THE AGB NEWSLETTER

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

Official publication of the IAU Working Group on Abundances in Red Giants

No. 173 — 2 December 2011

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

Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is a pleasure to present you the 173rd issue of the AGB Newsletter.

However, we are very sorry to hear that Michael Friedjung passed away October 22nd, in Paris.

Michael Friedjung was born in 1940 in England of Austrian refugee parents. He was already deeply interested in science at eleven years of age, and uniting science and spirituality eventually became his aim. He studied astronomy, obtained a BSc in 1961, and obtained his PhD from the Victoria University of Manchester in 1965. After short stays in South Africa and Canada, he went to France in 1967 on a post-doctoral fellowship and later was appointed to a permanent position at the French National Center for Scientific Research (CNRS) in 1969, where he became Research Director.

Michael was an expert on novae and symbiotic binaries. His is also known for his book "Putting Soul into Science". Michael's colourful personality will be sorely missed.

Please find also the personal obituary kindly written by Roberto Viotti, one of Michael's close friends.

You may also find interesting the announcements of a Ph.D. position in Switzerland to study planet-engulfing, or the workshop on mass return from stars to galaxies at STScI.

Last month's "Food for Thought" provoked a few reactions – from people who do read the newsletter. We welcome suggestions how to make the newsletter a more effective *discussion forum* (without invoking social network media).

The next issue is planned to be distributed in early January. We wish everyone a pleasant holiday season.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Is there a place for spirituality in science?

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)

Michael Friedjung in memoriam

Last October 22nd we lost Michael Friedjung, a great scientist and an open soul friend, a big loss to Science, who, in spite of his very poor physical conditions, continued to work intensively and enthusiastically until his last hospitalisation.

Indeed, before leaving our World, Friedjung had achieved his main goals of this year, the completion of his last critical article on classical novae and the publication in French of his book "Putting Soul into Science", a masterpiece in spiritual sciences.

During the whole of his life, starting from his 1965 thesis in Manchester up to date, Michael Friedjung has given a profound contribution to the study of the "physics" of novae during their explosive evolution, and, in particular, strongly supported the model of formation of optically thick envelopes with increasing ejection velocities during the early stages after their outburst. As a worldwide known expert in novae as well in many types of interacting binaries, in particular symbiotic stars, Friedjung has had many research programmes in collaboration with very many scientists from the whole world. We want also to recall his efforts, since the beginning of his researches, to extract information on the structure of the extended envelopes of hot sources using the emission line spectrum (particularly of Fe II lines); these studies led him with his team to develop the Self Absorption Curve (SAC) Method, which can be applied to a large variety of astrophysical sources.

We think that the originality of Friedjung's researches can be better illustrated by the fact that he organised several "first" international conferences: on Novae and Related Stars (Paris, 1976), on the Nature of Symbiotic Stars (Observatoire de Haute Provence, 1981), on the Physics of Formation of Fe II Lines outside LTE (Capri Island, 1986), on the Physics of Classical Novae (Madrid, 1989).

We would finally like to recall his last single-author paper (in press in Astronomy and Astrophysics), to which Friedjung has devoted most of his remaining energies before death: it is a general discussion for belief in the presence of optically thick winds in classical novae after their explosion, a model to which he devoted many papers during his life.

I tanti amici che ha lasciato in tutto il mondo lo ricordano con affetto e profonda tristezza.

Roberto Viotti

Figure 1: Michael Friedjung in his Paris office in the 1980s (photo taken by Roberto Viotti).

Refereed Journal Papers

Study of the impact of the post-MS evolution of the host star on the orbits of close-in planets. I. Sample definition and physical properties

M.I. Jones[1,2], J.S. Jenkins[1], P. Rojo[1] and C.H.F. Melo[2]

[1]Universidad de Chile, Chile

[2]ESO, Vitacura, Chile

Context: To date, more than 30 planets have been discovered around giant stars, but only one of them has been found to be orbiting within 0.6 AU from the host star, in direct contrast to what is observed for FGK dwarfs. This result suggests that evolved stars destroy/engulf close-in planets during the red giant phase.
Aims: We are conducting a radial velocity survey of 164 bright G and K giant stars in the southern hemisphere with the aim of studying the effect of the host star evolution on the inner structure of planetary systems. In this paper we present the spectroscopic atmospheric parameters ($T_{\rm eff}$, $\log g$, ξ, [Fe/H]) and the physical properties (mass, radius, evolutionary status) of the program stars. In addition, rotational velocities for all of our targets were derived.
Methods: We used high resolution and high S/N spectra to measure the equivalent widths of many Fe I and Fe II lines, which were used to derive the atmospheric parameters by imposing local thermodynamic and ionization equilibrium. The effective temperatures and metallicities were used, along with stellar evolutionary tracks to determine the physical properties and evolutionary status of each star.
Results: We found that our targets are on average metal rich and they have masses between ~ 1.0 $M_\odot$ and 3.5 $M_\odot$. In addition, we found that 122 of our targets are ascending the RGB, while 42 of them are on the HB phase.

Accepted for publication in A&A
Available from arXiv:1110.6459

The photometric and spectral evolution of the 2008 luminous optical transient in NGC 300

Roberta M. Humphreys [1], Howard E. Bond [2], Luigi R. Bedin[3], Alceste Z. Bonanos[4], Kris Davidson [1], L.A.G. Berto Monard[5], José L. Prieto[6] and Frederick M. Walter[7]

[1]University of Minnesota, USA

[2]Space Telescope Science Institute, USA

[3]INAF – Osservatorio Astronomico di Padova, Italy

[4]National Observatory of Athens, Greece

[5]Klein Karoo Observatory, South Africa

[6]Carnegie Observatories, USA

[7]Stony Brook University, USA

The 2008 optical transient in NGC 300 is one of a growing class of intermediate-luminosity transients that brighten several orders of magnitude from a previously optically obscured state. The origin of their eruptions is not understood. Our multi-wavelength photometry and spectroscopy from maximum light to more than a year later provide a record of its post-eruption behavior. We describe its changing spectral-energy distribution, the evolution of its absorption- and emission line-spectrum, the development of a bipolar outflow, and the rapid transition from a dense wind to an optically thin ionized wind. In addition to strong, narrow hydrogen lines, the F-type absorption-line spectrum of

the transient is characterized by strong Ca II and [Ca II] emission. The very broad wings of the Ca II triplet and the asymmetric [Ca II] emission lines are due to strong Thomson scattering in the expanding ejecta. Post-maximum, the hydrogen and Ca II lines developed double-peaked emission profiles that we attribute to a bipolar outflow. Between approximately 60 and 100 days after maximum, the F-type absorption spectrum, formed in its dense wind, weakened and the wind became transparent to ionizing radiation. We discuss the probable evolutionary state of the transient and similar objects such as SN 2008S, and conclude that they were most likely post-red supergiants or post-AGB stars on a blue loop to warmer temperatures when the eruption occurred. These objects are not LBVs.

Accepted for publication in Astrophysical Journal
Available from arXiv:1109.5131

Optical and infrared imaging and spectroscopy of the multiple-shell planetary nebula NGC 6369

G. Ramos-Larios[1], *M.A. Guerrero*[2], *R. Vázquez*[3] *and J.P. Phillips*[1]

[1]Instituto de Astronomía y Meteorología, Av. Vallarta No. 2602, Col. Arcos Vallarta, C.P. 44130 Guadalajara, Jalisco, México
[2]Instituto de Astrofísica de Andalucía, CSIC, Glorieta de la Astronomía s/n, 18008 Granada, Spain
[3]Instituto de Astronomía, Universidad Nacional Autónoma de México, Apdo. Postal 877, 22800 Ensenada, B.C., México

NGC 6369 is a double-shell planetary nebula (PN) consisting of a bright annular inner shell with faint bipolar extensions and a filamentary envelope. We have used ground- and space-based narrow-band optical and near-IR images, broad-band mid-IR images, optical long-slit echelle spectra, and mid-IR spectra to investigate its physical structure. These observations indicate that the inner shell of NGC 6369 can be described as a barrel-like structure shape with polar bubble-like protrusions, and reveal evidence for H_2 and strong polycyclic aromatic hydrocarbons (PAHs) emission from a photo-dissociative region (PDR) with molecular inclusions located outside the bright inner shell. High-resolution *HST* narrow-band images reveal an intricate excitation structure of the inner shell and a system of "cometary" knots. The knotty appearance of the envelope, the lack of kinematical evidence for shell expansion and the apparent presence of emission from ionized material outside the PDR makes us suggest that the envelope of NGC 6369 is not a real shell, but a flattened structure at its equatorial regions. We report the discovery of irregular knots and blobs of diffuse emission in low-excitation and molecular line emission that are located up to $80''$ from the central star, well outside the main nebular shells. We also show that the filaments associated to the polar protrusions have spatial extents consistent with post-shock cooling regimes, and likely represent regions of interaction of these structures with surrounding material.

Accepted for publication in MNRAS
Available from arXiv:1111.1474

Metal-poor lithium-rich giants in the RAVE survey

Gregory R. Ruchti[1,2], *Jon P. Fulbright*[1], *Rosemary F.G. Wyse*[1], *Gerard F. Gilmore*[3,4], *Eva K. Grebel*[5], *Olivier Bienaymé*[6], *Joss Bland-Hawthorn*[7], *Ken C. Freeman*[8], *Brad K. Gibson*[9,10], *Ulisse Munari*[11], *Julio F. Navarro*[12], *Quentin A. Parker*[13,14,15], *Warren Reid*[14], *George M. Seabroke*[16], *Arnaud Siebert*[6], *Alessandro Siviero*[17,18], *Matthias Steinmetz*[18], *Fred G. Watson*[13], *Mary Williams*[18] *and Tomaz Zwitter*[19,20]

[1]Bloomberg Center for Physics & Astronomy, Johns Hopkins University, 3400 North Charles Street, Baltimore, MD 21218, USA: gruchti@mpa-garching.mpg.de

[2]Current Address: Max Planck Institut für Astrophysik, Postfach 1317, Karl-Schwarzschild-Str. 1, D-85748 Garching, Germany

[3]Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK

[4]Astronomy Department, Faculty of Science, King Abdulaziz University, P.O. Box 80203, Jeddah 21589, Saudi Arabia

[5]Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Mönchhofstr. 12–14, 69120 Heidelberg, Germany

[6]Observatoire de Strasbourg, 11 Rue de L'Université, 67000 Strasbourg, France

[7]Sydney Institute for Astronomy, School of Physics A28, University of Sydney, NSW 2006, Australia

[8]RSAA Australian National University, Mount Stromlo Observatory, Cotter Road, Weston Creek, Canberra, ACT 2611, Australia

[9]Jeremiah Horrocks Institute for Astrophysics & Super-computing, University of Central Lancashire, Preston, PR1 2HE, UK

[10]Department of Astronomy & Physics, Saint Marys University, Halifax, B3H 3C3, Canada

[11]INAF Osservatorio Astronomico di Padova, Via dell'Osservatorio 8, Asiago I-36012, Italy

[12]Department of Physics and Astronomy, University of Victoria, P.O. Box 3055, Station CSC, Victoria, BC V8W 3P6, Canada

[13]Australian Astronomical Observatory, Coonabarabran, NSW 2357, Australia

[14]Department of Physics and Astronomy, Macquarie University, Sydney, NSW 2109, Australia

[15]Macquarie Research Centre for Astronomy, Astrophysics & Astrophotonics, Macquarie University, Sydney, NSW 2109, Australia

[16]Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Dorking RH5 6NT, UK

[17]Department of Astronomy, Padova University, Vicolo dell'Osservatorio 2, Padova 35122, Italy

[18]Leibniz-Institut für Astrophysik Potsdam (AIP), An der Sternwarte 16, 14482 Potsdam, Germany

[19]Faculty of Mathematics and Physics, University of Ljubljana, Jadranska 19, 1000 Ljubljana, Slovenia

[20]Center of Excellence SPACE-SI, Askerceva cesta 12, 1000 Ljubljana, Slovenia

We report the discovery of eight lithium-rich field giants found in a high resolution spectroscopic sample of over 700 metal-poor stars ([Fe/H] < -0.5) selected from the RAVE survey. The majority of the Li-rich giants in our sample are very metal-poor ([Fe/H] < -1.9), and have a Li abundance (in the form of ^{7}Li), $A(\mathrm{Li}) = \log(n(\mathrm{Li})/n(\mathrm{H})) + 12$, between 2.30 and 3.63, well above the typical upper red giant branch limit, $A(\mathrm{Li}) < 0.5$, while two stars, with $A(\mathrm{Li}) \sim 1.7$–1.8, show similar lithium abundances to normal giants at the same gravity. We further included two metal-poor, Li-rich globular cluster giants in our sample, namely the previously discovered M 3-IV101 and newly discovered (in this work) M 68-A96. This comprises the largest sample of metal-poor Li-rich giants to date. We performed a detailed abundance analysis of all stars, finding that the majority our sample stars have elemental abundances similar to that of Li-normal halo giants. Although the evolutionary phase of each Li-rich giant cannot be definitively determined, the Li-rich phase is likely connected to extra mixing at the red giant branch bump or early asymptotic giant branch that triggers cool bottom processing in which the bottom of the outer convective envelope is connected to the H-burning shell in the star. The surface of a star becomes Li-enhanced as ^{7}Be (which burns to ^{7}Li) is transported to the stellar surface via the Cameron–Fowler mechanism. We discuss and discriminate among several models for the extra mixing that can cause Li-production, given the detailed abundances of the Li-rich giants in our sample.

Accepted for publication in Astrophysical Journal
Available from arXiv:1111.1623

Two populations of X-ray pulsars produced by two types of supernovae

Christian Knigge[1], *Malcolm Coe*[1] *and Philipp Podsiadlowski*[2]

[1]University of Southampton, UK

[2]University of Oxford, UK

Two types of supernova are thought to produce the overwhelming majority of neutron stars in the Universe. The first type, iron-core collapse supernovae, occurs when a high-mass star develops a degenerate iron core that exceeds the

Chandrasekhar limit. The second type, electron-capture supernovae, is associated with the collapse of a lower-mass oxygen-neon-magnesium core as it loses pressure support owing to the sudden capture of electrons by neon and/or magnesium nuclei. It has hitherto been impossible to identify the two distinct families of neutron stars produced in these formation channels. Here we report that a large, well-known class of neutron-star-hosting X-ray pulsars is actually composed of two distinct sub-populations with different characteristic spin periods, orbital periods and orbital eccentricities. This class, the Be/X-ray binaries, contains neutron stars that accrete material from a more massive companion star. The two sub-populations are most probably associated with the two distinct types of neutron-star-forming supernovae, with electron-capture supernovae preferentially producing system with short spin period, short orbital periods and low eccentricity. Intriguingly, the split between the two sub-populations is clearest in the distribution of the logarithm of spin period, a result that had not been predicted and which still remains to be explained.

Published in Nature
Available from arXiv:1111.2051

Variability of hot post-AGB star IRAS 19336−0400 in the early phase of its Planetary Nebula ionization

V.P. Arkhipova [1], M.A. Burlak[1], V.F. Esipov[1], N.P. Ikonnikova[1] and G.V. Komissarova[1]

[1]Moscow State University, Sternberg State Astronomical Institute, Moscow, Russia

We present photoelectric and spectral observations of a hot candidate protoplanetary nebula – early B-type supergiant with emission lines in spectrum – IRAS 19336−0400. The light and color curves display fast irregular brightness variations with maximum amplitudes $\Delta V = 0\overset{\mathrm{m}}{.}30$, $\Delta B = 0\overset{\mathrm{m}}{.}35$, $\Delta U = 0\overset{\mathrm{m}}{.}40$ and color–brightness correlations. By the variability characteristics IRAS 19336−0400 appears similar to other hot protoplanetary nebulae. Based on low-resolution spectra in the range λ 4000–7500 Å we have derived absolute intensities of the emission lines Hα, Hβ, Hγ, [S II], [N II], physical conditions in gaseous nebula: $n_\mathrm{e} = 10^4$ cm^{-3}, $T_\mathrm{e} = 7000 \pm 1000$ K. The emission line Hα, Hβ equivalent widths are found to be considerably variable and related to light changes. By UBV-photometry and spectroscopy the color excess has been estimated: $E_{B-V} = 0.50$–0.54. Joint photometric and spectral data analysis allows us to assume that the star variability is caused by stellar wind variations.

Accepted for publication in Pis'ma Astron. Zh. (Astronomy Letters)
Available from arXiv:1111.2408

The transition from carbon dust to silicates production in low-metallicity AGB and SAGB stars

P. Ventura[1], M. Di Criscienzo[1], R. Schneider[1], R. Carini[1,2], R. Valiante[1,3], F. D'Antona[1], S. Gallerani[1], R. Maiolino[1] and A. Tornambé[1]

[1]INAF – Osservatorio Astronomico di Roma, Via Frascati 33, 00040, Monte Porzio Catone, Italy
[2]Dipartimento di Fisica, Università di Roma "La Sapienza", P.le Aldo Moro 5, 00143, Italy
[3]INAF – Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, 50125 Firenze, Italy

We compute the mass and composition of dust produced by stars with masses in the range 1 $\mathrm{M}_\odot \leq M \leq 8$ $\mathrm{M}_\odot$ and with a metallicity of $Z = 0.001$ during their AGB and Super AGB phases. Stellar evolution is followed from the pre-main sequence phase using the code ATON which provides, at each timestep, the thermodynamics and the chemical stucture of the wind. We use a simple model to describe the growth of the dust grains under the hypothesis of a time-independent, spherically symmetric stellar wind. Although part of the modelling which describes the stellar outflow is not completely realistic, this approach allows a straight comparison with results based on similar assumptions present in the literature, and thus can be used as an indication of the uncertainties affecting the theoretical investigations focused on the dust formation process in the surroundings of AGB stars.

We find that the total mass of dust injected by AGB stars in the interstellar medium does not increase monotonically with stellar mass and ranges between a minimum of 10^{-6} $M_\odot$ for the 1.5 $M_\odot$ stellar model, up to 2×10^{-4} $M_\odot$, for the 6 $M_\odot$ case. Dust composition depends on the stellar mass: low-mass stars ($M < 3$ $M_\odot$) produce carbon-rich dust, whereas more massive stars, experiencing Hot Bottom Burning, never reach the carbon-star stage, and produce silicates and iron. This is in partial disagreement with previous investigations in the literature, which are based on synthetic AGB models and predict that, when the initial metallicity is $Z = 0.001$, C-rich dust is formed at all stellar masses. The differences are due to the different modelling of turbulent convection in the super-adiabaticity regime. Also in this case, like for other physical features of the AGB, the treatment of super-adiabatic convection shows up as the most relevant issue affecting the dust-formation process.
We also investigate Super AGB stars with masses 6.5 $M_\odot \leq M \leq 8$ $M_\odot$ that evolve over an ONe core. Due to a favourable combination of mass loss and Hot Bottom Burning, these stars are predicted to be the most efficient silicate-dust producers, releasing $[2–7]\times10^{-4}$ $M_\odot$ masses of dust.
We discuss the robustness of these predictions and their relevance for the nature and evolution of dust at early cosmic times.

Accepted for publication in MNRAS
Available from arXiv:1111.2053

The rich circumstellar chemistry of SMP LMC 11

Sarah Malek[1], *Jan Cami*[1,2] *and Jerónimo Bernard-Salas*[3]

[1]University of Western Ontario, London, Canada
[2]SETI Institute, Mountain View, USA
[3]Institut d'Astrophysique Spatiale, CNRS/Université Paris-Sud, France

Carbon-rich evolved stars from the asymptotic giant branch to the planetary nebula phase are characterized by a rich and complex carbon chemistry in their circumstellar envelopes. A peculiar object is the preplanetary nebula SMP LMC 11, whose *Spitzer*-IRS spectrum shows remarkable and diverse molecular absorption bands. To study how the molecular composition in this object compares to our current understanding of circumstellar carbon chemistry, we modeled this molecular absorption. We find high abundances for a number of molecules, perhaps most notably benzene. We also confirm the presence of propyne (CH_3C_2H) in this spectrum. Of all the cyanopolyynes, only HC_3N is evident; we can detect at best a marginal presence of HCN. From comparisons to various chemical models, we can conclude that SMP LMC 11 must have an unusual circumstellar environment (a torus rather than an outflow).

Accepted for publication in The Astrophysical Journal
Available from arXiv:1111.2533

NSV 11749, an elder sibling of the born again stars V605 Aql and V4334 Sgr?

M.M. Miller Bertolami[1,2], *R.D. Rohrmann*[3], *A. Granada*[4] *and L.G. Althaus*[1,2]

[1]Facultad de Ciencias Astronómicas y Geofísicas, Universidad Nacional de La Plata, Paseo del Bosque s/n, 1900 La Plata, Argentina
[2]CCT-La Plata, CONICET, Argentina
[3]Instituto de Ciencias Astronómicas, de la Tierra y del Espacio, CONICET, Av. de España 1512 (Sur) CC 49,5400 San Juan, Argentina
[4]Observatoire Astronomique de l'Université de Genève 51, Chemin des Maillettes, CH-1290, Sauverny, Suisse

We argue that NSV 11749, an eruption observed in the early twentieth century, was a rare event known as "very late thermal pulse" (VLTP). To support our argument we compare the lightcurve of NSV 11749 with those of the two bonafide VLTP objects known to date, V4334 Sgr and V605 Aql, and with those predicted by state of the art stellar evolution models. Next, we explore the IPHAS and 2MASS catalogues for possible counterparts of the eruption. Our analysis shows that the VLTP scenario outperforms all other proposed scenarios as an explanation of NSV 11749. We

identify an IPHAS/2MASS source at the eruption location of NSV 11749. The derived colors suggest that the object is not enshrouded in a thick dust shell as V605 Aql and V4334 Sgr. Also the absence of an apparent planetary nebula (PN) at the eruption location suggests differences with known VLTP objects which might be linked to the intensity of the eruption and the mass of the object. Further exploration of this source and scenario seems desirable. If NSV 11749 was a born again star, it would be the third event of its kind to have been observed and will strongly help us to increase our understanding on the later stages of stellar evolution and violent reactive convective burning.

Accepted for publication in ApJ Letters
Available from arXiv:1111.2333
and from http://www.fcaglp.unlp.edu.ar/~mmiller/

Evolution and nucleosynthesis of AGB stars in three Magellanic Cloud clusters

D. Kamath[1], *A.I. Karakas*[1] *and P.R. Wood*[1]

[1]Research School of Astronomy & Astrophysics, Mount Stromlo Observatory, Weston Creek ACT 2611, Australia

We present stellar evolutionary sequences for asymptotic giant branch (AGB) stars in the Magellanic Cloud clusters NGC 1978, NGC 1846 and NGC 419. The new stellar models for the three clusters match the observed effective temperatures on the giant branches, the oxygen-rich to carbon-rich transition luminosities, and the AGB-tip luminosities. A major finding is that a large amount of convective overshoot (up to 3 pressure scale heights) is required at the base of the convective envelope during third dredge-up in order to get the correct oxygen-rich to carbon-rich transition luminosity. The stellar evolution sequences are used as input for detailed nucleosynthesis calculations. For NGC 1978 and NGC 1846 we compare our model results to the observationally derived abundances of carbon and oxygen. We find that additional mixing processes (extra-mixing) are required to explain the observed abundance patterns. For NGC 1846 we conclude that non-convective extra-mixing processes are required on both the RGB and the AGB, in agreement with previous studies. For NGC 1978 it is possible to explain the C/O and $^{12}C/^{13}C$ abundances of both the O-rich and the C-rich AGB stars by assuming that the material in the intershell region contains high abundances of both C and O. This may occur during a thermal pulse when convective overshoot at the inner edge of the flash-driven convective pocket dredges C and O from the core to the intershell. For NGC 419 we provide our predicted model abundance values although there are currently no published observed abundance studies for the AGB stars in this cluster.

Accepted for publication in ApJ
Available from arXiv:1111.1722

The 5 hr pulse period and broadband spectrum of the symbiotic X-ray binary 3A 1954+319

Diana M. Marcu[1,2], *Felix Fürst*[3], *Katja Pottschmidt*[1,2], *Victoria Grinberg*[3], *Sebastian Müller*[3], *Jörn Wilms*[3], *Konstantin A. Postnov*[4], *Robin H.D. Corbet*[2,5], *Craig B. Markwardt*[5] *and Marion Cadolle Bel*[6]

[1]NASA Goddard Space Flight Center, Astrophysics Science Division, Code 661, Greenbelt, MD 20771, USA
[2]CRESST & University of Maryland Baltimore County, Baltimore, MD 21250, USA
[3]Dr. Karl Remeis Observatory & ECAP, University of Erlangen–Nuremberg, 96049 Bamberg, Germany
[4]Sternberg Astronomical Institute, 119992 Moscow, Russia
[5]NASA Goddard Space Flight Center, Astrophysics Science Division, Code 662, Greenbelt, MD 20771, USA
[6]European Space Agency, European Space Astronomy Centre, 28691 Villanueva de la Cañada, 28692 Madrid, Spain

We present an analysis of the highly variable accreting X-ray pulsar 3A 1954+319 using 2005–2009 monitoring data obtained with INTEGRAL and *Swift*. This considerably extends the pulse period history and covers flaring episodes in 2005 and 2008. In 2006 the source was identified as one of only a few known symbiotic X-ray binaries (SyXBs), i.e.,

systems composed of a neutron star accreting from the inhomogeneous medium around an M-giant star. The extremely long pulse period of ~ 5.3 hr is directly visible in the 2008 INTEGRAL-ISGRI outburst light curve. The pulse profile is double peaked and generally not significantly energy dependent although there is an indication of possible softening during the main pulse. During the outburst a strong spin-up of -1.8×10^{-4} hr hr^{-1} occurred. Between 2005 and 2008 a long-term spin-down trend of 2.1×10^{-5} hr hr^{-1} was observed for the first time for this source. The 3–80 keV pulse peak spectrum of 3A 1954+319 during the 2008 flare could be well described by a thermal Comptonization model.We interpret the results within the framework of a recently developed quasi-spherical accretion model for SyXBs.

Published in The Astrophysical Journal Letters
Available from arXiv:1111.1019

The morphology and kinematics of the Fine Ring Nebula, planetary nebula Sp 1, and the shaping influence of its binary central star

David Jones[1], Deborah Mitchell[2,3], Myfanwy Lloyd[3], Don Pollacco[4], Tim O'Brien[3], John Meaburn[3] and Neil Vaytet[5]

[1]European Southern Observatory, Chile
[2]Chalmers Tekniska Hogskola, Sweden
[3]Jodrell Bank Centre for Astrophysics, UK
[4]Queen's University Belfast, UK
[5]École Normale Supérieure de Lyon, France

We present the first detailed spatio-kinematical analysis and modelling of the planetary nebula Shapley 1 (Sp 1), which is known to contain a close-binary central star system. Close-binary central stars have been identified as a likely source of shaping in planetary nebulae, but with little observational support to date. Deep narrowband imaging in the light of [O III] λ5007Å suggests the presence of a large bow-shock to the west of the nebula, indicating that it is undergoing the first stages of an interaction with the interstellar medium. Further narrowband imaging in the light of Hα+[N II] λ6584Å combined with longslit observations of the Hα emission have been used to develop a spatio-kinematical model of Sp 1. The model clearly reveals Sp 1 to be a bipolar, axisymmetric structure viewed almost pole-on. The symmetry axis of the model nebula is within a few degrees of perpendicular to the orbital plane of the central binary system – strong evidence that the central close-binary system has played an important role in shaping the nebula. Sp 1 is one of very few nebulae to have this link, between nebular symmetry axis and binary plane, shown observationally.

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from arXiv:1111.2860

Lithium abundances along the RGB: FLAMES-GIRAFFE spectra of a large sample of low-mass Bulge stars

T. Lebzelter[1], S. Uttenthaler[1], M. Busso[2], M. Schultheis[3] and B. Aringer[4]

[1]University of Vienna, Department of Astronomy, Austria
[2]Dipartimento di Fisica, Università di Perugia, and INFN, Sezione di Perugia, Perugia, Italy
[3]Observatoire de Besançon, Besançon, France
[4]INAF – Padova Astronomical Observatory, Padova, Italy

Context: A small number of K-type giants on the red giant branch (RGB) is known to be very rich in lithium (Li). This fact is not accounted for by standard stellar evolution theory. The exact phase and mechanism of Li enrichment is still a matter of debate.
Aims: Our goal is to probe the abundance of Li along the RGB, from its base to the tip, to confine Li-rich phases that are supposed to occur on the RGB. Methods: For this end, we obtained medium-resolution spectra with the FLAMES spectrograph at the VLT in GIRAFFE mode for a large sample of 401 low-mass RGB stars located in the Galactic bulge. The Li abundance was measured in the stars with a detectable Li 670.8 nm line by means of spectral synthesis

with COMARCS model atmospheres. A new 2MASS (J–K)–T_{eff} calibration from COMARCS models is presented in the Appendix.
Results: Thirty-one stars with a detectable Li line were identified, three of which are Li-rich according to the usual criterion ($\log \epsilon(\mathrm{Li}) > 1.5$). The stars are distributed all along the RGB, not concentrated in any particular phase of the red giant evolution (e.g., the luminosity bump or the red clump). The three Li-rich stars are clearly brighter than the luminosity bump and red clump, and do not show any signs of enhanced mass loss.
Conclusions: We conclude that the Li enrichment mechanism cannot be restricted to a clearly defined phase of the RGB evolution of low-mass stars ($M \sim 1$ $M_\odot$), contrary to earlier suggestions from disk field stars.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:1111.3572

Implications of the non-detection of X-ray emission from HD 149427

Matthias Stute[1] *and Gerardo J.M. Luna*[2,3]

[1]Institute for Astronomy and Astrophysics, Section Computational Physics, Eberhard Karls University Tübingen, Germany
[2]Instituto de Ciencias Astronomicas, de la Tierra y del Espacio (ICATE), San Juan, Argentina
[3]Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA

HD 149427 is a very enigmatic object. It has been classified either as a planetary nebula or as a D′-type symbiotic star. Its distance is also highly uncertain. Furthermore, HD 149427 is a potential jet source. We report the non-detection of X-ray emission from HD 149427 and explore the implications to its nature. We observed the object with XMM-*Newton* with an effective exposure time of 33.5 ks. The upper limit for the flux of the X-ray emission in the soft band (< 2 keV) is 10^{-15} erg s^{-1} cm^{-2}, while in the hard band (> 2 keV) it is about 10^{-14} erg s^{-1} cm^{-2}. We discuss the implication of our results in light of the possible natures of HD 149427 – being a planetary nebula or a symbiotic star, close or very distant. The derived upper limits on the mass accretion rate of the white dwarf are untypical for symbiotic stars and may favor the picture of HD 149427 being a young PN. HD 149427 might be a symbiotic star in hibernation – if a symbiotic star at all. We estimate the possible mass-loss rate and kinetic luminosity of the jet and find no contradiction with our upper limit of soft X-ray emission. Therefore the jet may be still present but it was too faint to be detected via soft X-ray emission.

Published in IBVS 6003
Available from arXiv:1111.3360
and from http://www.konkoly.hu/cgi-bin/IBVS?6003

The realistic response of giant stars upon dynamical timescale mass loss

Jean-Claude Passy[1,2], *Falk Herwig*[1] *and Bill Paxton*[3]

[1]Department of Physics and Astronomy, University of Victoria, Victoria, BC, Canada
[2]Department of Astrophysics, American Museum of Natural History, New York, NY, USA
[3]Kavli Institute for Theoretical Physics, UC Santa Barbara, CA, USA

Mass transfer in close binaries significantly alters the evolution of both components. Depending on how the system parameters and the donor's radius vary, mass transfer can be dynamically unstable and lead to runaway evolution. Until now, the standard picture was that giant stars expand when they lose mass so mass transfer in systems with such donors is in most cases unstable. In this contribution, we show that this description is not accurate as it was based on invalid assumptions. We run one-dimensional simulations for donors on both the red and the asymptotic giant branches, with mass-loss rates going from 0.01 up to 2 $M_\odot$ yr^{-1}. We show that in the case of dynamical timescale mass loss, mass-losing giant stars are out of hydrostatic equilibrium and their evolution is not adiabatic as the superadiabatic outer layer of their envelope has a local thermal timescale comparable to the dynamical timescale induced by mass loss. Therefore, this layer has enough time to readjust and in most cases, giant donors do not expand.

If the mass-loss rate is high enough, the superadiabatic layer is consumed progressively and a radiative zone forms below it as the opacity decreases.

Submitted to ApJ
Available from arXiv:1111.4202

Orbital separation amplification in fragile binaries with evolved components

K.B. Johnston[1], *T.D. Oswalt*[1] *and D. Valls-Gabaud*[2]

[1]Dept. of Physics & Astronomy, Florida Institute of Technology, 150 West University Blvd., Melbourne, FL 32901, USA

[2]LERMA, CNRS UMR 8112, Observatoire de Paris, 61 Avenue de l'Observatoire, 75014 Paris, France

The secular stellar mass loss causes an amplification of the orbital separation in fragile, common proper motion, binary systems with separations of the order of 1000 A.U. In these systems, companions evolve as two independent coeval stars as they experience negligible mutual tidal interactions or mass transfer. We present models for how post-main sequence mass-loss statistically distorts the frequency distribution of separations in fragile binaries. These models demonstrate the expected increase in orbital seapration resulting from stellar mass loss, as well as a perturbation of associated orbital parameters. Comparisons between our models and observations resulting from the Luyten survey of wide visual binaries, specifically those containing MS and white-dwarf pairs, demonstrate a good agreement between the calculated and the observed angular separation distribution functions.

Accepted for publication in New Astronomy
Available from arXiv:1111.4100

Post common-envelope binaries from SDSS. XII: The orbital period distribution

A. Nebot Gómez-Morán[1,2], *B.T. Gänsicke*[3], *M.R. Schreiber*[4], *A. Rebassa-Mansergas*[4], *A.D. Schwope*[2], *J. Southworth*[5], *A. Aungwerojwit*[6,7], *M. Bothe*[2], *P.J. Davis*[8], *U. Kolb*[9], *M. Müller*[2], *C. Papadaki*[10], *S. Pyrzas*[3], *A. Rabitz*[2], *P. Rodríguez-Gil*[11,12,13], *L. Schmidtobreick*[14], *R. Schwarz*[2], *C. Tappert*[4], *O. Toloza*[4], *J. Vogel*[2] *and M. Zorotovic*[4,15]

[1]Université de Strasbourg, CNRS, UMR7550, Observatoire Astronomique de Strasbourg, 11 Rue de l'Université, F-67000 Strasbourg, France

[2]Leibniz Institut für Astrophysik Potsdam, An der Sternwarte 16, D-14482 Potsdam, Germany

[3]Department of Physics, University of Warwick, Coventry CV4 7AL, UK

[4]Departamento de Física y Astronomía, Facultad de Ciencias, Universidad de Valparaíso, Valparaíso, Chile

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

[6]Department of Physics, Faculty of Science, Naresuan University, Phitsanulok 65000, Thailand

[7]ThEP Centre, CHE, 328 Si Ayutthaya Road, Bangkok, 10400, Thailand

[8]Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, CP226, Boulevard du Triomphe, B-1050, Belgium

[9]Open University, dept. Physics & Astronomy, Milton Keynes MK7 6BJ, UK

[10]Institute of Astronomy & Astrophysics, National Observatory of Athens, 15236 Athens, Greece

[11]Instituto de Astrofísica de Canarias, Vía Lactea, s/n, La Laguna, E-38205, Tenerife, Spain

[12]Departamento de Astrofísica, Universidad de La Laguna, Avda. Astrofísico Fco. Sanchez, sn, La Laguna, E-38206, Tenerife, Spain

[13]Isaac Newton Group of Telescopes, Apartado de correos 321, S/C de la Palma, E-38700, Canary Islands, Spain

[14]European Southern Observatory, Alonso de Córdova 3107, Vitacura, Santiago, Chile

[15]Departamento de Astronomía y Astrofísica, Pontificia Universidad Católica, Vicuña Mackenna 4860, 782-0436 Macul, Chile

The complexity of the common-envelope phase and of magnetic stellar wind braking currently limits our understanding of close binary evolution. Because of their intrinsically simple structure, observational population studies of white dwarf plus main sequence (WDMS) binaries can potentially test theoretical models and constrain their parameters. The Sloan Digital Sky Survey (SDSS) has provided a large and homogeneously selected sample of WDMS binaries, which we characterise in terms of orbital and stellar parameters. We have obtained radial velocity information for 385 WDMS binaries from follow-up spectroscopy and for an additional 861 systems from the SDSS subspectra. Radial velocity variations identify 191 of these WDMS binaries as post common-envelope binaries (PCEBs). Orbital periods of 58 PCEBs were subsequently measured, predominantly from time-resolved spectroscopy, bringing the total number of SDSS PCEBs with orbital parameters to 79. Observational biases inherent to this PCEB sample were evaluated through extensive Monte Carlo simulations. We find that 21–24% of all SDSS WDMS binaries have undergone common-envelope evolution, which is in good agreement with published binary population models and high-resolution *HST* imaging of WDMS binaries unresolved from the ground. The bias-corrected orbital period distribution of PCEBs ranges from 1.9 h to 4.3 d and approximately follows a normal distribution in $\log(P_{\rm orb})$, peaking at ~ 10.3 h. There is no observational evidence for a significant population of PCEBs with periods in the range of days to weeks. The large and homogeneous sample of SDSS WDMS binaries provides the means to test fundamental predictions of binary population models, hence to observationally constrain the evolution of all close compact binaries.

Accepted for publication in A&A
Available from arXiv:1109.6662

Herschel/HIFI observations of O-rich AGB stars : molecular inventory

Kay Justtanont[1], *T. Khouri*[2], *M. Maercker*[3,16], *J. Alcolea*[4], *L. Decin*[5,2], *H. Olofsson*[1], *F.L. Schöier*[1], *V. Bujarrabal*[6], *A.P. Marston*[7], *D. Teyssier*[7], *J. Cernicharo*[8], *C. Dominik*[2,9], *A. de Koter*[2,10], *G. Melnick*[11], *K.M. Menten*[12], *D. Neufeld*[13], *P. Planesas*[4,14], *M. Schmidt*[15], *R. Szczerba*[15] *and R. Waters*[2,5]

[1]Onsala Space Observatory, Dept. Earth and Space Science, Chalmers University of Technology, S-439 92 Onsala, Sweden
[2]Sterrenkundig Instituut Anton Pannekoek, University of Amsterdam, Science Park 904, NL-1098 Amsterdam, The Netherlands
[3]University of Bonn, Argelander-Institut für Astronomie, Auf dem Hügel 71, D-53121 Bonn, Germany
[4]Observatorio Astronómico Nacional (IGN), Alfonso XII N°3, E-28014 Madrid, Spain
[5]Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium
[6]Observatorio Astronómico Nacional. Ap 112, E-28803 Alcalá de Henares, Spain
[7]European Space Astronomy Centre, ESA, P.O. Box 78, E-28691 Villanueva de la Cañada, Madrid, Spain
[8]CAB, INTA–CSIC, Ctra. de Torrejón a Ajalvir, km 4, 28850 Torrejón de Ardoz, Madrid, Spain
[9]Department of Astrophysics/IMAPP, Radboud University Nijmegen, Nijmegen, The Netherlands
[10]Astronomical Institute, Utrecht University, Princetonplein 5, 3584 CC Utrecht, The Netherlands
[11]Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA
[12]Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany
[13]Johns Hopkins University, Baltimore, MD 21218, USA
[14]Joint ALMA Observatory, Alonso de Córdova 3107, Vitacura, Santiago, Chile
[15]N. Copernicus Astronomical Center, Rabiańska 8, 87-100 Toruń, Poland
[16]European Southern Observatory, Karl Schwarzschild Str. 2, Garching bei München, Germany

Aims: Spectra, taken with the heterodyne instrument, HIFI, aboard the *Herschel* Space Observatory, of O-rich asymptotic giant branch (AGB) stars which form part of the guaranteed time key program HIFISTARS are presented. The aim of this program is to study the dynamical structure, mass-loss driving mechanism, and chemistry of the outflows from AGB stars as a function of chemical composition and initial mass.
Methods: We used the HIFI instrument to observe nine AGB stars, mainly in the H_2O and high rotational CO lines. We investigate the correlation between line luminosity, line ratio and mass-loss rate, line width and excitation energy.
Results: A total of nine different molecules, along with some of their isotopologues have been identified, covering a wide range of excitation temperature. Maser emission is detected in both the ortho- and para-H_2O molecules. The line luminosities of ground state lines of ortho- and para-H_2O, the high-J CO and NH_3 lines show a clear correlation with mass-loss rate. The line ratios of H_2O and NH_3 relative to CO $J = 6$–5 correlate with the mass-loss rate while ratios of higher CO lines to the 6–5 is independent of it. In most cases, the expansion velocity derived from the observed line width of highly excited transitions formed relatively close to the stellar photosphere is lower than that of lower excitation transitions, formed farther out, pointing to an accelerated outflow. In some objects, the vibrationally excited H_2O and SiO which probe the acceleration zone suggests the wind reaches its terminal velocity already in the innermost part of the envelope, i.e., the acceleration is rapid. Interestingly, for R Dor we find indications of a deceleration of the outflow in the region where the material has already escaped from the star.

Accepted for publication in A&A
Available from arXiv:1111:5156

Spatially resolving the outer atmosphere of the M giant BK Virginis in the CO first overtone lines with VLTI/AMBER

Keiichi Ohnaka[1], *Karl-Heinz Hofmann*[1], *Dieter Schertl*[1], *Gerd Weigelt*[1], *Fabien Malbet*[2], *Fabrizio Massi*[3], *Anthony Meilland*[4] *and Philippe Stee*[4]

[1]Max-Planck-Institut für Radioastronomie, Bonn, Germany

[2]Institut de Planétologie et d'Astrophysique de Grenoble, Grenoble, France

[3]INAF–Osservatorio Astrofisico di Arcetri, Firenze, Italy

[4]Observatoire de la Cote d'Azur, Nice, France

The mass-loss mechanism in normal K–M giant stars with small variability amplitudes is not yet understood, although the majority among red giant stars are precisely of this type. We present high-spatial and high-spectral resolution observations of the 2.3 μm CO lines in the M7 giant BK Vir with a spatial resolution of 9.8 mas and a spectral resolving power of 12000, using AMBER at the Very Large Telescope Interferometer (VLTI). The angular diameters observed in the CO lines are 12–31% larger than those measured in the continuum. We also detected asymmetry in the CO line-forming region. The data taken 1.5 months apart show possible time variation on a spatial scale of 30 mas (corresponding to 3 $\times$ stellar diameter) at the CO band head. Comparison of the observed data with the MARCS photospheric model shows that whereas the observed CO line spectrum can be satisfactorily reproduced by the model, the angular sizes observed in the CO lines are much larger than predicted by the model. Our model with two additional CO layers above the MARCS photosphere reproduces the observed spectrum and interferometric data in the CO lines simultaneously. This model suggests that the inner CO layer at $\sim$ 1.2 $R_\star$ is very dense and warm with a CO column density of $\sim 10^{22}$ cm^{-2} and temperatures of 1900–2100 K, while the outer CO layer at 2.5–3.0 $R_\star$ is characterized by column densities of 10^{19}–10^{20} cm^{-2} and temperatures of 1500–2100 K. Our AMBER observations of BK Vir have spatially resolved the extended molecular outer atmosphere of a normal M giant in the individual CO lines for the first time. The temperatures derived for the CO layers are higher than, or equal to, the uppermost layer of the MARCS photospheric model, implying the operation of some heating mechanism in the outer atmosphere.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:1111.5987

Characterization of the power excess of solar-like oscillations in red giants with *Kepler*

B. Mosser[1], *Y. Elsworth*[2], *S. Hekker*[2,3], *D. Huber*[4], *T. Kallinger*[5,6], *S. Mathur*[7], *K. Belkacem*[1], *M.J. Goupil*[1], *C. Barban*[1], *T.R. Bedding*[4], *W.J. Chaplin*[2], *R.A. García*[9], *D. Stello*[4], *J. De Ridder*[6], *C.K. Middour*[10], *R.L. Morris*[11] *and E.V Quintana*[11]

[1]LESIA, CNRS, Université Pierre et Marie Curie, Université Denis Diderot, Observatoire de Paris, 92195 Meudon, France

[2]School of Physics and Astronomy, University of Birmingham, Edgbaston, Birmingham B15 2TT, United Kingdom

[3]Astronomical Institute "Anton Pannekoek", University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands

[4]Sydney Institute for Astronomy, School of Physics, University of Sydney, NSW 2006, Australia

[5]Institute for Astronomy (IfA), University of Vienna, Türkenschanzstraße 17, 1180 Vienna, Austria

[6]Instituut voor Sterrenkunde, K.U. Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium

[7]High Altitude Observatory, NCAR, P.O. Box 3000, Boulder, CO 80307, USA

[8]Institut d'Astrophysique Spatiale, UMR 8617, Université Paris XI, Bâtiment 121, 91405 Orsay Cedex, France

[9]Laboratoire AIM, CEA/DSM CNRS - Université Paris Diderot IRFU/SAp, 91191 Gif-sur-Yvette Cedex, France

[10]Orbital Sciences Corporation/NASA Ames Research Center, Moffett Field, CA 94035, USA

[11]SETI Institute/NASA Ames Research Center, Moffett Field, CA 94035, USA

Context: The space mission *Kepler* provides us with long and uninterrupted photometric time series of red giants. This allows us to examine their seismic global properties and to compare these with theoretical predictions.
Aims: We aim to describe the oscillation power excess observed in red giant oscillation spectra with global seismic parameters, and to investigate empirical scaling relations governing these parameters. From these scalings relations, we derive new physical properties of red giant oscillations.

Methods: Various different methods were compared in order to validate the processes and to derive reliable output values. For consistency, a single method was then used to determine scaling relations for the relevant global asteroseismic parameters: mean mode height, mean height of the background signal superimposed on the oscillation power excess, width of the power excess, bolometric amplitude of the radial modes and visibility of non-radial modes. A method for deriving oscillation amplitudes is proposed, which relies on the complete identification of the red giant oscillation spectrum.
Results: The comparison of the different methods has shown the important role of the way the background is modelled. The convergence reached by the collaborative work enables us to derive significant results concerning the oscillation power excess. We obtain several scaling relations, and identify the influence of the stellar mass and the evolutionary status. The effect of helium burning on the red giant interior structure is confirmed: it yields a strong mass-radius relation for clump stars. We find that none of the amplitude scaling relations motivated by physical considerations predict the observed mode amplitudes of red giant stars. In parallel, the degree-dependent mode visibility exhibits important variations. Both effects seem related to the significant influence of the high mode mass of non-radial mixed modes. A family of red giants with very weak dipole modes is identified, and its properties are analyzed.
Conclusions: The clear correlation between the power densities of the background signal and of the stellar oscillation induces important consequences to be considered for deriving a reliable theoretical relation of the mode amplitude. As a by-product of this work, we have verified that red giant asteroseismology delivers new insights for stellar and Galactic physics, given the evidence for mass loss at the tip of the red giant branch.

Accepted for publication in A&A

New evidence for mass loss from δ Cephei from H I 21-cm line observations

L.D. Matthews[1], *M. Marengo*[2], *N.R. Evans*[3] *and G. Bono*[4,5]

[1]MIT Haystack Observatory, USA
[2]Iowa State University, USA
[3]Harvard–Smithsonian Center for Astrophysics, USA
[4]Università di Roma, Italy
[5]Rome Astronomical Observatory, Italy

Recently published *Spitzer* Space Telescope observations of the classical Cepheid archetype δ Cephei revealed an extended dusty nebula surrounding this star and its hot companion HD 213307. At far infrared wavelengths, the emission resembles a bow shock aligned with the direction of space motion of the star, indicating that δ Cephei is undergoing mass loss through a stellar wind. Here we report H I 21-cm line observations with the Very Large Array (VLA) to search for neutral atomic hydrogen associated with this wind. Our VLA data reveal a spatially extended H I nebula ($\sim 13'$ or 1 pc across) surrounding the position of δ Cephei. The nebula has a head–tail morphology, consistent with circumstellar ejecta shaped by the interaction between a stellar wind and the interstellar medium (ISM). We directly measure a mass of circumstellar atomic hydrogen $M_{\rm HI} \approx 0.07$ M$_\odot$, although the total H I mass may be larger, depending on the fraction of circumstellar material that is hidden by Galactic contamination within our band or that is present on angular scales too large to be detected by the VLA. It appears that the bulk of the circumstellar gas has originated directly from the star, although it may be augmented by material swept from the surrounding ISM. The H I data are consistent with a stellar wind with an outflow velocity $V_{\rm o} = 35.6 \pm 1.2$ km s^{-1} and a mass-loss rate of $\dot{M} \approx (1.0 \pm 0.8) \times 10^{-6}$ M$_\odot$ yr^{-1}. We have computed theoretical evolutionary tracks that include mass loss across the instability strip and show that a mass-loss rate of this magnitude, sustained over the preceding Cepheid lifetime of δ Cephei, could be sufficient to resolve a significant fraction of the discrepancy between the pulsation and evolutionary masses for this star.

Accepted for publication in ApJ
Available from arXiv:1112.0028
and from http://www.haystack.mit.edu/hay/staff/lmatthew/matthews_deltaCep.pdf

Conference Papers

Direct imaging with a hypertelescope of red supergiant stellar surfaces

Fabien Patru[1], Andrea Chiavassa[2], Denis Mourard[3] and Nassima Tarmoul[3]

[1]European Southern Observatory (ESO), Alonso de Cordova 3107, Vitacura, Santiago, Chile
[2]Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, C.P. 226, Boulevard du Triomphe, B-1050 Bruxelles, Belgium
[3]Laboratoire Fizeau UMR6525, Avenue Nicolas Copernic, 06130 Grasse, France

High angular resolution images obtained with a hypertelescope can strongly constrain the radiative-hydrodynamics simulations of red supergiant (RSG) stars, in terms of intensity contrast, granulation size and temporal variations of the convective motions that are visible on their surface. The characterization of the convective pattern in RSGs is crucial to solve the mass-loss mechanism which contributes heavily to the chemical enrichment of the Galaxy. We show here how the astrophysical objectives and the array configuration are highly dependent to design a hypertelescope. For a given field of view and a given resolution, there is a trade-off between the array geometry and the number of required telescopes to optimize either the (u, v) coverage (to recover the intensity distribution) or the dynamic range (to recover the intensity contrast). To obtain direct snapshot images of Betelgeuse with a hypertelescope, a regular and uniform layout of telescopes is the best array configuration to recover the intensity contrast and the distribution of both large and small granulation cells, but it requires a huge number of telescopes (several hundreds or thousands). An annular configuration allows a reasonable number of telescopes (lower than one hundred) to recover the spatial structures but it provides a low-contrast image. Concerning the design of a pupil densifier to combine all the beams, the photometric fluctuations are not critical Δ photometry $< 50\%$) contrary to the residual piston requirements (OPD $< \lambda/8$) which requires the development of an efficient cophasing system to fully exploit the imaging capability of a hypertelecope.

Oral contribution, published in SPIE
Available from arXiv:1108.2320

Fullerenes in circumstellar and interstellar environments

Jan Cami[1,2], Jerónimo Bernard-Salas[3,4], Els Peeters[1,2] and Sarah E. Malek[1]

[1]Department of Physics & Astronomy, The University of Western Ontario, London, ON N6A 3K7, Canada
[2]SETI Institute, 189 Bernardo Avenue Suite 100, Mountain View, CA 94043, USA
[3]Institut d'Astrophysique Spatiale, CNRS/Université Paris-Sud 11, 91405 Orsay, France
[4]Cornell University, 222 Space Sciences Bld., Ithaca, NY 14853, USA

We recently identified several emission bands in the *Spitzer*-IRS spectrum of the unusual planetary nebula Tc 1 with the infrared active vibrational modes of the neutral fullerene species C_{60} and C_{70}. Since then, the fullerene bands have been detected in a variety of sources representing circumstellar and interstellar environments. Abundance estimates suggest that C_{60} represents $\sim$ 0.1%–1.5% of the available carbon in those sources. The observed relative band intensities in various sources are not fully compatible with single-photon heating and fluorescent cooling, and are better reproduced by a thermal distribution at least in some sources. The observational data suggests that fullerenes form in the circumstellar environments of evolved stars, and survive in the interstellar medium. Precisely how they form is still a matter of debate.

Oral contribution, published in "The Molecular Universe", IAU symposium No. 280, 2010
Available from arXiv:1111.2254

White dwarf mergers and the origin of R Coronae Borealis stars

P. Lorén-Aguilar[1,2], *R. Longland*[3,2], *J. José*[3,2], *E. García-Berro*[1,2], *L.G. Althaus*[4] *and J. Isern*[5,2]

[1]Departament de Física Aplicada, Universitat Politècnica de Catalunya, c/Esteve Terrades, 5, 08860 Castelldefels, Spain

[2]Institut d'Estudis Espacials de Catalunya, c/Gran Capità 2-4, Ed. Nexus 201, 08034 Barcelona, Spain

[3]Departament de Física i Enginyeria Nuclear, Universitat Politècnica de Catalunya, c/Compte d'Urgell 187, 08036, Barcelona, Spain

[4]Facultad de Ciencias Astronómicas y Geofísicas, Universidad Nacional de La Plata, Paseo del Bosque s/n, (1900) La Plata, Argentina

[5]Institut de Ciències de l'Espai (CSIC), Facultat de Ciències, Campus UAB, 08193 Bellaterra, Spain

We present a nucleosynthesis study of the merger of a 0.4 $M_\odot$ helium white dwarf with a 0.8 $M_\odot$ carbon–oxygen white dwarf, coupling the thermodynamic history of Smoothed Particle Hydrodynamics particles with a post-processing code. The resulting chemical abundance pattern, particularly for oxygen and fluorine, is in qualitative agreement with the observed abundances in R Coronae Borealis stars.

Oral contribution, published in "Advances in Computational Astrophysics: methods, tools and outcomes", Cefalù, 2011
Available from arXiv:1110.1855

High energy emission of symbiotic recurrent novae: RS Ophiuchi and V407 Cygni

Margarita Hernanz[1] *and Vincent Tatischeff*[2]

[1]Institut de Ciències de l'Espai (CSIC–IEEC), Spain

[2]Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse CNRS/IN2P3 and Université Paris-Sud, France

Recurrent novae occurring in symbiotic binaries are candidate sources of high energy photons, reaching GeV energies. Such emission is a consequence of particle acceleration leading to pion production. The shock between matter ejected by the white dwarf, undergoing a nova explosion, and the wind from the red giant companion is responsible for such a process, which mimics a supernova remnant but with much smaller energetic output and much shorter time scales. Inverse Compton can also be responsible for high energy emission. Recent examples are V407 Cyg, detected by *Fermi*, and RS Oph, which unfortunately exploded in 2006, before *Fermi* was launched.

Poster contribution, published in Asiago Workshop on Symbiotic Stars, eds. A. Siviero & U. Munari, Baltic Astronomy special issue
Available from arXiv:1111.4129

Review Papers

Molecular processes from the AGB to the PN stage

D.A. García-Hernández[1,2]

[1]IAC, Spain

[2]ULL, Spain

Many complex organic molecules and inorganic solid-state compounds have been observed in the circumstellar shell of stars (both C-rich and O-rich) in the transition phase between Asymptotic Giant Branch (AGB) stars and Planetary Nebulae (PNe). This short ($\sim$ 100–10,000 years) phase of stellar evolution represents a wonderful laboratory for astrochemistry and provides severe constraints on any model of gas-phase and solid-state chemistry. One of the major challenges of present day astrophysics and astrochemistry is to understand the formation pathways of these

complex organic molecules and inorganic solid-state compounds (e.g., polycyclic aromatic hydrocarbons, fullerenes, and graphene in the case of a C-rich chemistry and oxides and crystalline silicates in O-rich environments) in space. In this review, I present an observational review of the molecular processes in the late stages of stellar evolution with a special emphasis on the first detections of fullerenes and graphene in PNe.

Published in IAU Symposium 283, "Planetary Nebulae: An Eye to the Future", eds. Manchado, Stanghellini & Schönberner (Invited Review)
Available from arXiv:1111.1890

Shape, structure and morphology in Planetary Nebulae

Richard A. Shaw[1]

[1]National Optical Astronomy Observatory, USA

A revival over the past two decades in planetary nebula (PN) morphological studies springs from a combination of factors, including the advent of wide-area, high dynamic range detectors; the growing archives of high resolution images from the X-ray to the sub-mm; and the advent of sophisticated models of the co-evolution of PNe and their central stars. Yet the story of PN formation from their immediate precursors, the AGB stars, is not yet fully written. PN morphology continues to inspire, provide context for physical interpretation, and serve as an ultimate standard of comparison for many investigations in this area of astrophysics. After a brief review of the remarkable successes of PN morphology, I summarize how this tool has been employed over the last half-decade to advance our understanding of PNe.

Published in IAUS 283, "Planetary Nebulae: an Eye to the Future"
Available from arXiv:1111.3269

Job Advert

Istituto Ricerche Solari Locarno PhD position in stellar physics at the Istituto Ricerche Solari Locarno (Switzerland)

Topic: Planet engulfing scenarios

A Swiss-NSF-funded PhD position is now open at the solar physics research institute Istituto Ricerche Solari Locarno, IRSOL, located in Locarno in the Southern part of Switzerland. The project will be carried out in collaboration with the University of Geneva, and Kiepenheuer Institut in Freiburg, Germany. The PhD student will be enrolled as a PhD student at the University of Geneva.

The PhD student will have the opportunity to work in a lively small group on a challenging and cutting-edge topic. The work will address on planet engulfing scenarios considering both theoretical and observational aspects. The goal will be to study the consequences on the star involved in the process of planet engulfing, through numerical modeling, and to find corresponding observational signatures. The PhD student is expected to get familiar with the instrumentation and the observational techniques at the IRSOL observatory, where it will be possible to carry out spectroscopy observations of bright stars and to perform calibration observations on the Sun. Fainter stars will be observed at the Gregor telescope in Tenerife or at other large telescopes.

We are seeking an outstanding and highly motivated candidate with a MSc or equivalent degree in astrophysics, astronomy or physics with interests in observational techniques and numerical modeling. The candidates should send a letter of motivation, a CV, academic transcripts and contact details of three potential referees by post or by email to the address below. Electronic material should be sent in a single PDF-file.

IRSOL – via Patocchi – CH-6605 Locarno Monti – Switzerland
Email: info@irsol.ch with CC: mbianda@irsol.ch
Links: www.irsol.ch

Gross annual salary: $\sim$ 40000 CHF (ca. 34000 EUR)
Review of applications will begin November 14, 2011.
Start date: to be agreed.

For more information please contact: Dr. Michele Bianda (IRSOL): mbianda@irsol.ch, +41 91 743 42 26
Prof. Georges Meynet (University of Geneva): Georges.Meynet@unige.ch
Prof. Svetlana Berdjugina (KIS): sveta@kis.uni-freiburg.de

See also http://www.irsol.ch/Concorso_dottorando.pdf

Announcement

STScI Workshop: Mass Loss Return from Stars to Galaxies

In this small workshop of about 60 participants, we will discuss the topic of mass-loss return to galaxies and the resulting dust and metal enrichment process. The workshop will be about 2.5 days and involve talks and audience-wide discussions. We have plenty of room for contributed talks and posters. As the title suggests, the focus of our workshop is four areas:

1 The parameterizations of mass-loss rates and their basis on facts for both massive stars and intermediate mass stars.

2 The variations in mass loss due to quiescent/smooth, eruptive/episodic, or explosive processes and to the effects of binary companions.

3 How these parameterizations affect both theoretical modeling of stellar evolution and estimates for mass-loss return to galaxies from stellar populations.

4 The composition in dust, metals and total gas of the ejecta and how these are incorporated into dust and chemical evolution of galaxies.

The deadline for registration is March 16$^{\rm th}$.
The deadline for abstract submission is March 2$^{\rm nd}$.

See also http://www.stsci.edu/institute/conference/stellar-mass-return