# 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. 182 — 10 September 2012

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 182$^{\rm nd}$ issue of the AGB Newsletter. R Coronæ Borealis stars are definitely in fashion! Note in particular the student report by Scarlett-Rose Boiardi on their search for R Coronæ Borealis stars in globular clusters.

In response to last month's 'Food for Thought', Noam Soker thinks "that many of the 'predicted' mergers occur at the termination of the CE evolution. This explains some properties (like H, massive envelope, and maybe more). Namely, not only FF explains massive nebula, but merger can as well. So they might be seen in star forming regions as well. This possibility is mentioned in section 5 (only one paragraph) of N. Soker (2012), http://arxiv.org/abs/1204.3173" This month's 'Food for Thought' was kindly contributed by Ehsan Moravveji.

Please see the announcement of the IAU Symposium on magnetic fields, in Biarritz in France; we also remind you of the abstract deadline for the workshop on Betelgeuse and red supergiants, in Paris (http://betelgeuse.sciencesconf.org).

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

Editorially Yours,
Jacco van Loon and Albert Zijlstra

## *Food for Thought*

This month's thought-provoking statement is:

*What is the wavelength dependence of the angular diameter of AGB stars?*

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

# *Refereed Journal Papers*

## A kinematic study of planetary nebulae in the dwarf irregular galaxy IC 10

*Denise Gonçalves*[1,2], *Ana M. Teodorescu*[3], *Alan Alves-Brito*[4], *Roberto H. Méndez*[3] *and Laura Margini*[5]

[1]Observatório do Valongo – Universidade Federal do Rio de Janeiro, Brasil

[2]Department of Physics and Astronomy, University College London, UK

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

[4]Research School of Astronomy and Astrophysics, The Australian National University, Australia

[5]INAF – Osservatorio Astrofisico di Arcetri, Italy

We present positions, kinematics, and the planetary nebula luminosity function (PNLF) for 35 planetary nebulae (PNe) in the nearest starburst galaxy IC 10 extending out to 3 kpc from the galaxy's centre. We take advantage of the deep imaging and spectroscopic capabilities provided by the spectrograph FOCAS on the 8.2m *Subaru* telescope. The PN velocities were measured through the slitless-spectroscopy technique, which allows us to explore the kinematics of IC 10 with high precision. Using these velocities, we conclude that there is a kinematic connection between the H I envelope located around IC 10 and the galaxy's PN population. By assuming that the PNe in the central regions and in the outskirts have similar ages, our results put strong observational constraints on the past tidal interactions in the Local Group. This is so because by dating the PN central stars, we, therefore, infer the epoch of a major episode of star formation likely linked to the first encounter of the H I extended envelope with the galaxy. Our deep [O III] images also allow us to use the PNLF to estimate a distance modulus of $24.1 \pm 0.25$, which is in agreement with recent results in the literature based on other techniques.

**Accepted for publication in MNRAS**
*Available from* arXiv:1207.4459

## The chemistry of extragalactic carbon stars

*Paul M. Woods*[1,2], *C. Walsh*[3], *M.A. Cordiner*[4] *and F. Kemper*[5]

[1]Department of Physics & Astronomy, University College London, Gower Street, London, WC1E 6BT, UK

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

[3]Astrophysics Research Centre, School of Mathematics & Physics, Queen's University Belfast, University Road, Belfast, BT7 1NN, UK

[4]Astrochemistry Laboratory and The Goddard Center for Astrobiology, NASA Goddard Space Flight Center, Code 691, 8800 Greenbelt Road, Greenbelt, MD 20771, USA

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

Prompted by the ongoing interest in *Spitzer* Infrared Spectrometer spectra of carbon stars in the Large Magellanic Cloud, we have investigated the circumstellar chemistry of carbon stars in low-metallicity environments. Consistent with observations, our models show that acetylene is particularly abundant in the inner regions of low metallicity carbon-rich AGB stars – more abundant than carbon monoxide. As a consequence, larger hydrocarbons have higher abundances at the metallicities of the Magellanic Clouds than in stars with solar metallicity. We also find the oxygen and nitrogen chemistry is suppressed at lower metallicity, as expected. Finally, we calculate molecular line emission from carbon stars in the Large and Small Magellanic Cloud and find that several molecules should be readily detectable with the Atacama Large Millimeter Array at Full Science operations.

**Accepted for publication in MNRAS**
*Available from* arXiv:1207.5519

# Galactic chemical evolution and the oxygen isotopic composition of the Solar System

*Larry R. Nittler*[1] *and Eric Gaidos*[2]

[1]Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, DC 20015, USA

[2]Department of Geology & Geophysics, University of Hawai'i at Manoa, Honolulu, HI 96822, USA

We review current observational and theoretical constraints on the Galactic chemical evolution (GCE) of oxygen isotopes in order to explore whether GCE plays a role in explaining the lower $^{17}O/^{18}O$ ratio of the Sun, relative to the present-day interstellar medium, or the existence of distinct $^{16}O$-rich and $^{16}O$-poor reservoirs in the Solar System. Although the production of both $^{17}O$ and $^{18}O$ are related to the metallicity of progenitor stars, $^{17}O$ is most likely produced in stars that evolve on longer timescales than those that produce $^{18}O$. Therefore the $^{17}O/^{18}O$ ratio need not have remained constant over time, contrary to preconceptions and the simplest models of GCE. An apparent linear, slope-one correlation between $\delta^{17}O$ and $\delta^{18}O$ in the ISM need not necessarily reflect an O isotopic gradient, and any slope-one galactocentric gradient need not correspond to *evolution in time*. Instead, increasing $^{17}O/^{18}O$ is consistent both with observational data from molecular clouds and with modeling of the compositions of presolar grains. Models in which the rate of star formation has decelerated over the past few Gyr or in which an enhanced period of star formation occurred shortly before solar birth ("starburst") can explain the solar–ISM O-isotopic difference without requiring a local input of supernova ejecta into the protosolar cloud. "Cosmic chemical memory" models in which interstellar dust is on average older than interstellar gas predict that primordial Solar System solids should be $^{16}O$-rich, relative to the Sun, in conflict with observations. However, scenarios exist in which the $^{16}O$-rich contribution of very massive stars could lead to $^{16}O$-poor solids and a $^{16}O$-rich bulk Sun, if the Solar System formed shortly after a starburst, independent of the popular scenario of photochemical self-shielding of CO.

**Accepted for publication in Meteoritics and Planetary Science**
*Available from* arXiv:1207.7337
*and from* http://www.dtm.ciw.edu/users/nittler/publist.html

# New determination of the $^{13}C(\alpha, n)^{16}O$ reaction rate and its influence on the *s*-process nucleosynthesis in AGB stars

*B. Guo*[1]*, Z.H. Li*[1]*, M. Lugaro*[2]*, J. Buntain*[2]*, D.Y. Pang*[3]*, Y.J. Li*[1]*, J. Su*[1]*, S.Q. Yan*[1]*, X.X. Bai*[1]*, Y.S. Chen*[1]*, Q.W. Fan*[1]*, S.J. Jin*[1]*, A.I. Karakas*[4]*, E.T. Li*[1]*, Z.C. Li*[1]*, G. Lian*[1]*, J.C. Liu*[1]*, X. Liu*[1]*, J.R. Shi*[5]*, N.C. Shu*[1]*, B.X. Wang*[1]*, Y.B. Wang*[1]*, S. Zeng*[1] *and W.P. Liu*[1]

[1]China Institute of Atomic Energy, P.O. Box 275(1), Beijing 102413, China

[2]Monash Centre for Astrophysics, Monash University, Clayton 3800, Victoria, Australia

[3]School of Physics and State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing 100871, China

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

[5]National Astronomical Observatories, Chinese Academy of Science, Beijing 100012, China

We present a new measurement of the $\alpha$-spectroscopic factor $S_\alpha$) and the asymptotic normalization coefficient (ANC) for the 6.356 MeV $1/2^+$ subthreshold state of $^{17}O$ through the $^{13}C(^{11}B, ^{7}Li)^{17}O$ transfer reaction and we determine the $\alpha$-width of this state. This is believed to have a strong effect on the rate of the $^{13}C$ $\alpha$, $n)^{16}O$ reaction, the main neutron source for *slow* neutron captures (the *s*-process) in asymptotic giant branch (AGB) stars. Based on the new width we derive the astrophysical S-factor and the stellar rate of the $^{13}C(\alpha, n)^{16}O$ reaction. At a temperature of 100 MK our rate is roughly two times larger than the CF88 rate and two times smaller than that recommended by the NACRE compilation. We use the new rate and different rates available in the literature as input in simulations of AGB stars to study their influence on the abundances of selected *s*-process elements and isotopic ratios. There are no changes in the final results using the different rates for the $^{13}C(\alpha, n)^{16}O$ reaction when the $^{13}C$ burns completely in radiative conditions. When the $^{13}C$ burns in convective conditions, as in stars of initial mass lower than $\sim 2$ $M_\odot$ and in post-AGB stars, some changes are to be expected, e.g., of up to 25% for Pb in our models. These variations will have to be carefully analyzed when more accurate stellar mixing models and more precise observational constraints are available.

**Accepted for publication in ApJ**
*Available from* arXiv:1208.0714

# Fundamental properties of the Population II fiducial stars HD 122563 and Gmb 1830 from CHARA interferometric observations

*O.L. Creevey[1], F. Thevenin[1], T.S. Boyajian[2,3], P. Kervella[4], A. Chiavassa[5], L. Bigot[1], A. Merand[6], U. Heiter[7] et al.*

[1]Laboratoire Lagrange, OCA, Nice, France
[2]CHARA, Georgia State University, Atlanta, USA
[3]Hubble Fellow
[4]LESIA, Observatoire de Paris Diderot, Meudon, France
[5]IAA, Université Libre de Bruxelles, Belgium
[6]ESO, Santiago, Chile
[7]Dept. Physics and Astronomy, Uppsala, Sweden

We have determined the angular diameters of two metal-poor stars, HD 122563 and Gmb 1830, using CHARA and Palomar Testbed Interferometer observations. For the giant star HD 122563, we derive an angular diameter $\theta_{3D} = 0.940 \pm 0.011$ milliarcseconds (mas) using limb-darkening from 3D convection simulations and for the dwarf star Gmb 1830 (HD 103095) we obtain a 1D limb-darkened angular diameter $\theta_{1D} = 0.679 \pm 0.007$ mas. Coupling the angular diameters with photometry yields effective temperatures with precisions better than 55 K ($T_{\rm eff} = 4598 \pm 41$ K and $4818 \pm 54$ K – for the giant and the dwarf star, respectively). Including their distances results in very well-determined luminosities and radii ($L = 230 \pm 6$ $L_\odot$, $R = 23.9 \pm 1.9$ $R_\odot$ and $L = 0.213 \pm 0.002$ $L_\odot$, $R = 0.664 \pm 0.015$ $R_\odot$, respectively). We used the CESAM2K stellar structure and evolution code in order to produce models that fit the observational data. We found values of the mixing-length parameter alpha (which describes 1D convection) that depend on the mass of the star. The masses were determined from the models with precisions of $< 3\%$ and with the well-measured radii excellent constraints on the surface gravity are obtained ($\log g = 1.60 \pm 0.04$, $4.59 \pm 0.02$ dex, respectively). The very small errors on both log g and $T_{\rm eff}$ provide stringent constraints for spectroscopic analyses given the sensitivity of abundances to both of these values. The precise determination of $T_{\rm eff}$ for the two stars brings into question the photometric scales for metal-poor stars.

**Accepted for publication in Astronomy and Astrophysics**
*Available from* arXiv:1207.5954

# Explaining the Type Ia supernova PTF 11kx with the core degenerate scenario

*Noam Soker[1] et al.*

[1]Technion, Israel

We argue that the multiple shells of circumstellar material (CSM) and the supernovae (SN) ejecta interaction with the CSM starting 59 days after the explosion of the Type Ia SN (SN Ia) PTF 11kx, are best described by the core-degenerate (CD) scenario for SN Ia. In the CD scenario the super-Chandrasekhar mass white dwarf (WD) is formed at the termination of the common envelope phase from a merger of a WD companion with the hot core of a massive asymptotic giant branch (AGB) star. In most cases the WD is destructed and accreted onto the more massive core. However, in rare cases where mergers take place when the WD is denser than the core, the core will be destructed and accreted onto the cooler WD. In such cases the explosion might occur with no appreciable delay, i.e., months to years after the termination of the common envelope (CE) phase. This, we propose, is the evolutionary route that lead to the explosion of PTF 11kx. The CD scenario can account for the very massive CSM within $\sim 1000$ AU of the exploding PTF 11kx star, for the presence of hydrogen, and for the presence of shells in the CSM.

**Submitted to ApJL**
*Available from* arXiv:1207.5770

## The dust and gas content of carbon stars toward the Galactic Halo

*Eric Lagadec*[1], *Greg Sloan*[2], *Albert Zijlstra*[3], *Nicolas Mauron*[4] *and Jim Houck*[2]

[1]ESO (Garching), Germany
[2]Cornell, USA
[3]Jodrell Bank Centre for Astrophysics, UK
[4]Université de Montpellier, France

We present *Spitzer* IRS spectra of four carbon stars located in the Galactic Halo and the Thick Disc. The spectra display typical features of carbon stars with SiC dust emission and $C_2H_2$ molecular absorption. Dust radiative transfer models and infrared colors enable us to determine the dust production rates for these stars whilst prior CO measurements yield expansion velocities and total mass-loss rates.
The gas properties (low expansion velocities (around 7 km $s^{-1}$) and strong $C_2H_2$ molecular absorption bands) are consistent with the stars being metal-poor. However the dust content of these stars (strong SiC emission bands) is very similar to what is observed in metal-rich carbon stars. The strong SiC emission may indicate that the carbon stars derive from a metal-rich population, or that these AGB stars produce silicon.
The origin of the Halo carbon stars is not known. They may be extrinsinc Halo stars belonging to the Halo population, they may have been accreted from a satellite galaxy such as the Sagittarius Dwarf Spheroidal Galaxy, or they may be escapees from the Galactic Disc. If the stars are intrinsically metal-rich, an origin in the Disc would be most likely. If an $\alpha$-element enhancement can be confirmed, it would argue for an origin in the Halo (which is known to be $\alpha$-enhanced) or a Galactic satellite.

**Accepted for publication in MNRAS**
*Available from* arXiv:1208.1306

## The number of progenitors in the core-degenerate scenario for Type Ia supernovae

*Marjan Ilkov*[1] *and Noam Soker*[1]

[1]Technion, Israel

We calculate the expected number of Type Ia supernovae (SN Ia) in the core-degenerate (CD) scenario and find it to match observations within the uncertainties of the code. In the CD scenario the super-Chandrasekhar mass white dwarf (WD) is formed at the termination of the common envelope phase from a merger of a WD companion with the hot core of a massive asymptotic giant branch (AGB) star. We use a simple population synthesis code that avoids the large uncertainties involved in estimating the final orbital separation of the common envelope evolution. Instead, we assume that systems where the core of the secondary AGB star is more massive than the WD remnant of the primary star merge at the termination of the common envelope phase. We also use a simple prescription to count systems that have strong interaction during the AGB phase, but not during the earlier red giant branch (RGB) phase. That a very simple population synthesis code that uses the basics of stellar evolution ingredients can match the observed rate of SN Ia might suggest that the CD-scenario plays a major role in forming SN Ia.

**Submitted to MNRAS**
*Available from* arXiv:1208.0953

## Radio sources in the *Chandra* Galactic Bulge survey

*Thomas J. Maccarone*[1], *Manuel A.P. Torres*[2,3], *Christopher T. Britt*[4], *Sandra Greiss*[5], *Robert I. Hynes*[4], *Peter G. Jonker*[2,3,6], *Danny Steeghs*[5], *Rudy Wijnands*[7] *and Gijs Nelemans*[6,8]

[1]University of Southampton, UK
[2]SRON, The Netherlands
[3]CfA, USA
[4]LSU, USA
[5]University of Warwick, UK
[6]Radoud Universiteit, Nijmegen, The Netherlands
[7]Universteit van Amsterdam, The Netherlands
[8]KU Leuven, Belgium

We discuss radio sources in the *Chandra* Galactic Bulge survey region. By cross-matching the X-ray sources in this field with the NVSS archival data, we find 12 candidate matches. We present a classification scheme for radio/X-ray matches in surveys taken in or near the Galactic Plane, taking into account other multi-wavelength data. We show that none of the matches found here is likely to be due to coronal activity from normal stars because the radio to X-ray flux ratios are systematically too high. We show that one of the sources could be a radio pulsar, and that one could be a **planetary nebula**, but that the bulk of the sources are likely to be background active galactic nuclei (AGN), with many confirmed through a variety of approaches. Several of the AGN are bright enough in the near infrared (and presumably in the optical) to use as probes of the interstellar medium in the inner Galaxy.

**Accepted for publication in MNRAS**
*Available from* arXiv:1207.5915

## The enigmatic central star of the planetary nebula PRTM 1

*Henri Boffin*[1], *Brent Miszalski*[2] *and David Jones*[1]

[1]ESO, Chile
[2]South African Astronomical Observatory & Southern African Large Telescope Foundation, South Africa

The central star of the planetary nebula PRTM 1 (PN G 243.8−37.1) was previously found to be variable by M. Peña and colleagues. As part of a larger programme aimed towards finding post common-envelope binary central stars we have monitored the central star of PRTM 1 spectroscopically and photometrically for signs of variability. Over a period of $\sim 3$ months we find minimal radial velocity ($< 10$ km s$^{-1}$) and photometric ($< 0.2$ mag) variability. The data suggest a close binary nucleus can be ruled out at all but the lowest orbital inclinations, especially considering the spherical morphology of the nebula which we reveal for the first time. Although the current data strongly support the single star hypothesis, the true nature of the central star of PRTM 1 remains enigmatic and will require further radial velocity monitoring at higher resolution to rule out a close binary. If in the odd case that it is a close binary, it would be the first such case in a spherical planetary nebula, in contradiction to current thinking.

**Accepted for publication in A&A**
*Available from* arXiv:1208.3300

## A search for RCB stars in globular clusters

*Scarlett-Rose Boiardi*[1,2], *Sebastien Roger*[1,3] *and Emmanuel Davoust*[1]

[1]IRAP, Université de Toulouse, CNRS, 14 Avenue Edouard Belin, F-31400 Toulouse, France
[2]The University of Warwick, Coventry, CV4 8UW, United Kingdom
[3]Loughborough University, Loughborough, Leicestershire, LE11 3TU, United Kingdom

There are only about 65 R Coronae Borealis stars known in our Galaxy, and none in globular clusters. As these stars are thought to result from the merger of two white dwarfs, one would expect the higher stellar density of globular

clusters to favor their formation. We have searched for such stars in Galactic globular clusters, as their presence in a specific category of clusters might provide more clues as to their formation. We selected from the WISE all-sky source catalog all the stars within the tidal radius of the 150 globular clusters within 50 kpc, which is the distance to which RCB stars are detectable by WISE. The total number of stars selected in this way was 635,989. We then successively applied the eight selection criteria of Tisserand (2012) satisfied by RCB stars to the dereddened photometric WISE and 2MASS data. Only three stars satisfying the conditions were found in the field of three globular clusters. The star in the field of Liller 1 is most probably a protostar. For the two other candidates, the absence of photometry in the visible range did not allow us to establish their nature with certainty. We further identified one dust-enshrouded star that only satisfied the first selection criteria, and used DUSTY to determine that it is a star of temperature 4800K enshrouded in a dusty envelope with a temperature 300 K and an opacity in the visible of 0.59. It is probably an X-ray binary star with a dusty accretion disk. We found no RCB stars truly belonging to a globular cluster, thus providing a constraint on their formation mechanism.

*Available from* arXiv:1208.2528

## Fundamental parameters and infrared excesses of *Hipparcos* stars

*Iain McDonald*[1]*, Albert A. Zijlstra*[1] *and Martha L. Boyer*[2]

[1]Jodrell Bank Centre for Astrophysics, Alan Turing Building, Manchester, M13 9PL, UK
[2]STScI, 3700 San Martin Drive, Baltimore, MD 21218, USA

We derive the fundamental parameters (temperature and luminosity) of 107,619 *Hipparcos* stars and place these stars on a true Hertzsprung–Russell diagram. This is achieved by comparing BT–Settl model atmospheres to spectral energy distributions (SEDs) created from *Hipparcos*, *Tycho*, SDSS, DENIS, 2MASS, MSX, AKARI, IRAS and WISE data. We also identify and quantify from these SEDs any infrared excesses attributable to circumstellar matter. We compare our results to known types of objects, focussing on the giant branch stars. Giant star dust production (as traced by infrared excess) is found to start in earnest around 680 $L_{\odot}$.

**Accepted for publication in MNRAS**
*Available from* arXiv:1208.2037

## *Herschel*/HIFI observations of red supergiants and yellow hypergiants: I. Molecular inventory

*David Teyssier*[1] *and and the HIFISTARS team*[2]

[1]ESAC, Spain
[2](A *Herschel* Guaranteed Time Key Program)

Red supergiant stars (RSGs) and yellow hypergiant stars (YHGs) are believed to be the high-mass counterparts of stars in the AGB and early post-AGB phases. We study the mass loss in the post main-sequence evolution of massive stars, through the properties of their envelopes in the intermediate and warm gas layers. These are the regions where the acceleration of the gas takes place and the most recent mass-loss episodes can be seen. We used the HIFI instrument on-board the *Herschel* Space Observatory to observe sub-mm and FIR transitions of CO, water, and their isotopologues in a sample of two RSGs (NML Cyg and Betelgeuse) and two YHGs (IRC +10°420 and AFGL 2343) stars. We present an inventory of the detected lines and analyse the information revealed by their spectral profiles. On the basis of the results presented in an earlier study, we model the CO and $^{13}$CO emission in IRC +10°420 and compare it to a set of lines ranging from the mm, to the FIR. Red supergiants have stronger high-excitation lines than the YHGs, indicating that they harbour dense and hot inner shells contributing to these transitions. Consequently, these high-J lines in RSGs originate from acceleration layers that have not yet reached the circumstellar terminal velocity and have narrower profiles than their flat-topped lower-J counterparts. The YHGs tend to lack this inner component, in line

with the picture of detached, hollow envelopes derived from studies at longer wavelengths. $NH_3$ is only detected in two sources (NML Cyg, IRC +10°420), which are also observed to be the strongest water-line emitters of the studied sample. In contrast, OH is detected in all sources and does not seem to correlate with the water line intensities. We show that the IRC +10°420 model derived solely from mm low-J CO transitions is capable of reproducing the high-J transitions when the temperature in the inner shell is simply lowered by about 30%.

**Accepted for publication in A&A**
*Available from* arXiv:1208.3143

## Can R CrB stars form from the merger of two helium white dwarfs?

*Xianfei Zhang*[1] *and C. Simon Jeffery*[1,2]

[1]Armagh Observatory, Northern Ireland
[2]School of Physics, Trinity College Dublin, Ireland

Due to orbital decay by gravitational-wave radiation, some close-binary helium white dwarfs are expected to merge within a Hubble time. The immediate merger products are believed to be helium-rich sdO stars, essentially helium main-sequence stars. We present new evolution calculations for these post-merger stars beyond the core helium-burning phase. The most massive He-sdO's develop a strong helium-burning shell and evolve to become helium-rich giants. We include nucleosynthesis calculations following the merger of 0.4 $M_\odot$ helium white-dwarf pairs with metallicities $Z = 0.0001$, 0.004, 0.008 and 0.02. The surface chemistries of the resulting giants are in partial agreement with the observed abundances of R Coronae Borealis and extreme helium stars. Such stars might represent a third, albeit rare, evolution channel for the latter, in addition to the CO+He white dwarf merger and the very-late thermal pulse channels proposed previously. We confirm a recent suggestion that lithium seen in R CrB stars could form naturally during the hot phase of a merger in the presence of $^3$He from the donor white dwarf.

**Accepted for publication in MNRAS**
*Available from* arXiv:1208.3907

## Spatial distribution and interpretation of the 3.3 $\mu$m PAH emission band of the Red Rectangle

*A. Candian*[1]*, T.H. Kerr*[2]*, I.-O. Song*[1]*, J. McCombie*[1] *and P.J. Sarre*[1]

[1]School of Chemistry, University of Nottingham, UK
[2]UKIRT, Joint Astronomy Center, Hilo, USA

The spatial distribution of 3.3 $\mu$m PAH and associated emission in the $3\farcs3 \times 6\farcs0$ inner region of the Red Rectangle nebula has been determined using the UIST imager-spectrometer at the United Kingdom Infrared Telescope (UKIRT). Interpretation of the 3.3 $\mu$m feature as comprising two spectroscopic components centred at 3.30 $\mu$m and 3.28 $\mu$m, as put forward by Song et al., is supported by these data which reveal that they have different spatial distributions. It is deduced that there are two classes of 3.3 $\mu$m band carrier with a peak wavelength separation of $\sim 0.02$ $\mu$m. From comparison of the 3.3 $\mu$m observations with laboratory and theoretical spectra for a range of PAH molecules it is proposed that the 3.28 $\mu$m and 3.30 $\mu$m components arise from 'bay' and 'non-bay' hydrogen sites, respectively, on the periphery of small neutral PAHs. Observational data are also obtained for L-band continuum emission and for the Pfund$\epsilon$ hydrogen recombination line.

**Accepted for publication in MNRAS**
*Available from* arXiv:1207.6990

# Short-lived radioactivity in the early Solar System: the Super-AGB star hypothesis

*Maria Lugaro*[1], *Carolyn L. Doherty*[1], *Amanda. I. Karakas*[2], *Sarah T. Maddison*[3], *Kurt Liffman*[4], *D.A. García-Hernández*[5,6], *Lionel Siess*[7] *and John C. Lattanzio*[1]

[1]Monash Centre for Astrophysics (MoCA), Monash University, Victoria, Australia

[2]Mt. Stromlo Observatory, Australian National University, Canberra, Australia

[3]Centre for Astrophysics & Supercomputing, Swinburne University, Australia

[4]CSIRO/MSE, Victoria, Australia

[5]Instituto de Astrofísica de Canarias, E-38200 La Laguna, Spain

[6]Departamento de Astrofísica, Universidad de La Laguna (ULL), E-38205 La Laguna, Spain

[7]Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles (ULB), Belgium

The composition of the most primitive Solar System condensates, such as calcium–aluminum-rich inclusions (CAI) and micron-sized corundum grains, show that short-lived radionuclides (SLR), e.g., $^{26}$Al, were present in the early Solar System. Their abundances require a local origin, which however is far from being understood. We present for the first time the abundances of several SLR up to $^{60}$Fe predicted from stars with initial mass in the range $\sim$ 7–11 M$_{\odot}$. These stars evolve through core H, He, and C burning. After core C burning they go through a "Super"-asymptotic giant branch (Super-AGB) phase, with the H and He shells activated alternately, episodic thermal pulses in the He shell, a very hot temperature at the base of the convective envelope ($\sim 10^8$ K), and strong stellar winds driving the H-rich envelope into the surrounding interstellar medium. The final remnants of the evolution of Super-AGB stars are mostly O–Ne white dwarfs. Our Super-AGB models produce $^{26}$Al/$^{27}$Al yield ratios $\sim$ 0.02–0.26. These models can account for the canonical value of the $^{26}$Al/$^{27}$Al ratio using dilutions with the Solar Nebula of the order of 1 part of Super-AGB mass per several $10^2$ to several $10^3$ of Solar Nebula mass, resulting in associated changes in the O composition in the range 3 permil to 20 permil. This is in agreement with observations of the O isotopic ratios in primitive Solar System condensated, which do not carry the signature of a stellar pollutor. The radionuclides $^{41}$Ca and $^{60}$Fe are produced by neutron captures in Super-AGB stars and their meteoritic abundances are also matched by some of our models, depending on the nuclear and stellar physics uncertainties as well as the meteoritic experimental data. We also expect and are currently investigating Super-AGB production of SLR heavier than iron, such as $^{107}$Pd.

**Accepted for publication in Meteoritics and Planetary Science**
*Available from* arXiv:1208.5816

# On the metallicity dependence of crystalline silicates in oxygen-rich asymptotic giant branch stars and red supergiants

*O.C. Jones*[1], *F. Kemper*[2], *B.A. Sargent*[3,4], *I. McDonald*[1], *C. Gielen*[5], *Paul M. Woods*[6], *G.C. Sloan*[7], *M.L. Boyer*[4], *A.A. Zijlstra*[1], *G.C. Clayton*[8], *K.E. Kraemer*[9], *S. Srinivasan*[10] *and P.M.E. Ruffle*[1]

[1]Jodrell Bank Centre for Astrophysics, Alan Turing Building, Oxford Road, Manchester, M13 9PL, UK

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

[3]Center for Imaging Science, Rochester Institute of Technology, 54 Lomb Memorial Drive, Rochester, NY 14623, USA

[4]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA

[5]Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium

[6]Department of Physics and Astronomy, University College London, Gower Street, London, WC1E 6BT, UK

[7]Department of Astronomy, Cornell University, Ithaca, NY 14853, USA

[8]Department of Physics and Astronomy, Louisiana State University, Baton Rouge, LA 70803, USA

[9]Institute for Scientific Research, Boston College, Kenny Cottle L106B, Newton, MA 02459-1161, USA

[10]UPMC–CNRS UMR7095, Institut d'Astrophysique de Paris, F-75014 Paris, France

We investigate the occurrence of crystalline silicates in oxygen-rich evolved stars across a range of metallicities and mass-loss rates. It has been suggested that the crystalline silicate feature strength increases with increasing mass-loss rate, implying a correlation between lattice structure and wind density. To test this, we analyse *Spitzer* IRS and Infrared Space Observatory SWS spectra of 217 oxygen-rich asymptotic giant branch and 98 red supergiants in the

Milky Way, the Large and Small Magellanic Clouds and Galactic globular clusters. These encompass a range of spectral morphologies from the spectrally-rich which exhibit a wealth of crystalline and amorphous silicate features to 'naked' (dust-free) stars. We combine spectroscopic and photometric observations with the GRAMS grid of radiative transfer models to derive (dust) mass-loss rates and temperature. We then measure the strength of the crystalline silicate bands at 23, 28 and 33 $\mu$m. We detect crystalline silicates in stars with dust mass-loss rates which span over 3 dex, down to rates of $\sim 10^{-9}$ $M_{\odot}$ $yr^{-1}$. Detections of crystalline silicates are more prevalent in higher mass-loss rate objects, though the highest mass-loss rate objects do not show the 23-$\mu$m feature, possibly due to the low temperature of the forsterite grains or it may indicate that the 23-$\mu$m band is going into absorption due to high column density. Furthermore, we detect a change in the crystalline silicate mineralogy with metallicity, with enstatite seen increasingly at low metallicity.

**Accepted for publication in MNRAS**
*Available from* arXiv:1208.4950

*Conference Paper*

# Planetary nebulae and their mimics: the MASH–MEN project

*Rozenn Boissay*[1,2,3], *Quentin A. Parker*[2,3,4], *David J. Frew*[2,3] *and Ivan Bojicic*[2,3]

[1]Observatoire Astronomique, Université Louis Pasteur, 67000 Strasbourg, France

[2]Department of Physics, Macquarie University, North Ryde, NSW 2109, Australia

[3]Macquarie University Research Centre in Astronomy, Astrophysics and Astrophotonics, Australia

[4]Australian Astronomical Observatory (AAO), Epping, NSW 1710, Australia

The total number of true, likely and possible planetary nebulae (PN) now known in the Milky Way is about 3000, approximately twice the number known a decade ago. The new discoveries are a legacy of the recent availability of wide-field, narrowband imaging surveys, primarily in the light of H$\alpha$. The two most important are the AAO/UKST SuperCOSMOS H$\alpha$ survey – SHS, and the Isaac Newton photometric H$\alpha$ survey – IPHAS, which are responsible for most of the new discoveries. A serious problem with previous PN catalogues is that several different kinds of astrophysical objects are able to mimic PN in some of their observed properties leading to significant contamination. These objects include H II regions and Strömgren zones around young O/B stars, reflection nebulae, Wolf–Rayet ejecta, supernova remnants, Herbig–Haro objects, young stellar objects, B[e] stars, symbiotic stars and outflows, late-type stars, cataclysmic variables, low redshift emission-line galaxies, and even image/detector flaws. PN catalogues such as the Macquarie/AAO/Strasbourg H$\alpha$ Planetary Nebula catalogue (MASH) have been carefully vetted to remove these mimics using the wealth of new wide-field multi-wavelength data and our 100% follow-up spectroscopy to produce a compilation of new PN discoveries of high purity. During this process significant numbers of PN mimics have been identified. The aim of this project is to compile these MASH rejects into a catalogue of Miscellaneous Emission Nebulae (MEN) and to highlight the most unusual and interesting examples. A new global analysis of these MEN objects is underway before publishing the MEN catalogue online categorizing objects by type together with their spectra and multi-wavelength images.

**Poster contribution, published in IAUS 283, "Planetary Nebulae: An Eye To The Future"**
*Available from* arXiv:1207.7237

*Announcement*

# IAUS 302 – Magnetic Fields Throughout Stellar Evolution

First announcement
IAU Symposium 302
Magnetic Fields Throughout Stellar Evolution
26–30 August 2013
Biarritz, France
http://iaus302.sciencesconf.org

Dear colleagues,

This is the first announcement for the Symposium 302 of the International Astronomical Union, entitled "Magnetic fields throughout stellar evolution". The conference will be held in Biarritz (France), 26–30 August 2013. Preregistration is now open!

Topics include:

- Stellar structure and evolution
- Magnetized accretion and outflows in young stellar objects
- Magnetic braking of PMS stars
- Solar and stellar activity in photospheres, chromospheres and coronae, and stellar cycles
- Magnetism in very low-mass stars and brown dwarfs
- Star–planet interaction
- Stellar dynamos across the HR diagram
- Magnetic field origin and stability in massive stars
- Magnetically-confined winds of massive stars
- Small-scale dynamo and mass-loss in giant and supergiant stars
- Final phases of stellar evolution: magnetism in compact objects

Confirmed speakers:

Evelyne Alecian

Jonathan Braithwaite

Jean-François Donati

Rim Fares

Oleg Kochukhov

François Lignières

Stuart Littlefair

Nanda Rea

Andreas Reisenegger

Marina Romanova

Saku Tsuneta

Aline Vidotto

Important dates:

- Early registration opens: 07 Jan 2013
- Deadline for IAU grant application: 15 Feb 2013
- Decision for IAU financial support: 08 Mar 2013
- Deadline for early registration: 01 Apr 2013
- Abstract deadline for contributed talks: 03 May 2013
- Abstract deadline for posters: 21 Jun 2013
- Deadline for proceedings submission: 30 Sep 2013

We invite you to express your interest by filling out the preregistration form on the conference webpage (http://iaus302.sciencesconf.org).
You can also join us on facebook (http://www.facebook.com/events/100425383448793/).

We hope to see as many of you as possible in Biarritz next year!

Best regards,
Pascal Petit (on behalf of the SOC and LOC)

IRAP (Univ. Toulouse & CNRS)
14 avenue Edouard Belin
31400 Toulouse, France
web : http://sites.google.com/site/pascalpetit08
email : ppetit@irap.omp.eu
tel : +33 5 61 33 28 28

*See also* http://iaus302.sciencesconf.org