm range. All 26 low-resolution spectra show acetylene (C_2H_2) bands at 7 and 14 μm. The hydrogen cyanide (HCN) bands at these wavelengths are very weak or absent. This is consistent with low nitrogen abundances in the LMC. The observed 14 μm C_2H_2 band is reasonably reproduced by an excitation temperature of 500 K. There is no clear dilution of the 14 μm band by circumstellar dust emission. This 14 μm band originates from molecular gas in the circumstellar envelope in these high mass-loss rate stars, in agreement with previous findings for Galactic stars. The C_2H_2,column density, derived from the 13.7 μm band, shows a gas mass-loss rate in the range 3×10^{-6} to 5×10^{-5} $M_\odot$ yr^{-1}. This is comparable with the total mass-loss rate of these stars estimated from the spectral energy distribution. Additionally, we compare the line strengths of the 13.7 μm C_2H_2 band of our LMC sample with those of a Galactic sample. Despite the low metallicity of the LMC, there is no clear difference in the C_2H_2 abundance among LMC and Galactic stars. This reflects the effect of the 3rd dredge-up bringing self-produced carbon to the surface, leading to high C/O ratios at low metallicity.

Accepted for publication in MNRAS
Available from astro-ph/0606296

CS 30322-023: an ultra metal-poor TP-AGB star?

T. Masseron[1], *S. Van Eck*[2], *B. Famaey*[2], *S. Goriely*[2], *B. Plez*[1], *L. Siess*[2], *T.C. Beers*[3], *F. Primas*[4] *and A. Jorissen*[2]

[1]GRAAL, Univ. Montpellier II, France

[2]Univ. Libre de Bruxelles, Belgium

[3]Michigan State University, USA

[4]ESO, Garching, Germany

With [Fe/H]= −3.5, CS 30322-023 is the most metal-poor star to exhibit a clear s-process signature and the most metal-poor "lead star" known. CS 30322-023 is also remarkable in having the lowest surface gravity ($\log g \leq -0.3$) among the metal-poor stars studied to date. The available evidence indicates that this star is presently a thermally-pulsing asymptotic giant branch (TP-AGB) star, with no strong indication of binarity thus far (although a signal of period 192 d is clearly present in the radial-velocity data, this is likely due to pulsation of the stellar envelope). We show that low-mass TP-AGB stars are not expected to be exceedingly rare in a magnitude-limited sample such as the HK survey, because their high luminosities make it possible to sample them over a very large volume. The strong N overabundance and the low $^{12}C/^{13}C$ ratio (4) in this star is typical of the operation of the CN cycle. Coupled with a Na overabundance and the absence of a strong C overabundance, this pattern seems to imply that hot-bottom burning operated in this star, which should then have a mass of at least 2 $M_\odot$. However, the luminosity associated with this mass would put the star at a distance of about 50 kpc, in the outskirts of the galactic halo. We explore alternative scenarios in which the observed abundance pattern results from some mixing mechanism yet to be identified occurring in a single low-metallicity 0.8 $M_\odot$ AGB star, or from pollution by matter from an intermediate-mass AGB companion which has undergone hot-bottom burning. We stress, however, that our abundances may be subject to uncertainties due to NLTE or 3D granulation effects which were not taken into consideration.

Accepted for publication in A&A
Available from astro-ph/0605658
and from http://www.astro.ulb.ac.be/Html/ps.html#PRS

Near-IR variability properties of a selected sample of AGB stars

F.M. Jiménez-Esteban[1,2,3], *P. García-Lario*[4], *D. Engels*[3] *and A. Manchado*[5]

[1]Observatorio Astronómico Nacional, Apartado 112, E-28803 Alcalá de Henares, Spain.

[2]FRACTAL SLNE, Avda San Sebastián 5 3-D, E-38003 Santa Cruz de Tenerife, Spain.

[3]Hamburger Sternwarte, Gojenbergsweg 112, D-21029 Hamburg, Germany.

[4]Research and Scientific Support Department of ESA, European Space Astronomy Centre, Villafranca del Castillo, Apartado de Correos 50727, E-28080 Madrid, Spain.

[5]Instituto de Astrofísica de Canarias, Via Lactea s/n, E-38200 La Laguna, Tenerife, Spain.

We present the results of a near-infrared monitoring programme of a selected sample of stars, initially suspected to be Mira variables and OH/IR stars, covering more than a decade of observations. The objects monitored cover the typical range of IRAS colours shown by O-rich stars on the Asymptotic Giant Branch and show a surprisingly large diversity of variability properties. 16 objects are confirmed as large-amplitude variables. Periods between 360 and 1 800 days, and typical amplitudes 1 mag $\lesssim \Delta K \lesssim 2$ mag could be determined for nine of them. In three light curves we find a systematic decrease of the mean brightness, two light curves show pronounced asymmetry. One source, IRAS 07222–2005, shows infrared colours typical of Mira variables but pulsates with a much longer period (≈1200 days) than a normal Mira. Two objects are either close to (IRAS 03293+6010) or probably in (IRAS 18299–1705) the post-AGB phase. In IRAS 16029–3041 we found a systematic increase of the H–K colour of ≈1 mag, which we interpret as evidence of a recent episode of enhanced mass loss. IRAS 18576+0341, a heavily obscured Luminous Blue Variable was also monitored. The star showed a continued decrease of brightness over a period of 7 years (1995 – 2002).

Accepted for publication in Astronomy & Astrophysics
Available from astro-ph/0606380

Do most planetary nebulae derive from binaries? I Population synthesis model of the galactic planetary nebula population produced by single stars and binaries

Maxwell Moe[1] *and Orsola De Marco*[2]

[1]University of Colorado at Boulder, USA

[2]American Museum of Natural History, USA

We present a population synthesis calculation to derive the total number of planetary nebulae (PN) in the Galaxy that descend from single stars and stars in binary systems. Using the most recent literature results on galactic and stellar formation as well as stellar evolution, we predict the total number of galactic PNe with radii <0.9 pc to be $(4.6 \pm 1.3) \times 10^4$. We do not claim this to be the complete population, since there can be visible PNe with radii larger than this limit. However, by taking this limit, we make our predicted population inherently comparable to the observationally-based value of Peimbert, who determined (8000 ± 2000) PNe should reside in the Galaxy today (averaging the results from the two studies). Our prediction is discrepant with the observations at the 2.9 σ level, a disagreement which we argue is meaningful in view of our specific treatment of the uncertainty. We conclude that it is likely that only a subset of the stars thought to be capable of making a visible PN, actually do. In the second paper in this series, an argument will be presented that the bulk of the galactic PN population might be better explained if only binaries produce PNe.

The predicted PN formation rate density from single stars and binaries is $(1.1 \pm 0.5) \times 10^{-12}$ PN yr^{-1} pc^{-3} in the local neighborhood. This number is lower than the most recent PN birthrate density estimates (2.1×10^{-12} PN yr^{-1} pc^{-3}), which are based on local PN counts and the PN distance scale, but more in line with the white dwarf birthrate densities determined by Liebert et al. ($(1.0 \pm 0.25) \times 10^{-12}$ WD yr^{-1} pc^{-3}). The predicted PN birthrate density will be revised down, if we assume that only binaries make PNe. This revision will imply that the PN distance scale has to be revised to larger values.

Accepted for publication in Astrophysics Journal
Available from astro-ph/0606354

C stars in the outer spheroid of NGC 6822

Demers, S.[1]*, Battinelli, P.*[2] *and Artigau, E.*[1]

[1]Université de Montreal, Quebec

[2]Istituto Nazionale di Astrofisica, Italy

From a 2×2 degree survey of NGC 6822 we have previously established that this Local Group dwarf irregular galaxy possesses a huge spheroid having more than one degree in length. This spheroid is in rotation but its rotation curve is known only within $\sim 15'$ from the center. It is therefore critical to identify bright stars belonging to the spheroid to characterize, as far as possible, its outer kinematics. We use the new wide field near infrared imager CPAPIR, operated by the SMARTS consortium, to acquire J, K_s images of two $34.8' \times 34.8'$ areas in the outer spheroid to search for C stars. The colour diagram of the fields allows the identification of 192 C stars candidates but a study of the FWHM of the images permits the rejection of numerous non-stellar objects with colours similar to C stars. We are left with 75 new C stars, their mean K_s magnitude and mean colour are similar to the bulk of known NGC 6822 C stars. This outer spheroid survey confirms that the intermediate-age AGB stars are a major contributor to the stellar populations of the spheroid. The discovery of some 50 C stars well beyond the limit of the previously known rotation curve calls for a promising spectroscopic follow-up to a major axis distance of $40'$.

Accepted for publication in A&A
Available from astro-ph/0606243

ChaMPlane Discovery of Candidate Symbiotic Binaries in Baade's and Stanek's Windows

M. van den Berg[1], *J. Grindlay*[1], *S. Laycock*[1], *J. Hong*[1], *P. Zhao*[1], *X. Koenig*[1], *E. M. Schlegel*[2], *H. Cohn*[3], *P. Lugger*[3], *R. M. Rich*[4], *A. K. Dupree*[1], *G. H. Smith*[5] *and J. Strader*[5]

[1]Harvard-Smithsonian Center for Astrophysics, USA

[2]University of Texas, USA

[3]Indiana University, USA

[4]UCLA, USA

[5]University of California Observatories / Lick Observatory, USA

We have searched the *OGLE-II* archive for candidate counterparts of X-ray sources detected in two low-extinction windows included in our Galactic bulge *Chandra/HST* survey. We find that a significant number — i.e. in excess of the expected level of random associations — can be matched with probable M-giants. Their X-ray properties can be understood if these sources are symbiotic binaries where the X-rays are typically, either directly or indirectly, the result of a white dwarf accreting from the wind of a cool giant. Optical and near-infrared properties of selected sources are consistent with a symbiotic nature, although none of the spectra collected for 8 out of 13 candidate counterparts show the high-ionization nebular emission lines observed for many symbiotics. The hard X-ray emission for several sources (power-law photon indices $-1.5 \lesssim \Gamma \lesssim 1.5$) suggests our sample includes systems similar to the symbiotics recently detected with *INTEGRAL* and *Swift*.

Accepted for publication in ApJ Letters
Available from astro-ph/0606335
and from http://hea-www.harvard.edu/ChaMPlane/papers.html

Spitzer/MIPS Imaging of NGC 650: Probing the History of Mass Loss on the Asymptotic Giant Branch

Toshiya Ueta[1]

[1]USRA SOFIA Office/NASA Ames Research Center, USA

We present the far-infrared (IR) maps of a bipolar planetary nebula (PN), NGC 650, at 24, 70, and 160μm taken with the Multiband Imaging Photometer for Spitzer (MIPS) on-board the Spitzer Space Telescope. While the two-peak emission structure seen in all MIPS bands suggests the presence of a near edge-on dusty torus, the distinct emission structure between the 24μm map and the 70/160μm maps indicates the presence of two distinct emission components in the central torus. Based on the spatial correlation of these two far-IR emission components with respect to various optical line emission, we conclude that the 24μm emission is largely due to the [O IV] line at 25.9μm arising from highly ionized regions behind the ionization front, whereas the 70 and 160μm emission is due to dust continuum arising from low-temperature dust in the remnant asymptotic giant branch (AGB) wind shell. The far-IR nebula structure also suggests that the enhancement of mass loss at the end of the AGB phase has occurred isotropically, but has ensued only in the equatorial directions while ceasing in the polar directions. The present data also show evidence for the prolate spheroidal distribution of matter in this bipolar PN. The AGB mass loss history reconstructed in this PN is thus consistent with what has been previously proposed based on the past optical and mid-IR imaging surveys of the post-AGB shells.

Accepted for publication in Astrophysical Journal
Available from astro-ph/0606532

The compact circumstellar material around OH 231.8+4.2

M. Matsuura[1,2,3], O. Chesneau[4], A.A. Zijlstra[1], W. Jaffe[5], L.B.F.M. Waters[6,7], J. Yates[8], E. Lagadec[1], T. Gledhill[9], S. Etoka[1] and A.M.S. Richards[10]

[1]University of Manchester, P.O. Box 88, Manchester M60 1QD, UK

[2]Queen's University of Belfast, Belfast BT7 1NN, UK

[3]National Astronomical Observatory of Japan, Tokyo 181-8588, Japan

[4]Observatoire de la Cote d'Azur F-06130, Grasse, France

[5]Leiden Observatory, P.B. 9513, Leiden 2300 RA, The Netherlands

[6]Astronomical Institute 'Anton Pannekoek', University of Amsterdam, Kruislaan 403, 1098 SJ, Amsterdam, The Netherlands

[7]Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, Belgium

[8]University College London, London, WC1E 6BT, UK

[9]Centre for Astrophysics Research, Hatfield, Hertfordshire AL10 9AB, UK

[10]Jodrell Bank Observatory, University of Manchester, Jodrell Bank Observatory, University of Manchester, UK

We have observed the bipolar post-AGB candidate OH 231.8+4.2, using the mid-infrared interferometer MIDI and the infrared camera with the adaptive optics system NACO on the Very Large Telescope. An unresolved core (< 200 mas in FWHM) is found at the center of the OH 231.8+4.2 in the 3.8 μm image. This compact source is resolved with the interferometer. We used two 8-meter telescopes with four different baselines, which cover projected baseline lengths from 62 to 47 meters, and projected position angles from 112 to 131 degrees that are almost perpendicular to the bipolar outflow. Fringes from 8 to 9 μm and from 12 to 13.5 μm were clearly detected, whilst the strong silicate self-absorption allows only marginal detection of visibilities between 9 and 12 μm. The fringes from the four baselines consistently show the presence of a compact circumstellar object with an inner radius of 30-40 mas, which is equivalent to 40-50 AU at 1.3 kpc. This clearly shows that the mid-infrared compact source is not the central star (3 AU) but circumstellar material. The measured size of the circumstellar material is consistent with the size of such disks calculated by hydrodynamic models, implying the circumstellar material may have a disk configuration.

Accepted for publication in ApJL

Available from astro-ph/0606576

and from http://optik2.mtk.nao.ac.jp/∼mikako/astro_photo.html (high-resolution jpg image)

The Unusual Spitzer Spectrum of the Carbon Star IRAS 04496−6958: A Different Condensation Sequence in the LMC?

Angela Speck[1], Jan Cami[2], Ciska Markwick-Kemper[3], Jarron Leisenring[3], Ryszard Szczerba[4], Catharinus Dijkstra[1], Schuyler Van Dyk[5] and Margaret Meixner[6]

[1]University of Missouri - Columbia, USA

[2]NASA Ames, USA

[3]University of Virginia, USA

[4]NCAC, Torun, Poland

[5]Spitzer Space Center, USA

[6]Space Telescope Science Institute, USA

We present a new Spitzer Infrared Spectrograph (IRS) spectrum of the carbon star IRAS 04496−6958 in the Large Magellanic Cloud, which exhibits a fairly broad absorption feature at ∼11 μm. This feature is consistent with SiC absorption as seen in a few Galactic sources. Furthermore, the C_2H_2 (and other molecular) absorption bands are the deepest ever observed, indicative of a very high column density. While the Galactic sources with SiC absorption have cool colors(continuum temperature ∼300 K), IRAS 04496−6958 is much bluer, with a continuum temperature of ≈600 K. Based on the Galactic sample, SiC dust at this temperature should still display an emission feature at ∼11 μm. If SiC is the cause of the absorption feature, it suggests a subtly different evolutionary path and a change to a different condensation sequence than assumed for Galactic carbon stars. An alternative explanation for this feature is molecular line absorption, however, currently available line lists are not sufficient to properly assess this hypothesis.

Accepted for publication in Astrophysical Journal

Life Products of Stars

Aldo M. Serenelli[1] *and Masataka Fukugita*[1,2]

[1]Institute for Advanced Study, Princeton, NJ, 08540, USA

[2]Institute for Cosmic Ray Research, University of Tokyo, Kashiwa 277-8582, Japan

We attempt to document complete energetic transactions of stars in their life. We calculate photon and neutrino energies that are produced from stars in their each phase of evolution from 1 to $8M_{\odot}$, using the state-of-the-art stellar evolution code, tracing the evolution continuously from pre-main sequence gravitational contraction to white dwarfs. We also catalogue gravitational and thermal energies and helium, and heavier elements that are stored in stars and those ejected into interstellar space in each evolutionary phase.

Submitted to ApJS
Available from astro-ph/0606647

Shaping bipolar Planetary Nebulae : How mass loss leads to waistline development

C. Dijkstra[1] *and A. K. Speck*[1]

[1]Department of Physics and Astronomy, University of Missouri, Columbia, MO 65211, USA

Asymptotic Giant Branch (AGB) stars generally have spherically symmetric envelopes, whereas most post-AGB stars and Planetary Nebulae (PNe) show axisymmetric circumstellar envelopes. While various mechanisms for axisymmetric circumstellar structures may explain the shapes of PNe, they do not address how the shape of the circumstellar shell evolves. Here we address the temporal changes in the axisymmetry of AGB star envelopes, and in particular the development of the torus required in the Generalized Interacting Stellar Winds (GISW) model. Assuming (1) an AGB star rotates with sufficient angular speed at the start of the AGB phase; and (2) that the rotational angular momentum of the AGB star is conserved, we demonstrate that some very important observational features of AGB star axisymmetry evolution can be reproduced. We find that, compared to the star's increasing luminosity and decreasing effective temperature, the decreasing mass of the star primarily affects the axisymmetry of the envelope. When a representative mass loss history is adopted, where most of the mass is lost near the end of the AGB phase, the envelope's axisymmetry increases over time, with the strongest increase occurring near the end of the AGB phase. This may naturally explain why most AGB stars have spherically symmetric envelopes, while axisymmetry seems common-place in the post-AGB/PNe phase. The degree of axisymmetry at the end of the AGB phase is found to increase with increasing main sequence mass, and the onset of axisymmetry occurs only after the onset of the superwind (SW) phase, in good agreement with the observations.

Accepted for publication in ApJ

2MASS wide field extinction maps - I. The Pipe nebula

Lombardi, Marco[1,2]*, Alves, Joao*[1] *and Lada, Charles J.*[3]

[1]European Southern Observatory, Garching, Germany

[2]University of Milan, Italy

[3]Harvard-Smithsonian Center for Astrophysics, Cambridge, USA

We present a $8^{\circ} \times 6^{\circ}$, high resolution extinction map of the Pipe nebula using 4.5 million stars from the Two Micron

All Sky Survey (2MASS) point source catalog. The use of NICER, a robust and optimal technique to map the dust column density, allows us to detect a $A_{\rm v} = 0.5$ mag extinction at a 3-σ level with a 1 arcmin resolution. We find for the Pipe nebula a normal reddening law, $E(J-H) = (1.85 \pm 0.15)E(H-K)$. We measure the cloud distance using Hipparchos and Tycho parallaxes, and obtain ∼130 pc. This, together with the total estimated mass, 10^4 $M_\odot$, makes the Pipe the closest massive cloud complex to Earth. We compare the NICER extinction map to the NANTEN ^{12}CO observations and derive with unprecedented accuracy the relationship between the near-infrared extinction and the ^{12}CO column density and hence (indirectly) the ^{12}CO X-factor, that we estimate to be 2.91×10^{20} cm^{-2} K^{-1} km^{-1} s in the range $A_{\rm v} \in [0.9, 5.4]$ mag. *We identify ∼1500 OH/IR stars located within the Galactic bulge in the direction of the Pipe field. This represents a significant increase of the known numbers of such stars in the Galaxy.* Our analysis confirms the power and simplicity of the color excess technique to study molecular clouds. The comparison with the NANTEN ^{12}CO data corroborates the insensitivity of CO observations to low column densities (up to approximately 2 mag in $A_{\rm v}$), and shows also an irreducible uncertainty in the dust-CO correlation of about 1 mag of visual extinction.

Accepted for publication in A&A
Available from astro-ph/0606670
and from http://www.eso.org/∼mlombard/pipe.pdf

Conference Papers

Modelling of the spectra and atmospheres of evolved stars

Ya. Pavlenko[1]

[1]MAO of NASU, Ukrain

The method and results of the computation of the model atmospheres and spectral energy distributions of chemically peculiar stars, are discussed. The models are computed with a special consideration of the particular problems encountered when computing model atmospheres for M and C-giants, and of hydrogen deficient stars. We present some computed model atmospheres for Sakurai's object, giants of globular clusters, and C-giants.

Oral contribution, published in The VIII Torino Workshop on Nucleosynthesis in AGB Stars
Available from astro-ph/0606252

The Spectropolarimetric Evolution of V838 Monocerotis

John P. Wisniewski[1]

[1]USRA/NASA GSFC, USA

I review photo-polarimetric and spectropolarimetric observations of V838 Mon, which revealed that it had an asymmetrical inner circumstellar envelope following its 2$^{\rm nd}$ photometric outburst. Electron scattering, modified by pre- or post-scattering H absorption, is the polarizing mechanism in V838 Mon's envelope. The simplest geometry implied by these observations is that of a spheroidal shell, flattened by at least 10% and having a projected position angle on the sky of ∼37°. Analysis of V838 Mon's polarized flux reveals that this electron scattering shell lies interior to the envelope region in which Hα and Ca II triplet emission originates. To date, none of the theoretical models proposed for V838 Mon have demonstrated that they can reproduce the evolution of V838 Mon's inner circumstellar environment, as probed by spectropolarimetry.

Oral contribution, published in ASP Conf.Ser., The Nature of V838 Mon and its Light Echo, eds. R.L.M. Corradi and U. Munari
Available from astro-ph/0606424

Observations of V838 Mon and the nearby region in the CO $J = 1\rightarrow0$, $2\rightarrow1$ and $3\rightarrow2$ transitions

Tomasz Kamiński[1], Martin Miller[2], Ryszard Szczerba[3] and Romuald Tylenda[1,3]

[1]Nicolaus Copernicus University, Gagarina 11, 87-100 Toruń, Poland

[2]I. Physikalisches Institut, Universität zu Köln, Zülpicher Strasse 77, 50937 Köln, Germany

[3]Department for Astrophysics, Nicolaus Copernicus Astonomical Center, Rabiańska 8, 87-100 Toruń, Poland

We present observations of V838 Mon and its close vicinity in the three lowest rotational transitions of CO. The $J = 2\rightarrow1$ and $3\rightarrow2$ data were obtained using the 3 m KOSMA telescope. They include on-the-fly maps covering a large area (∼3.4 sq. deg.) around V838 Mon and long integrations on the star position. Complementary observations in the CO $J = 1\rightarrow0$ transition were obtained using the 13.7 m Delingha telescope. The star position as well as 25 other points preselected in the near vicinity of the object have been measured in this transition.

We report on a detection of two narrow emission components in $J = 2\rightarrow1$ and $3\rightarrow2$ transitions at the position of V838 Mon. Lines were found at radial velocities of $V_{\rm lsr} = 53.3$ km s^{-1} and $V_{\rm lsr} = -11.0$ km s^{-1}. Their origin is unclear. We also shortly discuss results of the observations of the vicinity of V838 Mon.

Oral contribution, published in ASP Conf.Ser., The Nature of V838 Mon and Its Light Echo, eds. R.L.M. Corradi and U. Munari
Available from astro-ph/0606402

Infrared observations of V838 Mon

M. T. Rushton[1], T. R. Geballe[2], A. Evans[3], J. Th. van Loon[3], B. Smalley[3] and S. P. S. Eyres[1]

[1]Centre for Astrophysics, University of Central Lancashire, Preston, PR1 2HE, UK

[2]Gemini Observatory, 670 N. A'ohoku Place, Hilo, HI 96720, USA

[3]Astrophysics Group, Keele University, Keele, Staffordshire, ST5 5BG, UK

We describe the results of fitting simple spherically symmetric models to the first overtone of CO and AlO A-X (2-0) bands in V838 Mon. We find that the temperature and column of both CO and AlO systematically decline over the period 2002 October-2005 February amd that an additional, hotter and denser, component is present from 2005 January. We also describe the results of an infrared observation at 850μm. We do not detect the 'infrared' echo at these wavelength, and place an upper limit of 3×10^7cm^{-2} on the column of grains.

Oral contribution, published in ASP Conf.Ser., The Nature of V838 Mon and Its Light Echo, eds. R.L.M. Corradi and U. Munari
Available from astro-ph/0606491

The Planets-Capture Model of V838 Monocerotis

Alon Retter[1], Bing Zhang[2], Lionel Siess[3], Amir Levinson[4] and Ariel Marom[5]

[1]Penn State University, USA

[2]University of Nevada, Las Vegas, USA

[3]Université Libre de Bruxelles, Bruxelles, Belgium

[4]Tel Aviv University, Israel

[5]Rafael Institute, Israel

The planets capture model for the eruption of V838 Mon is discussed. We used three methods to estimate the location where the planets were consumed. There is a nice consistency for the results of the three different methods, and we find that the typical stopping / slowing radius for the planets is about $1R_\odot$. The three peaks in the optical light curve of V838 Mon are either explained by the swallowing of three planets at different radii or by three steps in the slowing

down process of a single planet. We discuss the other models offered for the outburst of V838 Mon, and conclude that the binary merger model and the planet/s scenario seem to be the most promising. These two models have several similarities, and the main differences are the stellar evolutionary stage, and the mass of the accreted material. We show that the energy emitted in the V838 Mon event is consistent with the planets scenario. We suggest a few explanations for the trigger for the outburst and for the double structure of the optical peaks in the light curve of V838 Mon.

Oral contribution, published in The Nature of "V838 Mon and its Light Echo," eds. R.L.M. Corradi & U. Munari
Available from astro-ph/0606497

Dynamical PN Evolution with Magnetic Fields

Guillermo García-Segura[1]

[1]Instituto de Astronomía, Universidad Nacional Autónoma de México, México

Hydrodynamical simulations played an important role in understanding the dynamics and shaping of planetary nebulae in the past century. However, hydrodynamical simulations were just a first order approach. The new millennium arrived with the generalized understanding that the effects of magnetic fields were necessary to study the dynamics of planetary nebulae. Thus, B-fields introduced a whole new number of physical possibilities for the modeling. In this paper, we review observational works done in the last 5 years and several works on magnetohydrodynamics about proto-planetary nebulae, since all the effort has been focused on that stage, and discuss different scenarios for the origin of magnetized winds, and the relation binary-bipolararity.

Oral contribution, published in Planetary Nebulae in our Galaxy and Beyond, IAU 234
Available from astro-ph/0606632

Review Paper

Intracluster Planetary Nebulae

John J. Feldmeier[1]

[1]Youngstown State University, USA

I review the progress in research on intracluster planetary nebulae over the last five years. Hundreds more intracluster planetary nebulae have been detected in the nearby Virgo and Fornax galaxy clusters, searches of several galaxy groups have been made, and intracluster planetary candidates have been detected in the distant Coma cluster. The first theoretical studies of intracluster planetaries have also been completed, studying their utility as tracers of the intracluster light as a whole, and also as individual objects.

From the results to date, it appears that intracluster planetaries are common in galaxy clusters (10-20% of the total amount of starlight), but thus far, none have been detected in galaxy groups, a result which currently is not well understood. Limited spectroscopic follow-up of intracluster planetaries in Virgo indicate that they have a complex velocity structure, in agreement with numerical models of intracluster light. Hydrodynamic simulations of individual intracluster planetaries predict that their morphology is significantly altered by their intracluster environment, but their emission-line properties appear to be unaffected.

Published in IAU Symposium #234, "Planetary Nebulae in Our Galaxy and Beyond", Waikoloa, Hawaii, April 3-7, 2006 (eds. M.J. Barlow & R.H. Méndez)
Available from astro-ph/0606173

Thesis

The Evolution of Low Mass Helium Stars towards Supernova Type I Explosion

Roni Waldman[1]

[1]Hebrew University of Jerusalem, Israel

We explore the hypothesis, that helium stars in a certain mass range can evolve to a carbon core explosion similar to what is widely accepted as an explanation for the SN I phenomenon. This should happen when their carbon-oxygen core grows thanks to the helium shell burning above the core. We found that in the mass range of about 1.7-2.2 $M_\odot$, indeed this can happen. The main new insight we believe we gained is the crucial importance of an "early" off-center ignition of carbon, which at a later stage prevents the carbon which forms below the helium burning shell and ignites, from burning the carbon all the way to the center. When helium is almost depleted in the convective envelope by the helium burning shell at its bottom, the now super-Chandrasekhar mass carbon-oxygen core contracts, and the residual degenerate carbon at the center is ignited, resulting in a runaway similar to the classical SN I scenario. Since the structure and behavior of the carbon-oxygen core of the helium stars of our interest is very similar to that of a mass accreting carbon-oxygen star, we also thoroughly examined the behavior of carbon-oxygen stars. We discovered that the models which ignite carbon off-center (in the mass range of about 1.05-1.18 $M_\odot$, depending on the carbon mass fraction) present an interesting SN I progenitor scenario of their own, since whereas in the standard scenario runaway always takes place at the same density of about 2×10^9 g cm^{-3}, in our case, due to the small amount of carbon ignited, we get a whole range of densities from 1×10^9 up to 6×10^9 g cm^{-3}.

Available from astro-ph/0605692

Job Advert

Research Astronomer Positions at Armagh Observatory

Research Astronomer Positions - Solar Physics, Stellar and Galactic Astrophysics

Two permanent Research Astronomer positions are available from 2006 December 1. The Observatory has full access to all UK facilities and is a member of the UK SALT Consortium.

Applicants must have a PhD in an appropriate discipline and current or previous postdoctoral employment in astronomy or a related science. It is desirable that candidates have strong research interests in any branch of solar physics, solar-terrestrial physics including climate, and stellar or Galactic astrophysics, which should strengthen or complement the Observatory's existing research profile in these areas. Candidates should also have observational, theoretical, computational or modelling expertise, and experience of obtaining and/or managing grants and running an independent research programme.

Starting salary in the range 31927 – 47866 pounds (under review), depending on qualifications and experience. The positions are permanent posts subject to a normal retirement age of 65. Information about the Armagh Observatory may be obtained by consulting the web-site: http://star.arm.ac.uk/.

The closing date is 2006 September 8. Applicants should obtain an application pack from the Administrator or from the Observatory web-site, and send the completed application form together with a full curriculum vitae, statement of

research interests and complete bibliography to: The Administrator, Armagh Observatory, College Hill, Armagh BT61 9DG, Northern Ireland (Tel: +44-(0)28-3752-2928; FAX: +44-(0)28-3752-7174; e-mail: lfy@arm.ac.uk). References from three referees should be sent to the Administrator by the closing date.

See also http://star.arm.ac.uk/jobs/res-ast-2006/