THE AGB NEWSLETTER

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

No. 122 — 13 July 2007

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

Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 122$^{\rm nd}$ issue of the AGB Newsletter. With 32 refereed journal papers and 7 conference papers there is plenty to read and think about.

Looking for a PhD position or a postdoctoral fellowship? Check out the advertisements near the end of the newsletter. Also don't miss the announcement of a meeting on dust, which will take place in Germany in September this year.

The next issue will be distributed on the 27$^{\rm th}$ of August; the deadline for contributions is the 26$^{\rm th}$ of August.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Does AGB star related research attract funding and publicity in proportion to its importance and level of activity?

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 Supernova Channel of Super-AGB Stars

Arend J.T. Poelarends[1,2], Falk Herwig[3,2], Norbert Langer[1] and Alexander Heger[2,4,5]

[1]Astronomical Institute, Utrecht University, Utrecht, the Netherlands

[2]Theoretical Astrophysics Group T-6, Los Alamos National Laboratory, Los Alamos, NM, USA

[3]Keele Astrophysics Group, Keele University, Keele, UK

[4]Department of Astronomy and Astrophysics, University of California, Santa Cruz, USA

[5]Department of Astronomy and Astrophysics, University of Chicago, Chicago, USA

We study the late evolution of solar metallicity stars in the transition region between white dwarf formation and core collapse. This includes the super-asymptotic giant branch (super-AGB, SAGB) stars, which have massive enough cores to ignite carbon burning and form an oxygen-neon (ONe) core. The most massive SAGB stars have cores that may grow to the Chandrasekhar mass because of continued shell-burning. Their cores collapse, triggering a so called electron capture supernovae (ECSN).
From stellar evolution models we find that the initial mass range for SAGB evolution is 7.5 ... 9.25 $M_{\odot}$. We perform calculations with three different stellar evolution codes to investigate the sensitivity of this mass range to some of the uncertainties in current stellar models. The mass range significantly depends on the treatment of semiconvective mixing and convective overshooting. To consider the effect of a large number of thermal pulses, as expected in SAGB stars, we construct synthetic SAGB models that include a semi-analytical treatment of dredge-up, hot-bottom burning, and thermal pulse properties. To calibrate the time-dependent synthetic model, we have calibrated a number of SAGB stellar evolution models. This synthetic model enables us to compute the evolution of the main properties of SAGB stars from the onset of thermal pulses until the core reaches the Chandrasekhar mass or is uncovered by the stellar wind. Thereby, we determine the stellar initial mass ranges that produce ONe-white dwarfs and electron-capture supernovae. The latter is found to be 9.0 ... 9.25 $M_{\odot}$ for our fiducial model, implying that electron-capture supernovae would constitute about 4% of all supernovae in the local universe. Our synthetic approach allows us to explore the uncertainty of this number imposed by uncertainties in the third dredge-up efficiency and ABG mass loss rate. We find that for both processes, the most optimistic approach leads to about a doubling of the number of electron-capture supernovae, which provides a firm upper limit to their contribution to all supernovae of $\sim$20%.

Accepted for publication in Astrophysical Journal
Available from arXiv:0705.4643

Keck spectroscopy and Spitzer Space Telescope analysis of the outer disk of the Triangulum Spiral Galaxy M33

David L. Block[1,4], Francoise Combes[2], Ivanio Puerari[3], Kenneth C. Freeman[4], Alan Stockton[5], Gabriela Canalizo[6], Thomas H. Jarrett[7], Robert Groess[1], Guy Worthey[8], Robert D. Gehrz[9], Charles E. Woodward[9], Elisha F. Polomski[9] and Giovanni G. Fazio[10]

[1]WITS, South Africa

[2]LERMA, Paris

[3]INAOE, México

[4]Mount Stromlo, Australia

[5]IfA, Hawai'i, USA

[6]IGPP, California, USA

[7]CALTECH, USA

[8]WSU, Washington, USA

[9]Univ. Minnesota, USA

[10]CfA, Harvard, USA

In an earlier study of the spiral galaxy M33, we photometrically identified arcs or outer spiral arms of intermediate

age (0.6 Gyr - 2 Gyr) carbon stars precisely at the commencement of the H I-warp. Stars in the arcs were unresolved, but were likely thermally-pulsing asymptotic giant branch carbon stars. Here we present Keck I spectroscopy of seven intrinsically bright and red target stars in the outer, northern arc in M33. The target stars have estimated visual magnitudes as faint as $V \sim 25$ mag. Absorption bands of CN are seen in all seven spectra reported here, confirming their carbon star status. In addition, we present Keck II spectra of a small area 0.5° away from the centre of M33; the target stars there are also identified as carbon stars. We also study the non-stellar PAH dust morphology of M33 secured using IRAC on board the Spitzer Space Telescope. The Spitzer 8 μm image attests to a change of spiral phase at the start of the H I warp. The Keck spectra confirm that carbon stars may safely be identified on the basis of their red $J - K_s$ colours in the outer, low metallicity disk of M33. We propose that the enhanced number of carbon stars in the outer arms are an indicator of recent star formation, fueled by gas accretion from the H I-warp reservoir.

Accepted for publication in A&A
Available from arXiv:0706.0270

And in the Darkness Bind Them: Equatorial Rings, B[e] Supergiants, and the Waists of Bipolar Nebulae

Nathan Smith[1], *John Bally*[2] *and Josh Walawender*[3]

[1]Astronomy Department, University of California, 601 Campbell Hall, Berkeley, CA 94720, USA
[2]Center for Astrophysics and Space Astronomy, University of Colorado, 389 UCB, Boulder, CO 80309, USA
[3]Institute for Astronomy, 640 North A'ohoku Place, Hilo, HI 96720-2700, USA

We report the discovery of two new circumstellar ring nebulae in the western Carina Nebula, and we discuss their significance in stellar evolution. The brighter of the two new objects, SBW1, resembles a lidless staring eye and encircles a B1.5 Iab supergiant. Although seen in Carina, its luminosity class and radial velocity imply a larger distance of 7 kpc in the far Carina arm. At that distance its size and shape are nearly identical to the equatorial ring around SN1987A, but SBW1's low N abundance indicates that the ring was excreted without its star passing through a red supergiant phase. The fainter object, SBW2, is a more distorted ring, is N-rich, and is peculiar in that its central star seems to be invisible. We discuss the implications of these two new nebulae in context with other circumstellar rings such as those around SN1987A, Sher 25, HD 168625, RY Scuti, WeBo1, SuWt2, and others. The ring bearers fall into two groups: Five rings surround hot supergiants, and it is striking that all except for the one known binary are carbon copies of the ring around SN1987A. We propose a link between these B supergiant rings and B[e] supergiants, where the large spatially-resolved rings derive from the same material that would have given rise to emission lines during the earlier B[e] phase, when it was much closer to the star. The remaining four rings surround evolved intermediate-mass stars; all members of this ring fellowship are close binaries, hinting that binary interactions govern the forging of such rings. Two-thirds of our sample are found in or near giant H II regions. We estimate that there may be several thousand more dark rings in the Galaxy, but we are scarcely aware of their existence — either because they are only illuminated in precious few circumstances or because of selection effects. For intermediate-mass stars, these rings might be the pre-existing equatorial density enhancements invoked to bind the waists of bipolar nebulae.

Accepted for publication in AJ
Available from arXiv:0705.3054

AKARI observations of circumstellar dust in the globular clusters NGC104 and NGC362

Yoshifusa Ita[1], Toshihiko Tanabé[2], Noriyuki Matsunaga[2], Yoshikazu Nakada[2], Mikako Matsuura[3], Takashi Onaka[4], Hideo Matsuhara[1], Takehiko Wada[1], Naofumi Fujishiro[5], Daisuke Ishihara[4], Hirokazu Kataza[1], Woojung Kim[1], Toshio Matsumoto[1], Hiroshi Murakami[1], Youichi Ohyama[1], Fumihiko Usui[1], Shinki Oyabu[1], Itsuki Sakon[4], Toshinobu Takagi[1], Kazunori Uemizu[1], Munetaka Ueno[6] and Hidenori Watarai[7]

[1]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan

[2]Institute of Astronomy, Graduate School of Science, The University of Tokyo, 2-21-1 Osawa, Mitaka, Tokyo 181-0015, Japan

[3]National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo, 181-8588, Japan

[4]Department of Astronomy, Graduate School of Science, The University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan

[5]Department of Physics, Graduate School of Science, The University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan

[6]Department of Earth Science and Astronomy, Graduate School of Arts and Sciences, The University of Tokyo, Meguro-ku, Tokyo 153-8902, Japan

[7]Office of Space Applications, Japan Aerospace Exploration Agency, Tsukuba, Ibaraki 305-8505, Japan

We report preliminary results of AKARI observations of two globular clusters, NGC104 and NGC362. Imaging data covering areas of about 10×10 arcmin^2 centered on the two clusters have been obtained with InfraRed Camera (IRC) at 2.4, 3.2, 4.1, 7.0, 9.0, 11.0, 15.0, 18.0 and 24.0 μm. We used F_{11}/F_2 and F_{24}/F_7 flux ratios as diagnostics of circumstellar dust emission. Dust emissions are mainly detected from variable stars obviously on the asymptotic giant branch, but some variable stars that reside below the tip of the first-ascending giant branch also show dust emissions. We found eight red sources with F_{24}/F_7 ratio greater than unity in NGC362. Six out of the eight have no 2MASS counterparts. However, we found no such source in NGC104.

Accepted for publication in PASJ
Available from arXiv:0706.0045

The born again (VLTP) scenario revisited: The mass of the remnants and implications for V4334 Sgr

M. M. Miller Bertolami[1,2] and L. G. Althaus[1,2]

[1]Facultad de Ciencias Astronómicas y Geofisicas, UNLP, Argentina

[2]Instituto de Astrofísica La Plata, CONICET-UNLP, Argentina

We present 1-D numerical simulations of the very late thermal pulse (VLTP) scenario for a wide range of remnant masses. We show that by taking into account the different possible remnant masses, the observed evolution of V4334 Sgr (a.k.a. Sakurai's Object) can be reproduced within the standard 1D-MLT stellar evolutionary models without the inclusion of any $ad-hoc$ reduced mixing efficiency. Our simulations hint at a consistent picture with present observations of V4334 Sgr. From energetics, and within the standard MLT approach, we show that low mass remnants ($M \lesssim 0.6$ M$_\odot$) are expected to behave markedly different than higher mass remnants ($M \gtrsim 0.6$ M$_\odot$) in the sense that the latter are not expected to expand significantly as a result of the violent H-burning that takes place during the VLTP. We also assess the discrepancy in the born again times obtained by different authors by comparing the energy that can be liberated by H-burning during the VLTP event.

Submitted to MNRAS
Available from arXiv:0706.0714
and from http://www.fcaglp.unlp.edu.ar/evolgroup/publications.html

On the robustness of H-deficient post-AGB tracks

M. M. Miller Bertolami[1,2] *and L. G. Althaus*[1,2]

[1]Facultad de Ciencias Astronómicas y Geofisicas, UNLP, Argentina

[2]Instituto de Astrofísica La Plata, Argentina

We analyze the robustness of H-deficient post-AGB tracks regarding previous evolution of their progenitor stars and the constitutive physics of the remnants. Our motivation is a recent suggestion of Werner & Herwig (2006) that previous evolution should be important in shaping the final post-AGB track and the persisting discrepancy between asteroseismological and spectroscopical mass determinations. This work is thus complementary to our previous work (Miller Bertolami & Althaus 2006) and intends to shed some light on the uncertainty behind the evolutionary tracks presented there. We compute full evolutionary models for PG1159 stars taking into account different extramixing (overshooting) efficiencies and lifetimes on the TP-AGB during the progenitor evolution. We also assess the effect of possible differences in the opacities and equation of state by artificially changing them before the PG1159 stage. Also comparisons are made with the few H-deficient post-AGB tracks available in the literature. Contrary to our expectations, we found that previous evolution is not a main factor in shaping H-deficient post-AGB tracks. Interestingly enough, we find that only an increase of $\sim 50\%$ in the intershell opacities at high effective temperatures may affect the tracks as to reconcile spectroscopic and asteroseismologic mass determinations. This forces us to conclude that our previous tracks (Miller Bertolami & Althaus 2006) are robust enough as to be used for spectroscopic mass determinations, unless opacities in the intershell region are substantially different. Our results, then, call for an analysis of possible systematics in the usually adopted asteroseismological mass determination methods.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:0706.0713
and from http://www.fcaglp.unlp.edu.ar/evolgroup/publications.html

Correlation between Infrared Colors and Intensity Ratios of SiO Maser Lines

Jun-ichi Nakashima[1,2] *and Shuji Deguchi*[3]

[1]Academia Sinica Institute of Astronomy and Astrophysics, P.O. Box 23-141, Taipei 10617, Taiwan

[2]Department of Astronomy, University of Illinois at Urbana-Champaign, 1002 W. Green St., Urbana, IL 61801, USA

[3]Nobeyama Radio Observatory, National Astronomical Observatory, Minamimaki, Minamisaku, Nagano 384-1305, Japan

We present the results of SiO millimeter-line observations of a sample of known SiO maser sources covering a wide dust-temperature range. A cold part of the sample was selected from the SiO maser sources found in our recent SiO maser survey of cold dusty objects. The aim of the present research is to investigate the causes of the correlation between infrared colors and SiO maser intensity ratios among different transition lines. In particular, the correlation between infrared colors and SiO maser intensity ratio among the $J = 1{-}0$ v =1, 2, and 3 lines are mainly concerned in this paper. We observed in total 75 SiO maser sources with the Nobeyama 45m telescope quasi-simultaneously in the SiO $J = 1{-}0$ $v = 0$, 1, 2, 3, 4 and $J = 2{-}1$ $v = 1$, 2 lines. We also observed the sample in the ^{29}SiO $J = 1{-}0$ $v = 0$ and $J = 2{-}1$ $v = 0$, and ^{30}SiO $J = 1{-}0$ $v = 0$ lines, and the H_2O $6_{1,6}{-}5_{2,3}$ line. As reported in previous papers, we confirmed that the intensity ratios of the SiO $J = 1{-}0$ $v = 2$ to $v = 1$ lines clearly correlate with infrared colors. In addition, we found possible correlation between infrared colors and the intensity ratios of the SiO $J = 1{-}0$ $v = 3$ to $v = 1\&2$ lines. Two overlap lines of H_2O (i.e., $11_{6,6}$ $\nu_2 = 1{\rightarrow}12_{7,5}$ $\nu_2 = 0$ and $5_{0,5}$ $\nu_2 = 2{\rightarrow}6_{3,4}$ $\nu_2 = 1$) might explain these correlation if these overlap lines become stronger with increase of infrared colors, although the phenomena also might be explained by more fundamental ways if we take into account the variation of opacity from object to object.

Accepted for publication in ApJ
Available from arXiv:0706.0945
and from http://www.asiaa.sinica.edu.tw/∼junichi/paper/

The Abundances of Light Neutron-Capture Elements in Planetary Nebulae – II. *s*-process Enrichments and Interpretation

N. C. Sterling[1] *and Harriet L. Dinerstein*[2]

[1]NASA Goddard Space Flight Center, USA

[2]University of Texas at Austin, USA

We present the results of a large-scale survey of neutron(n)-capture elements in Galactic planetary nebulae (PNe), undertaken to study enrichments from s-process nucleosynthesis in their progenitor stars. From new K band observations of over 100 PNe supplemented by data from the literature, we have detected the emission lines [Kr III] 2.199 and/or [Se IV] 2.287 μm in 81 of 120 objects. We determine Se and Kr elemental abundances, employing ionization correction formulae derived in the first paper of this series. We find a significant range in Se and Kr abundances, from near solar (no enrichment) to enhanced by >1.0 dex relative to solar, which we interpret as self-enrichment due to *in situ* s-process nucleosynthesis. Kr tends to be more strongly enriched than Se; in 18 objects exhibiting both Se and Kr emission, we find that [Kr/Se] = 0.5±0.2.

Our survey has increased the number of PNe with n-capture element abundance determinations by a factor of ten, enabling us for the first time to search for correlations with other nebular properties. As expected, we find a positive correlation between s-process enrichments and the C/O ratio. Type I and bipolar PNe, which arise from intermediate-mass progenitors (> 3–4 $M_\odot$), exhibit little to no s-process enrichments. Finally, PNe with H-deficient Wolf-Rayet central stars do not exhibit systematically larger s-process enrichments than objects with H-rich nuclei. Overall, 44% of the PNe in our sample display significant s-process enrichments (> 0.3 dex). Using an empirical PN luminosity function to correct for incompleteness, we estimate that the true fraction of s-process enriched Galactic PNe is at least 20%.

Accepted for publication in ApJS

Available from arXiv:0706.1074

Late-Type Red Supergiants: Too Cool for the Magellanic Clouds?

Emily M. Levesque[1]*, Philip Massey*[2]*, K. A. G. Olsen*[3] *and Bertrand Plez*[4]

[1]Institute for Astronomy, University of Hawai'i, USA

[2]Lowell Observatory, USA

[3]NOAO, USA

[4]GRAAL, Université Montpellier II, France

We have identified seven red supergiants (RSGs) in the Large Magellanic Cloud (LMC) and four RSGs in the Small Magellanic Cloud (SMC), all of which have spectral types that are considerably later than the average type observed in their parent galaxy. Using moderate-resolution optical spectrophotometry and the MARCS stellar atmosphere models, we determine their physical properties and place them on the H-R diagram for comparison with the predictions of current stellar evolutionary tracks. The radial velocities of these stars suggest that they are likely all members of the Clouds rather than foreground dwarfs or halo giants. Their locations in the H-R diagram also show us that those stars are cooler than the current evolutionary tracks allow, appearing to the right of the Hayashi limit, a region in which stars are no longer in hydrodynamic equilibrium. These stars exhibit considerable variability in their V magnitudes, and three of these stars also show changes in their effective temperatures (and spectral types) on the time-scales of months. One of these stars, [M2002] SMC 055188, was caught in an M4.5 I state, as late as that seen in HV 11423 at its recent extreme: considerable later, and cooler, than any other supergiant in the SMC. In addition, we find evidence of variable extinction due to circumstellar dust and changes in the stars' luminosities, also consistent with our recent findings for HV 11423 — when these stars are hotter they are also dustier and more luminous. We suggest that these stars have unusual properties because they are in an unstable (and short-lived) evolutionary phase.

Accepted for publication in ApJ

Available from arXiv:0705.3431

Chemical evolution of the Small Magellanic Cloud based on planetary nebulae

T. P. Idiart[1], *W. J. Maciel*[1] *and R. D. D. Costa*[1]

[1]IAG/USP, São Paulo SP, Brazil

We investigate the chemical evolution of the Small Magellanic Cloud (SMC) based on abundance data of planetary nebulae (PNe). The main goal is to investigate the time evolution of the oxygen abundance in this galaxy by deriving an age-metallicity relation. Such a relation is of fundamental importance as an observational constraint of chemical evolution models of the SMC. We have used high quality PNe data in order to derive the properties of the progenitor stars, so that the stellar ages could be estimated. We collected a large number of measured spectral fluxes for each nebula, and derived accurate physical parameters and nebular abundances. New spectral data for a sample of SMC PNe obtained between 1999 and 2002 are also presented. These data are used together with data available in the literature to improve the accuracy of the fluxes for each spectral line. We obtained accurate chemical abundances for PNe in the Small Magellanic Cloud, which can be useful as tools in the study of the chemical evolution of this galaxy and of Local Group galaxies. We present the resulting oxygen versus age diagram and a similar relation involving the [Fe/H] metallicity based on a correlation with stellar data. We discuss the implications of the derived age-metallicity relation for the SMC formation, in particular by suggesting a star formation burst in the last 2-3 Gyr.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:0706.1967
and from http://www.astro.iag.usp.br/∼maciel/

IRAS 08281−4850 and IRAS 14325−6428: two A-type post-AGB stars with s-process enrichment

M. Reyniers[1], *G.C. Van de Steene*[2], *P.A.M. van Hoof*[2] *and H. Van Winckel*[1]

[1]Instituut voor Sterrenkunde, Departement Natuurkunde en Sterrenkunde, K.U.Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium
[2]Koninklijke Sterrenwacht van België, Ringlaan 3, 1180 Brussel, Belgium

Aims. One of the puzzling findings in the study of the chemical evolution of (post-)AGB stars is why very similar stars (in terms of metallicity, spectral type, infrared properties, etc...) show a very different photospheric composition. We aim at extending the still limited sample of s-process enriched post-AGB stars, in order to obtain a statistically large enough sample that allows us to formulate conclusions concerning the 3rd dredge-up occurrence. Methods. We selected two post-AGB stars on the basis of IR colours indicative of a past history of heavy mass loss: IRAS 08281−4850 and IRAS 14325−6428. They are cool sources in the locus of the Planetary Nebulae (PNe) in the IRAS colour-colour diagram. Abundances of both objects were derived for the first time on the basis of high-quality UVES and EMMI spectra, using a critically compiled line list with accurate log(gf) values, together with the latest Kurucz model atmospheres. Results. Both objects have very similar spectroscopically defined effective temperatures of 7750 - 8000 K. They are strongly carbon and s-process enriched, with a C/O ratio of 1.9 and 1.6, and an [ls/Fe] of +1.7 and +1.2, for IRAS 08281−4850 and IRAS 14325−6428 respectively. Moreover, the spectral energy distributions (SEDs) point to heavy mass-loss during the preceding AGB phase. Conclusions. IRAS 08281−4850 and IRAS 14325−6428 are prototypical post-AGB objects in the sense that they show strong post 3rd dredge-up chemical enrichments. The neutron irradiation has been extremely efficient, despite the only mild sub-solar metallicity. This is not conform with the recent chemical models. The existence of very similar post-AGB stars without any enrichment emphasizes our poor knowledge of the details of the AGB nucleosynthesis and dredge-up phenomena. We call for a very systematic chemical study of all cool sources in the PN region of the IRAS colour-colour diagram.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0706.2120

Water Maser Kinematics in the Jet of OH 12.8−0.9

David A. Boboltz[1] *and Kevin B. Marvel*[2]

[1]U.S. Naval Observatory, USA

[2]American Astronomical Society, USA

We present Very Long Baseline Array observations of the kinematics of the water masers associated with OH 12.8−0.9, the fourth member of the so-called "water fountain" class of sources. We find that the masers occupy two distinct regions at the ends of a bipolar jet-like structure oriented north–south, with the blue-shifted masers located to the north and the red-shifted masers to the south. The masers are distributed along arc-like structures 12–20 mas across oriented perpendicular to the separation axis with an angular separation of ∼110 mas on the sky. Our multi-epoch observations, show the two maser arcs to be expanding away from each other along the axis of separation. The relative proper motions of the two maser regions is 2.7 mas yr^{-1} (∼105 km s^{-1} at the assumed distance of 8 kpc). The measured radial velocity difference between the northern, blue-shifted masers and the southern, red-shifted masers is 48.4 km s^{-1}. The radial velocity, when combined with the proper motion, yields a three-dimensional expansion velocity of 58 km s^{-1} and an inclination angle of 24° for the jet. By combining our radial velocities with historical values, we estimate the three dimensional acceleration of the masers to be ∼0.63 km s^{-1} yr^{-1} and a dynamical age for the collimated outflow of ∼90 yr.

Accepted for publication in Astrophysical Journal
Available from arXiv:0706.2900

Constraining white-dwarf kicks in globular clusters

Jeremy Heyl[1]

[1]University of British Columbia, Canada

The wind of an asymptotic-giant-branch stars is sufficiently strong that if it is slightly asymmetric, it can propel the star outside of the open cluster of its birth or significantly alter its trajectory through a globular cluster; therefore, if these stellar winds are asymmetric, one would expect a deficit of white dwarfs of all ages in open clusters and for young white dwarfs to be less radially concentrated than either their progenitors or older white dwarfs in globular clusters. This latter effect has recently been observed. Hence, detailed studies of the radial distribution of young white dwarfs in globular clusters could provide a unique probe of mass loss on the asymptotic giant branch and during the formation of planetary nebulae both as a function of metallicity and a limited range of stellar mass.

Submitted to MNRAS
Available from arXiv:0706.0900

Orbital evolution with white-dwarf kicks

Jeremy Heyl[1]

[1]University of British Columbia, Canada

Recent observations of white dwarfs in globular clusters indicate that these stars may get a velocity kick during their time as giants. This velocity kick could originate naturally if the mass loss while on the asymptotic giant granch is slightly asymmetric. If white dwarfs get a kick comparable to the orbital velocity of the binary, the initial Runge-Lenz vector (eccentricity vector) of the orbit is damped to be replaced by a component pointing toward the cross product of the initial angular momentum and the force. The final eccentricity may be of order unity and if the kick is sufficiently large, the system may be disrupted. These results may have important ramifications for the evolution of binary stars and planetary systems.

Submitted to MNRAS
Available from arXiv:0706.0912

Planets around evolved intermediate-mass stars. I. Two substellar companions in the open clusters NGC 2423 and NGC 4349

C. Lovis[1] *and M. Mayor*[1]

[1]Geneva Observatory, Switzerland

Context. Many efforts are being made to characterize extrasolar planetary systems and unveil the fundamental mechanisms of planet formation. An important aspect of the problem, which remains largely unknown, is to understand how the planet formation process depends on the mass of the parent star. In particular, as most planets discovered to date orbit a solar-mass primary, little is known about planet formation around more massive stars.
Aims. To investigate this point, we present first results from a radial velocity planet search around red giants in the clump of intermediate-age open clusters. We choose clusters harbouring red giants with masses between 1.5 and 4 $M_{\odot}$, using the well-known cluster parameters to accurately determine the stellar masses. We are therefore exploring a poorly-known domain of primary masses, which will bring new insights into the properties of extrasolar planetary systems. Methods. We are following a sample of about 115 red giants with the Coralie and HARPS spectrographs to obtain high-precision radial velocity (RV) measurements and detect giant planets around these stars. We use bisector and activity index diagnostics to distinguish between planetary-induced RV variations and stellar photospheric jitter. Results. We present the discoveries of a giant planet and a brown dwarf in the open clusters NGC 2423 and NGC 4349, orbiting the 2.4-$M_{\odot}$-star NGC2423 No3 (TYC 5409-2156-1) and the 3.9-$M_{\odot}$-star NGC4349 No127 (TYC 8975-2606-1). These low-mass companions have orbital periods of 714 and 678 days and minimum masses of 10.6 and 19.8 $M_{\rm jup}$, respectively. Combined with the other known planetary systems, these detections indicate that the frequency of massive planets is higher around intermediate-mass stars, and therefore probably scales with the mass of the protoplanetary disk.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0706.2174

Molecular opacities for low-mass metal-poor AGB stars undergoing the Third Dredge Up

Cristallo, S.[1]*, Straniero, O.*[1]*, Lederer, M.T.*[2] *and Aringer, B.*[2]

[1]Osservatorio Astronomico Teramo (INAF), Italy
[2]Institut für Astronomie Wien, Austria

The concomitant overabundances of C, N and s-process elements are commonly ascribed to the complex interplay of nucleosynthesis, mixing and mass loss taking place in Asymptotic Giant Branch stars. At low metallicity, the enhancement of C and/or N may be up to 1000 times larger than the original iron content and significantly affects the stellar structure and its evolution. For this reason, the interpretation of the already available and still growing amount of data concerning C-rich metal-poor stars belonging to our Galaxy as well as to dwarf spheroidal galaxies would require reliable AGB stellar models for low and very low metallicities. In this paper we address the question of calculation and use of appropriate opacity coefficients, which take into account the C enhancement caused by the third dredge up. A possible N enhancement, caused by the cool bottom process or by the engulfment of protons into the convective zone generated by a thermal pulse and the subsequent huge third dredge up, is also considered. Basing on up-to-date stellar models, we illustrate the changes induced by the use of these opacity on the physical and chemical properties expected for these stars.

Accepted for publication in ApJ
Available from arXiv:0706.2100

Compulsory Deep Mixing of ^{3}He and CNO Isotopes in the Envelopes of low-mass Red Giants

Peter Eggleton[1]*, David Dearborn*[1] *and John Lattanzio*[2]

[1]Lawrence Livermore National Laboratory, USA

[2]Monash University, Australia

Three-dimensional stellar modeling has enabled us to identify a deep-mixing mechanism that must operate in all low mass giants. This mixing process is not optional, and is driven by a molecular weight inversion created by the ^{3}He(^{3}He,2p)^{4}He reaction. In this paper we characterize the behavior of this mixing, and study its impact on the envelope abundances. It not only eliminates the problem of ^{3}He overproduction, reconciling stellar and big bang nucleosynthesis with observations, but solves the discrepancy between observed and calculated CNO isotope ratios in low mass giants, a problem of more than 3 decades' standing. This mixing mechanism, which we call '$\delta\mu$-mixing', operates rapidly (relative to the nuclear timescale of overall evolution, $\sim 10^8$ yrs) once the hydrogen burning shell approaches the material homogenized by the surface convection zone. In agreement with observations, Pop I stars between 0.8 and 2.0 $M_\odot$ develop $^{12}C/^{13}C$ ratios of 14.5 ± 1.5, while Pop II stars process the carbon to ratios of 4.0 ± 0.5. In stars less than 1.25 $M_\odot$, this mechanism also destroys 90% to 95% of the ^{3}He produced on the main sequence.

Submitted to Astrophysical Journal
Available from arXiv:0706.2710

Optical spectroscopy of RU Cam, a pulsating carbon star

Tõnu Kipper[1] *and Valentina G. Klochkova*[2]

[1]Tartu Observatory, Tõravere, Estonia

[2]Special Astrophysical Observatory RAS, Nizhnij Arkhyz, Russia

We analysed the high resolution spectra of a RU Cam, classified as W Vir type star. The atmospheric parameters of RU Cam were estimated $T_{\rm eff}$=5250 K and $\log g$=1.0. The hydrogen deficiency of RU Cam was not confirmed. The iron abundance, [Fe/H]=−0.37, is close to the solar one. Abundances of most other elements are also close to normal. We found considerable excesses of carbon and nitrogen: [C/Fe]=+0.98, [N/Fe]=+0.60. The carbon to oxygen ratio is C/O>1. The carbon isotopic abundance ratio is equal to $^{12}C/^{13}C$=4.5. For sodium a moderate overabundance Na/Fe=+0.55 was obtained. For two moments of observations we found close heliocentric velocity values, $v_{\rm r}=-21.7 \pm 0.8$ and $-23.1 \pm 1.0\,{\rm km\,s^{-1}}$. Both spectra contain a peculiar feature — an emission component of Na I doublet which location agrees with the radial velocity from the bulk of metallic lines. For our two observing moments we found no dependence of radial velocities on the formation depth or on excitation energy.

Submitted to Baltic Astronomy
Available from arXiv:0706.2969

Abundances of Planetary Nebula M 1-42

S.R. Pottasch[1]*, J. Bernard-Salas*[2] *and T.L. Roellig*[3]

[1]Kapteyn Astronomical Institute, Groningen, The Netherlands

[2]Cornell University, Ithaca, NY, USA

[3]NASA Ames Research Center, Moffett Field, CA, USA

The spectra of the planetary nebula M 1-42 is reanalysed using spectral measurements made in the mid-infrared with the Spitzer Space Telescope. The aim is to determine the chemical composition of this object. We also make use of ISO, IUE and ground based spectra. Abundances determined from the mid- and far-infrared lines, which are insensitive to electron temperature, are used as the basis for the determination of the composition, which are found to substantially differ from earlier results. High values of neon, argon and sulfur are found. They are higher than in other PN, with the

exception of NGC 6153, a nebula of very similar abundances. The high values of helium and nitrogen found indicate that the second dredge-up and hot bottom burning has occurred in the course of evolution and that the central star was originally more massive than 4 $M_{\odot}$. The present temperature and luminosity of the central star is determined and at first sight may be inconsistent with such a high mass.

Accepted for publication in A&A
Available from arXiv:0706.3407

The optical spectrum of R Coronae Borealis close to 2003 decline

Tõnu Kipper[1] *and Valentina G. Klochkova*[2]

[1]Tartu Observatory, Tõravere, Estonia

[2]Special Astrophysical Observatory RAS, Nizhnij Arkhyz, Russia

Two sets of high-resolution spectra of R CrB obtained during the 2003 light decline are described. The first set was obtained on the descending branch of the light curve when $V \approx 12.0$ and the second one in the recovery phase with $V \approx 7.5$. The usual sharp and broad emissions are described and the lines radial velocities measured. C_2 Swan system (0,0) band was found to be in emission for the first set. The other C_2 bands were in absorption. Few CN red system (5,1) band rotational lines and low excitation Fe I lines were in absorption. A table with measured radial velocities of various spectral features is presented.

Published in Baltic Astronomy, 15, p.521-530 (2006)
Available from arXiv:0706.3085

A cool R Coronae Borealis star Z UMi

Tõnu Kipper[1] *and Valentina G. Klochkova*[2]

[1]Tartu Observatory, Tõravere, Estonia

[2]Special Astrophysical Observatory RAS, Nizhnij Arkhyz, Russia

The high resolution spectra of a R CrB type star Z UMi are analysed. The atmospheric parameters of Z UMi are estimated: $T_{\rm eff} = 5250 \pm 250$ K and $\log g = 0.5 \pm 0.3$. This places Z UMi among the coolest R CrB stars. The hydrogen deficiency of Z UMi is confirmed. The abundances of other elements resemble those found for the minority group of R CrB stars. We note very low iron abundance, [Fe/H]=−1.85, and an excess of lithium, [Li/Fe]=+1.9.

Published in Baltic Astronomy, 15, p.531-537 (2006)
Available from arXiv:0706.3271

The chemical composition of the circumstellar envelopes around yellow hypergiant stars

Guillermo Quintana-Lacaci[1]*, Valentin Bujarrabal*[1]*, Arancha Castro-Carrizo*[2] *and Javier Alcolea*[3]

[1]Observatorio Astronómico Nacional (IGN), Apdo. 112, E-28803 Alcalá de Henares, Spain

[2]Institut de RadioAstronomie Millimétrique, 300 rue de la Piscine, 38406 Saint Martin d'Hères, France

[3]Observatorio Astronómico Nacional (IGN), Alfonso XII No. 3, E-28014 Madrid, Spain

The yellow hypergiant stars (YHGs) are extremely luminous and massive objects whose general properties are poorly known. Only two of this kind of star show massive circumstellar envelopes, IRC+10420 and AFGL2343. We aim to study the chemistry of the circumstellar envelopes around these two sources, by comparison with well known AGB stars and protoplanetary nebulae. We also estimate the abundances of the observed molecular species. We have

performed single-dish observations of different transitions for twelve molecular species. We have compared the ratio of the intensities of the molecular transitions and of the estimated abundances in AFGL2343 and IRC+10420 with those in O-rich and C-rich AGB stars and protoplanetary nebulae. Both YHGs, AFGL2343, and IRC+10420, have been found to have an O-rich chemistry similar to that in O-rich AGB stars, though for AFGL2343 the emission of most molecules compared with ^{13}CO lines is relatively weak. Clear differences with the other evolved sources appear when we compare the line intensity corrected for distance and the profile widths which are, respectively, very intense and very wide in YHGs. The abundances obtained for IRC+10420 agree with those found in AGB stars, but in general those found in AFGL2343, except for ^{13}CO, are too low. This apparently low molecular abundance in AFGL2343 could be due to the fact that these molecules are present only in an inner region of the shell where the mass is relatively low.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0706.1639

High-resolution FUSE and HST ultraviolet spectroscopy of the white dwarf central star of Sh 2-216

T. Rauch[1], M. Ziegler[1], K. Werner[1], J.W. Kruk[2], C.M. Oliveira[2], D. Vande Putte[3], R.P. Mignani[3] and F. Kerber[4]

[1]Institut für Astronomie und Astrophysik, Tübingen, Germany
[2]Department of Physics and Astronomy, Johns Hopkins University, Baltimore, U.S.A.
[3]Mullard Space Science Laboratory, University College London, Dorking, United Kingdom
[4]European Southern Observatory, Garching, Germany

LS V +4621 is the DAO-type central star of the planetary nebula Sh 2-216. We perform a comprehensive spectral analysis of high-resolution, high-S/N ultraviolet observations obtained with FUSE and STIS aboard the HST as well as the optical spectrum of LS V +4621 by means of state-of-the-art NLTE model-atmosphere techniques in order to compare its photospheric properties to theoretical predictions from stellar evolution theory as well as from diffusion calculations. From the N IV - N V, O IV - O VI, Si IV - Si V, and Fe V - Fe VII ionization equilibria, we determined an effective temperature of 95 ± 2 kK with high precision. The surface gravity is $\log g = 6.9 \pm 0.2$. An unexplained discrepancy appears between the spectroscopic distance $d = 224^{+46}_{-58}$ pc and the parallax distance $d = 129^{+6}_{-5}$ pc of LS V +4621. For the first time, we have identified Mg sc iv and Ar VI absorption lines in the spectrum of a hydrogen-rich central star and determined the Mg and Ar abundances as well as the individual abundances of iron-group elements (Cr, Mn, Fe, Co, and Ni). With the realistic treatment of metal opacities up to the iron group in the model-atmosphere calculations, the so-called Balmer-line problem (found in models that neglect metal-line blanketing) vanishes. Spectral analysis by means of NLTE model atmospheres has presently arrived at a high level of sophistication, which is now hampered largely by the lack of reliable atomic data and accurate line-broadening tables. Strong efforts should be made to improve upon this situation.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0706.2256

Evolutionary status of the spectral variable BD +48°1220 = IRAS 05040+4820

V.G. Klochkova[1], E.L. Chentsov[1], N.S. Tavolganskaya[1] and V.E. Panchuk[1]

[1]Special Astrophysical Observatory RAS, Nizhnij Arkhyz, Russia

Based on high-resolution observations (R = 60000 and 75000), we have studied the optical spectral variability of the star BD+48° 1220, associated with the IR-source IRAS 05040+4820. We have measured the equivalent widths of numerous absorption lines of neutral atoms and ions within the region 4500–6760 Å, as well as the corresponding radial velocities. We use model atmospheres method to determine the effective temperature $T_{\rm eff}$=7900 K, surface gravity $\log g = 0.0$,

microturbulence velocity $\xi_t = 6.0$, and the abundances for 16 elements. The metallicity of BD+48° 1220 differs little from the solar one: [Fe/H]=−0.10 dex. The main peculiarities of the chemical content of the star are a large helium excess, derived from the He I 5876 Å absorption, [He/H] = +1.04, and the oxygen excess, [O/Fe]=+0.72. The carbon overabundance is small, [C/Fe] = +0.09, and the ratio [C/O]< 1. We obtained an altered relation for the light-metal abundances: [Na/Fe] = +0.87 with [Mg/Fe] = −0.31. The barium abundance is lowered, [Ba/Fe] = −0.84. The radial velocity of the star measured from photospheric absorption lines over three years of observations varies in the interval $V_r = -(7 \div 15)\,\mathrm{km\,s^{-1}}$. Time variable differential line shifts have been revealed. The entire set of available data (the luminosity $M_v \approx -5^m$, velocity $V_{lsr} = -20\,\mathrm{km\,s^{-1}}$, metallicity [Fe/H] = −0.10, and peculiarities of the optical spectrum and chemical composition) confirms the status of BD+48° 1220 as a massive post-AGB star with He- and O-excesses belonging to the disk population.

Accepted for publication in Astronomy Reports, 2007, v.51
Available from arXiv:0706.3767

The onset of photoionization in Sakurai's Object (V4334 Sgr)

P.A.M. van Hoof[1], M. Hajduk [2], Albert A. Zijlstra[3,4], F. Herwig [5], A. Evans[5], G.C Van de Steene[1], S. Kimeswenger[6], F. Kerber[7] and S.P.S. Eyres[8]

[1]Royal Observatory of Belgium, Ringlaan 3, 1180 Brussels, Belgium
[2]Centrum Astronomii UMK, ul.Gagarina 11, PL-87-100 Torun, Poland
[3]University of Manchester, School of Physics & Astronomy, P.O. Box 88, Manchester M60 1QD, UK
[4]South African Astronomical Observatory, P.O. Box 7935, Observatory, South Africa
[5]Astrophysics Group, School of Physical and Geographical Sciences, Keele University, Staffordshire ST5 5BG, UK
[6]Institute of Astro and Particle Physics, University Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria
[7]European Southern Observatory, Karl-Schwarzschild-Straße 2, D-85748 Garching, Germany
[8]Centre for Astrophysics, University of Central Lancashire, Preston PR1 2HE, UK

We investigate the reheating of the very late thermal pulse (VLTP) object V4334 Sgr (Sakurai's Object) using radio observations from the Very Large Array, and optical spectra obtained with the Very Large Telescope. We find a sudden rise of the radio flux at 5 and 8 GHz — from $\leq 90\mu$Jy and $80 \pm 30\mu$Jy in February 2005 to 320μJy and 280μJy in June 2006. Optical line emission is also evolving, but the emission lines are fading. The optical line emission and early radio flux are attributed to a fast shock (and not photoionization as was reported earlier) which occurred around 1998. The fading is due to post-shock cooling and recombination. The recent rapid increase in radio flux is evidence for the onset of photoionization of carbon starting around 2005. The current results indicate an increase in the stellar temperature to 12 kK in 2006. The mass ejected in the VLTP eruption is $M_{ej} \geq 10^{-4}$ $M_\odot$, but could be as high as 10^{-2} $M_\odot$, depending mainly on the distance and the clumping factor of the outflow. We derive a distance between 1.8 and 5 kpc. A high mass loss could expose the helium layer and yield abundances compatible with those of [WC] and PG1159 stars.

Accepted for publication in A&A Letters
Available from arXiv:0706.3857

The formation of a detached shell around the carbon star Y CVn

Y. Libert[1], E. Gérard[2] and T. Le Bertre[1]

[1]LERMA, UMR 8112, Observatoire de Paris, 61 av. de l'Observatoire, F-75014 Paris, France
[2]GEPI, UMR 8111, Observatoire de Paris, 5 place J. Janssen, F-92195 Meudon Cedex, France

Y CVn is a carbon star surrounded by a detached dust shell that has been imaged by the *Infrared Space Observatory* at 90 μm. With the Nançay Radio Telescope we have studied the gaseous counterpart in the 21-cm H I emission line. New data have been acquired and allow to improve the signal to noise ratio on this line. The high spectral resolution line profiles obtained at the position of the star and at several offset positions set strong constraints on the

gas temperature and kinematics within the detached shell; the bulk of the material should be at $\sim$ 100–200 K and in expansion at $\sim$ 1–2 km s^{-1}. In addition, the line profile at the central position shows a quasi-rectangular pedestal that traces an 8 km s^{-1} outflow of $\sim$ 1.0 10^{-7} M$_\odot$ yr^{-1}, stable for about 2 10^4 years, which corresponds to the central outflow already studied with CO rotational lines.
We present a model in which the detached shell results from the slowing-down of the stellar wind by surrounding matter. The inner radius corresponds to the location where the stellar outflow is abruptly slowed down from $\sim$ 8 km s^{-1} to 2 km s^{-1} (termination shock). The outer radius corresponds to the location where external matter is compressed by the expanding shell (bow shock). In this model the mass loss rate of Y CVn has been set constant, at the same level of 1.0 10^{-7} M$_\odot$ yr^{-1}, for $\sim$ 4.5 10^5 years. The gas temperature varies from $\sim$ 1800 K at the inner limit to 165 K at the interface between circumstellar matter and external matter.
Our modelling shows that the presence of a detached shell around an AGB star may not mean that a drastic reduction of the mass loss rate has occurred in the past. The inner radius of such a shell might only be the effect of a termination shock rather than of an interruption of the mass loss process.

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from arXiv:0706.4211
and from http://aramis.obspm.fr/∼lebertre/Libert_YCVn_acc.pdf

Atmospheric dynamics and the mass-loss process in red supergiant stars

E. Josselin[1] *and B. Plez*[1]

[1]GRAAL, Université Montpellier II, CNRS, Place Eugene Bataillon, 34095 Montpellier Cedex, France

Context: Red supergiant stars represent a key phase in the evolution of massive stars. Recent radiative hydrodynamic simulations suggest that their atmospheres may be the location of large-scale convective motions.
Aims: As supergiant convection is expected to generate supersonic motions and shocks, we seek constraints on these atmospheric motions and their possible relation with mass-loss rates.
Methods: We present high-resolution, visible spectroscopy of a sample of red supergiants (spectral type M I) and analyse them with a tomographic technique.
Results: We observe steep velocity gradients, characterising both upward and downward supersonic motions, which are time variable on time scales of a few hundred days.
Conclusions: These convective motions will generate turbulent pressure, which will strongly decrease the effective gravity. We suggest that this decrease, combined with radiative pressure on molecular lines, initiate the mass loss in red supergiant stars.

Published in Astronomy & astrophysics
Available from arXiv:0705.0266

The massive expanding molecular torus in the planetary nebula NGC 6302

Nicolas Peretto[1]*, Gary Fuller*[1]*, Albert Zijlstra*[1] *and Nimesh Patel*[2]

[1]School of Physics & Astronomy, University of Manchester, UK
[2]Harvard-Smithsonian Center for Astrophysics, USA

We measure the mass and kinematics of the massive molecular torus in the planetary nebula NGC 6302. The nebula is the proto-typical butterfly nebula. The origin of the wing-like morphology is disputed: determining the mass-loss history of the confining torus is an important step in understanding the formation of this structure. We performed submillimeter observations with JCMT and the SMA interferometer. The continuum emission as well as the J=2-1 and 3-2 transitions of ^{12}CO and ^{13}CO are analysed at arcsecond resolution. The CO emission indicates a mass of the torus of $\sim$ 2 M$_\odot$ $\pm$ 1M$_\odot$. The ^{12}CO and ^{13}CO emission matches the dark lane seen in absorption in the Hα image of the object. The CO torus is expanding with a velocity of $\sim$ 8 km s^{-1}, centred at $V_{\rm lsr} = -31.5$ km s^{-1}. The size and

expansion velocity of the torus indicates that the torus was ejected from $\sim$ 7500 yr to 2900 yr ago, with a mass-loss rate of 5×10^{-4} $M_\odot$ yr^{-1}. We also see a ballistic component in the CO images with a velocity gradient of 140 km s^{-1} pc^{-1}. The derived mass-loss history of the torus favours binary interaction as the cause of the ejection of the torus. We predict the existence of a companion with an orbital period $P < 1$ month.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0706.3831

Low-mass lithium-rich AGB stars in the Galactic bulge: evidence for Cool Bottom Processing?

Stefan Uttenthaler[1], *Thomas Lebzelter*[1], *Sara Palmerini*[2], *Maurizio Busso*[2], *Bernhard Aringer*[1] *and Michael T. Lederer*[1]

[1]Institute for Astronomy, University of Vienna, Austria
[2]Department of Physics, University of Perugia, Italy

Context: The stellar production of the light element lithium is still a matter of debate.
Aims: We report the detection of low-mass, Li-rich Asymptotic Giant Branch (AGB) stars located in the Galactic bulge.
Methods: A homogeneous and well-selected sample of low mass, oxygen-rich AGB stars in the Galactic bulge has been searched for the absorption lines of Li. Using spectral synthesis techniques, we determine from high resolution UVES/VLT spectra the Li abundance in four out of 27 sample stars, and an upper limit for the remaining stars.
Results:Two stars in our sample have a solar Li abundance or above; these stars seem to be a novelty, since they do not show any s-element enhancement. Two more stars have a Li abundance slightly below solar; these stars do show s-element enhancement in their spectra. Different scenarios which lead to an increased Li surface abundance in AGB stars are discussed.
Conclusions: Of the different enrichment scenarios presented, Cool Bottom Processing (CBP) is the most likely one for the Li-rich objects identified here. Self-enrichment by Hot Bottom Burning (HBB) seems very unlikely as all Li-rich stars are below the HBB mass limit. Also, the ingestion of a low mass companion into the stars' envelope is unlikely because the associated additional effects are lacking. Mass transfer from a former massive binary companion is a possible scenario, if the companion produced little s-process elements. A simple theoretical estimation for the Li abundance due to CBP is presented and compared to the observed values.

Accepted for publication in A&A Letters
Available from arXiv:0707.1380

Carbonates in space - The challenge of low temperature data

Th. Posch[1], *A. Baier*[1], *H. Mutschke*[2] *and Th. Henning*[3]

[1]Institute for Astronomy, University of Vienna
[2]AIU Jena, Germany
[3]Max Planck Institute for Astronomy (MPIA), Heidelberg, Germany

Carbonates have repeatedly been discussed as possible carriers of stardust emission bands. However, the band assignments proposed so far were mainly based on room temperature powder transmission spectra of the respective minerals. Since very cold calcite grains have been claimed to be present in protostars and in Planetary Nebulae such as NGC 6302, the changes of their dielectric functions at low temperatures are relevant from an astronomical point of view.
We have derived the IR optical constants of calcite and dolomite from reflectance spectra — measured at 300, 200, 100 and 10 K — and calculated small particle spectra for different grain shapes, with the following results: i) The absorption efficiency factors both of calcite and dolomite are extremely dependent on the particle shapes. This is due to the high peak values of the optical constants of $CaCO_3$ and $CaMg[CO_3]_2$. ii) The far infrared properties of calcite

and dolomite depend also very significantly on the temperature. Below 200 K, a pronounced sharpening and increase in the band strengths of the FIR resonances occurs. iii) In view of the intrinsic strength and sharpening of the $\sim$44 μm band of calcite at 200–100 K, the absence of this band — inferred from Infrared Space Observatory data — in PNe requires dust temperatures below 45 K. iv) Calcite grains at such low temperatures can account for the '92' μm band, while our data rule out dolomite as the carrier of the 60–65 μm band.
The optical constants here presented are publicly available in the electronic database
http://www.astro.uni-jena.de/Laboratory/OCDB

Submitted to ApJ
Available from arXiv:0706.3963

Improved VLBI astrometry of OH maser stars

W.H.T. Vlemmings[1] *and H.J. van Langevelde*[2]

[1]Argelander Institute for Astronomy, University of Bonn, Germany
[2]JIVE; Leiden Observatory, The Netherlands

Aims: Accurate distances to evolved stars with high mass loss rates are needed for studies of many of their fundamental properties. However, as these stars are heavily obscured and variable, optical and infrared astrometry is unable to provide enough accuracy.
Methods: Astrometry using masers in the circumstellar envelopes can be used to overcome this problem. We have observed the OH masers of a number of Asymptotic Giant Branch (AGB) stars for approximately 1 year with the Very Long Baseline Array (VLBA). We have used the technique of phase referencing with in-beam calibrators to test the improvements this technique can provide to Very Long Baseline Interferometry (VLBI) OH maser astrometric observations.
Results: We have significantly improved the parallax and proper motion measurements of the Mira variable stars U Her, S CrB and RR Aql.
Conclusions: It is shown that both in-beam phase-referencing and a decrease in solar activity during the observations significantly improves the accuracy of the astrometric observations. The improved distances to S CrB (418^{+21}_{-18} pc) and RR Aql (633^{+214}_{-128} pc) are fully consistent with published P-L relations, but the distance to U Her (266^{+32}_{-28} pc) is significantly smaller. We conclude that for sources that are bright and have a nearby in-beam calibrator, VLBI OH maser astrometry can be used to determine distances to OH masing stars of up to $\sim$ 2 kpc.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0707.0918
and from www.astro.uni-bonn.de/$\sim$wouter/papers/astrom/astrom.shtml

The 3-D Ionization Structure and Evolution of NGC 6720, the Ring Nebula

C. R. O'Dell[1]*, F. Sabbadin*[2] *and W. J. Henney*[3]

[1]Department of Physics and Astronomy, Vanderbilt University, Box 1807-B, Nashville, TN 37235, USA
[2]INAF-Astronomical Observatory of Padua, Vicolo dell'Osservatorio 5, 35122 Padua, Italy
[3]Centro de Radioastronomía y Astrofísica, UNAM Campus Morelia, Apartado Postal 3-72, 58090 Morelia, Michaoacán, México

We have determined the gas kinematics, diagnostic and ionic radial profiles, spatial structure, and evolutionary phase of NGC 6720 (the Ring Nebula) by means of tomography and a 3-D recovery technique applied to long-slit high-resolution spectra. The main shell of the Ring Nebula is a tri-axial ellipsoid (radii 0.10, 0.13 and 0.20 pc) seen nearly pole-on and expanding in an approximately ballistic fashion ($V_{\rm exp}$ = 0.65 km s^{-1} arcsec^{-1}). The central star characteristics ($\log(L_\star/{\rm L}_\odot) \simeq 2.3$, $T_\star \simeq 120\,000$ K), combined with the nebular age of 7000 yr, indicate that the $M_\star \simeq$ 0.61-0.62 M$_\odot$ post-AGB star is approaching the white dwarf cooling sequence. The equator of the Ring Nebula is optically thick and much denser than the optically thin poles. The inner halo surrounding NGC 6720 represents the

pole-on projection of the AGB wind at high latitudes (circum-polar) directly ionized by the central star, whereas the outer, fainter and circular halo is the projection of the recombining AGB wind at mean-to-low latitudes, shadowed by the main nebula. The spatio-kinematical properties of the Ring Nebula and the origin of the dense knots commonly observed in late-stage planetary nebulae are critically compared with the predictions of radiation-hydrodynamic and wind interaction models.

Submitted to Astronomical Journal

Conference Papers

Infrared Properties Of AGB Stars: from Existing Databases to Antarctic Surveys

R. Guandalini[1] *and M. Busso*[1]

[1]Dipartimento di Fisica, Universitá di Perugia, Via A. Pascoli, 06123 Perugia, Italy

We present here a study of the Infrared properties of Asymptotic Giant Branch stars (hereafter AGB) based on existing databases, mainly from space-borne experiments. Preliminary results about C and S stars are discussed, focusing on the topics for which future Infrared surveys from Antarctica will be crucial. This kind of surveys will help in making more quantitative our knowledge of the last evolutionary stages of low mass stars, especially for what concerns luminosities and mass loss.

Oral contribution, published in EAS Publications Series, Volume 25, 2007, p. 119 , 1st ARENA Conference on "Large Astronomical Infrastructures at CONCORDIA, prospects and constraints for Antarctic optical/IR Astronomy", 16-19 October, 2006
Available from http://dx.doi.org/10.1051/eas:2007082

Methods for determining AGB mass loss rates based on radio data

Fredrik Schöier[1]

[1]Stockholm Observatory, Sweden

In the radio regime the mass-loss rate of AGB stars is best probed using molecular (and atomic) line emission arising in the CSE formed by the stellar wind. The numerical modelling of the circumstellar emission where intricate interplays between physical and chemical processes take place, is a challenge. The derived mass-loss rates depend crucially on the assumptions in the circumstellar model, of which some can be constrained if enough observational data exist. Therefore, a reliable mass-loss-rate determination for an individual star requires, in addition to a detailed radiative transfer analysis, good observational constraints in the form of multi-line observations and radial brightness distributions. Of the methods used to estimate mass-loss rates from galactic AGB stars those based on radiative transfer modelling of CO line emission are most commonly used and possibly also the most accurate. Typically, CO multi-transitional observations can constrain the mass-loss rate to better than 50%, within the adopted circumstellar model. Comparison with complementary methods, such as estimates based on dust radiative transfer modelling coupled with a dynamical model, are consistent within a factor of three.

Oral contribution, published in "Why Galaxies Care about AGB Stars", held in Vienna, August 7-11, 2006; eds. F. Kerschbaum, C. Charbonnel, B. Wing, ASP Conf.Ser.
Available from arXiv:0705.2654
and from http://www.astro.su.se/∼fredrik/papers.html

Non-equilibrium chemistry and dust formation in AGB stars as probed by SiO line emission

Fredrik L. Schöeier[1], *Hans Olofsson*[1,2], *Tony Wong*[3], *David Fong*[4], *Michael Lindqvist*[2] *and Lorant O. Sjouwerman*[5]

[1]Stockholm Observatory, Sweden

[2]Onsala Space Observatory, Sweden

[3]CSIRO Australia Telescope National Facility, Australia

[4]Harvard-Smithsonian Center for Astrophysics, USA

[5]National Radio Astronomy Observatory, USA

We have performed high spatial resolution observations of SiO line emission for a sample of 11 AGB stars using the ATCA, VLA and SMA interferometers. Detailed radiative transfer modelling suggests that there are steep chemical gradients of SiO in their circumstellar envelopes. The emerging picture is one where the radial SiO abundance distribution starts at an initial high abundance, in the case of M-stars consistent with LTE chemistry, that drastically decreases at a radius of $\sim 1 \times 10^{15}$ cm. This is consistent with a scenario where SiO freezes out onto dust grains. The region of the wind with low abundance is much more extended, typically $\sim 1 \times 10^{16}$ cm, and limited by photodissociation. The surpisingly high SiO abundances found in carbon stars requires non-equilibrium chemical processes.

Poster contribution, published in "Why Galaxies Care about AGB Stars", held in Vienna, August 7-11, 2006; F. Kerschbaum, C. Charbonnel, B. Wing eds, ASP Conf.Ser. in press
Available from arXiv:0705.2651
and from http://www.astro.su.se/∼fredrik/papers.html

Submillimeter and Millimeter Masers

Liz Humphreys[1]

[1]Harvard-Smithsonian CfA, USA

Despite theoretical predictions of the existence of many submillimeter masers, and some pioneering observational discoveries over the past few decades, these lines have remained relatively unstudied due to (i) challenges associated with observing at shorter wavelength; and, (ii) lack of possibility of high ($< 14''$ at 345 GHz) angular resolution observations. With the advent of the SMA, the first submillimeter imaging array capable of sub-arcsecond resolution, APEX, and the promise of ALMA, opportunities are opening for performing new science with millimeter/submillmeter masers. In this talk, I will review recent work in the field — including extragalactic water millimeter masers, hydrogen recombination masers, submillimeter masers in star-forming regions, and in the envelopes of evolved stars — and discuss prospects for the future.

Oral contribution, published in IAU 242: "Astrophysical Masers and their Environments", Alice Springs, March 2007
Available from arXiv:0705.4456

EVN observations of an OH maser burst in OH17.7−2.0

M. Szymczak[1], *A. Bartkiewicz*[1] *and E. Gérard*[2]

[1]Torun Centre for Astronomy, Nicolaus Copernicus University, Poland

[2]Observatoire de Paris, France

We have observed the OH 1612-MHz maser emission towards the proto-planetary nebula candidate OH17.7−2.0 that underwent a very strong and unusual outburst in 2003. Phase-referencing data were obtained with the EVN in order to localize the outburst and to examine its possible causes. The majority of the emission comes from an incomplete spherical shell with inner and outer radii of 220 and 850 mas, respectively. There is a strong evidence for maser

components that arise due to the interaction of a jet-like post-AGB outflow with the remnant outer AGB shell. The most prominent signature of such an interaction is the strongly bursting polarized emission near 73.3 km s^{-1} coming from two unresolved components of brightness temperature up to 10^{11} K located at the edge of the biconal region 2500 AU from the central star. It is remarkable that this OH biconal region is well-aligned with the polar outflow inferred from the near-infrared image.

Oral contribution, published in 8^{th} European VLBI Network Symposium
Available from arXiv:0706.0836
and from http://pos.sissa.it/cgi-bin/reader/conf.cgi?confid=36

Thresholds for the Dust Driven Mass Loss from C-rich AGB Stars

Lars Mattsson[1], *Rurik Wahlin*[1] *and Susanne Höfner*[1]

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

It is well established that mass loss from AGB stars due to dust driven winds cannot be arbitrarily low. We model the mass loss from carbon rich AGB stars using detailed frequency-dependent radiation hydrodynamics including dust formation. We present a study of the thresholds for the mass loss rate as a function of stellar parameters based on a subset of a larger grid of such models and compare these results to previous theoretical work. Furthermore, we demonstrate the impact of the pulsation mechanism and dust formation for the creation of a stellar wind and how it affects these thresholds and briefly discuss the consequences for stellar evolution.

Poster contribution, published in IAU symposium "Stellar Populations as Building Blocks of Galaxies", eds. A. Vazdekis & R. F. Peletier
Available from arXiv:0705.2809

The physics and chemistry of circumstellar envelopes of S-stars on the AGB

Sofia Ramstedt[1], *Fredrik L. Schöier*[1] *and Hans Olofsson*[1,2]

[1]Stockholm Observatory, Sweden

[2]Onsala Space Observatory, Sweden

The S-stars have been suggested to be a brief transitional phase as stars evolve from oxygen-rich M-type stars into carbon stars, through the dredge up of carbon from He-shell burning. As possible transition objects, S-stars might help achieve a deeper understanding of the chemical evolution as a star ascends the AGB, as well as shed more light on the mass-loss mechanism. We have initiated a large survey of 40 S-stars to observe line emission in common molecules such as CO, SiO, HCN, CS and SiS. Detailed radiative transfer modelling of multi-transition CO radio line observations towards a sample of 40 S-stars shows that the mass-loss rate distribution of S-stars is consistent with those found for M-type AGB stars and carbon stars. Initial results from modelling of the circumstellar SiO emission are also presented.

Poster contribution, published in Why Galaxies Care About AGB Stars
Available from arXiv:0706.2559

PhD thesis

Title: Origin and evolution of the chemical elements in light of new generation stellar models including rotation, internal gravity waves and magnetic fields

Description: New observational and theoretical advances make the present a particularly exciting time for the study of the origin and evolution of the chemical elements from the local to the high-redshit universe. With the increased light-gathering power recently achieved by the very large telescopes, abundance analysis of individual stars can now be conducted in diverse types of galactic and extragalactic systems. These studies reveal important differences of the chemical patterns in various environments that hold clues to how stellar formation and evolution as well as chemical and dynamical evolution of stellar systems vary from one environment to another. In order to interpret these observations one has to properly understand the interplay between stellar dynamics and stellar evolution. One has also to precisely describe how stars of various types contribute to the production of chemicals, and how they pollute their surroundings. This requires reliable chemical yields from new generation stellar models.

The first goal of this thesis is to provide the community with such updated chemical yields from stellar models that take into account the physical processes related to stellar rotation, internal gravity waves and magnetic fields. These models will be computed by the applicant with the stellar evolution code STAREVOL. Special emphasis will be given to low- and intermediate-mass stars. During the project the student will study the impact of the above mentioned processes on the evolutionary paths, mass loss, chemical yields and ultimate fates of individual stars. He/she will analyse how the corresponding stellar characteristics affect the chemical and dynamical evolution of the clusters and systems in which stars are born and live. The theoretical predictions will be tested with respect to relevant spectroscopic observations gathered in the Galactic halo, in open and globular clusters, and in dwarf galaxies. The long-term project aims at providing new lights on the history of chemical enrichment in different environments. It is at the crossroads of stellar physics, stellar dynamics, the physics of galaxies, and cosmology.

The project will be hosted by the Geneva Observatory under the supervision of Dr C. Charbonnel. It is financed by a FNS (Fonds National Suisse) PhD fellowship, starting on October, 2007. The recruited fellow will benefit from an international network of collaborations with some of the best world specialists on spectroscopic analysis, nuclear physics, stellar hydrodynamics and nucleosynthesis, and galactic chemical and dynamical evolution. He/she will do some short-term visits (a few weeks to a couple of months) to the University of Montreal and to the Université Libre de Bruxelles to work in close collaboration with Dr S. Talon and Dr L. Siess. He/she will participate in dissemination tasks (workshops, conferences and publications).

For more informations please contact and send your application with curriculum vitae and motivations **before July 12, 2007** to Dr Corinne Charbonnel Observatoire Astronomique de l'Université de Geneve. 51, chemin des Maillettes. 1290 Sauverny. Switzerland. Corinne.Charbonnel@obs.unige.ch. tel (41) 22 379 24 52

See also http://obswww.unige.ch/∼charbonn/

Post-doctoral position: Atmospheres of red supergiant stars

A one-year (renewable one year, funds are available) post-doctoral position is available in the astrophysics group of Montpellier University. Our group is mainly involved in stellar physics and connected subjects, including stellar atmospheres, stellar interiors and evolution, primordial stars (see http://www.graal.univ-montp2.fr). The successful applicant will work in the Stellar Atmospheres group, and is expected to actively participate to our on-going research on the dynamics of atmospheres and winds of red supergiant stars.

The research project aims at a better understanding of the atmospheric dynamics of red supergiant stars (RSG). Based on radiative hydrodynamics simulations performed with the CO5BOLD code (B. Freytag et al.; http://www.astro.uu.se/∼bf/co5bold_main.html) we compute synthetic spectra (under the assumption of pure LTE) in order to constrain dynamic properties of RSG. Non-LTE radiative transfer is however required in order to properly analyse RSG spectra, the final objective of this approach including reliable determination of abundances for these stars. A groundbreaking attack of this problem will consist in NLTE modelling of molecular lines in 1D models.

The successful candidate should thus have experience in the area of radiative transfer, spectrum synthesis, preferably in NLTE, and stellar atmosphere modelling. The net salary is about 1500 euros per month, with medical insurance and retirement plan. Adequate research resources, including travel funding, will be provided.

This project is part of the program "Massive Stars in the Local Universe" funded by the French National Science Agency (ANR), involving researchers at GRAAL and at the Laboratoire d'Astrophysique de Marseille (http://www.oamp.fr/lam/). The general goal of this program is to achieve a better understanding and treatment of mass loss in stellar atmosphere models for stars in the upper Hertzsprung-Russell diagram (for more details, see http://www.graal.univ-mtp2.fr/perso/josselin/MaSiLU.html).

Applications will be considered until the position is filled. The contract should start no later than October 2007.

The material (including resume, bibliography, statement of research and three letters of reference) should be sent to:
Dr Eric JOSSELIN
GRAAL - Université Montpellier II
cc 072
F-34095 MONTPELLIER Cedex 05
Fax: +33 4 67 14 45 35
e-mail: josselin@graal.univ-montp2.fr

See also http://www.graal.univ-montp2.fr/perso/josselin/MaSiLU.html

Splinter-Meeting: "The chemical evolution of the universe on its smallest scales: Dust in stars, disks and planets"

We set out to organize a splinter meeting at the annual meeting of the Astronomische Gesellschaft which will take place in Würzburg (Germany) September 24 - 28, 2007.

The topic of the splinter meeting "The chemical evolution of the universe on its smallest scales: Dust in stars, disks and planets" is centered around "Dust" and the intention is to get together people working on dust in different astrophysical (and linked) areas.

Usually, the topic of the entire conference is somewhat broader and a splinter meetings can narrow or add a topic. It would be very interesting if we could bring together observation, theory and laboratory across disciplines (in & outside astrophysics!) on a workshop like basis allowing for cross-disciplinary discussions.

For a summary see also http://star-www.st-and.ac.uk/ ch80/SplinterDustWuer2007.html

The conference time table is here: https://www.cosmic-matter.org/indico/conferenceTimeTable.py?confId=0

Deadlines are (were):
31 June 2007 – deadline for abstract (poster&contributed talk) submission
31 July 2007 – deadline for registration

However, if you are interested in participation let us know.

Christiane Helling
Anja Andersen
Jane Greaves