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. 247 — 1 February 2018

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

Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

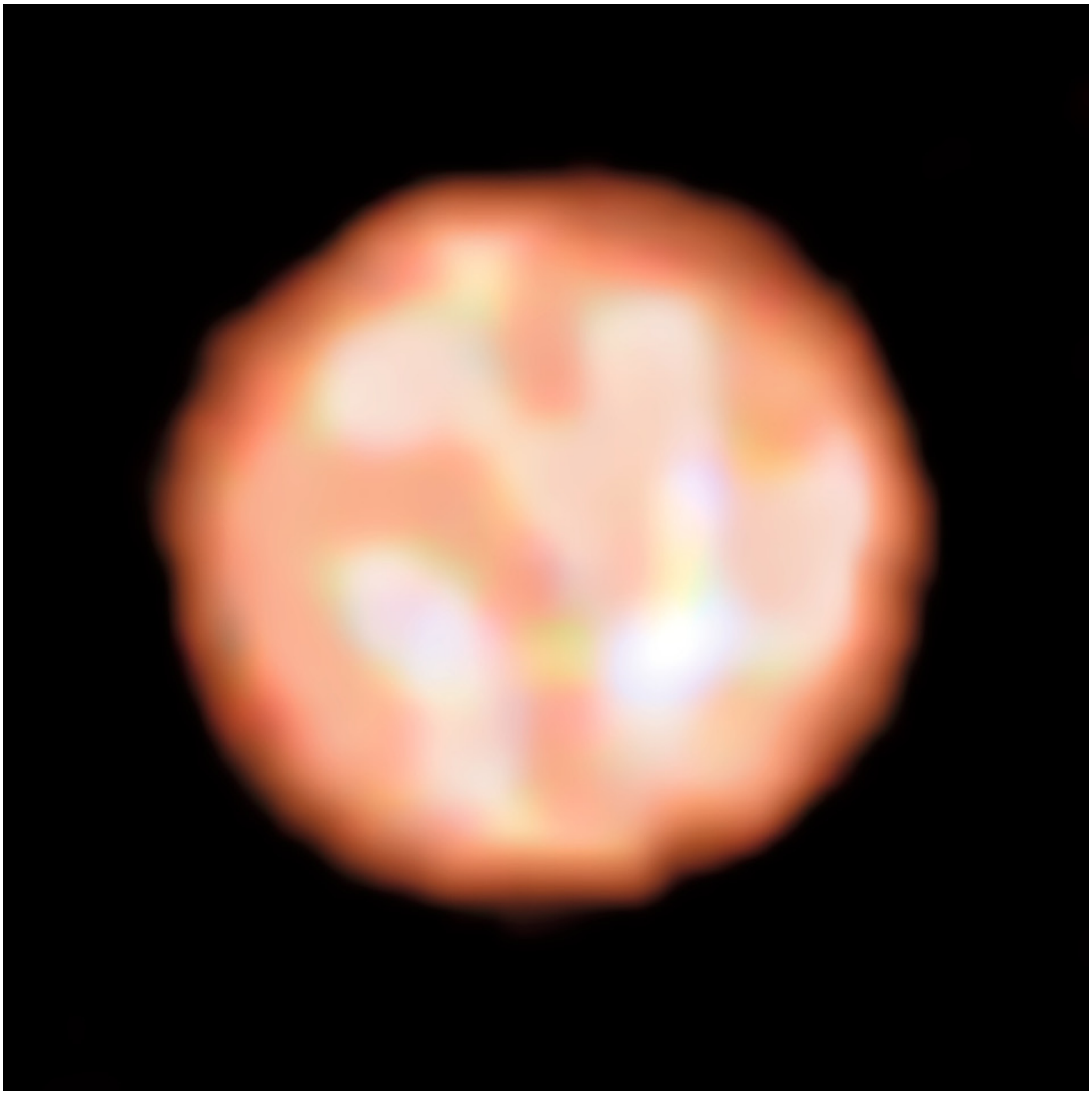

Figure 1: The surface of π^1 Gruis – see Paladini et al. (Nature).

Figure 2: The planetary nebula surrounding symbiotic binary R Aqr, suggested by Sakib Rasool and imaged by the CHART32 team – see http://www.chart32.de/index.php/component/k2/item/244 for details. His suggestion coincides remarkably well with the new work published by Tiina Liimets – see this issue of the newsletter.

Editorial

Dear Colleagues,

It is a pleasure to present you the 247th issue of the AGB Newsletter.

Jobs galore! Do you want to start a Ph.D. project? Cape Town is the place, in a fantastic group of scientists. Do you already have one, but you're looking for a postdoc position? Surely Surrey, working with one of the coolest, cleverest people in the field, should be on your list.

Do have a look also at the announcements of two meetings: one on laboratory astrophysics (Georgia, USA) and one on Gaia and other surveys (Warsaw, Poland).

We continue to welcome suggestions for the most iconic ever picture related to red giants and supergiants, for the cover of the 250th issue of the newsletter. Suggestions received so far include the magnificent shell around U Ant – https://www.eso.org/public/images/eso1730d/ (suggested by Josiah Schwab) – the *Hubble* image of the Red Rectangle – https://en.wikipedia.org/wiki/Red_Rectangle_Nebula#/media/File:Redrectangle_hst_full.jpg (suggested by Adolf Witt) – and Mira's tail – http://www.galex.caltech.edu/media/glx2007-04r_img03.html (suggested by Chris Wareing). We may need a poll!

Meanwhile, Hong Kong (China) based amateur astronomer Chairrex Chung pondered about a previous Food for Thought, "Super-AGB stars matter". We have paraphrased one of his suggestions for this month's Food for Thought.

The next issue is planned to be distributed around the 1st of March.

Editorially Yours,
Jacco van Loon, Ambra Nanni and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Should a new (sub)class of "hyper-AGB" stars be introduced for those super-AGB stars that experience off-centre neon burning, possibly leading to oxygen–neon white dwarfs with significant magnesium and aluminium content?

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

Refereed Journal Papers

Tomography of cool giant and supergiant star atmospheres I. Validation of the method

K. Kravchenko[1], *S. Van Eck*[1], *A. Chiavassa*[2], *A. Jorissen*[1], *B. Freytag*[3] *and B. Plez*[4]

[1]Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, CP. 226, Boulevard du Triomphe, 1050 Bruxelles, Belgium
[2]Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Lagrange, CS 34229, 06304 Nice Cedex 4, France
[3]Department of Physics and Astronomy at Uppsala University, Regementsvägen 1, Box 516, SE-75120 Uppsala, Sweden
[4]Laboratoire Univers et Particules de Montpellier, Université Montpellier II, CNRS, 34095, Montpellier Cedex 05, France

Context: Cool giant and supergiant star atmospheres are characterized by complex velocity fields originating from convection and pulsation processes which are not fully understood yet. The velocity fields impact the formation of spectral lines, which thus contain information on the dynamics of stellar atmospheres.
Aims: The tomographic method allows to recover the distribution of the component of the velocity field projected on the line of sight at different optical depths in the stellar atmosphere. The computation of the contribution function to the line depression aims at correctly identifying the depth of formation of spectral lines in order to construct numerical masks probing spectral lines forming at different optical depths.
Methods: The tomographic method is applied to one-dimensional (1D) model atmospheres and to a realistic three-dimensional (3D) radiative hydrodynamics simulation performed with CO5BOLD in order to compare their spectral line formation depths and velocity fields.
Results: In 1D model atmospheres, each spectral line forms in a restricted range of optical depths. On the other hand, in 3D simulations, the line formation depths are spread in the atmosphere mainly because of temperature and density inhomogeneities. Comparison of cross-correlation function (CCF) profiles obtained from 3D synthetic spectra with velocities from the 3D simulation shows that the tomographic method correctly recovers the distribution of the velocity component projected on the line of sight in the atmosphere.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1711.08327

On graphene in the interstellar medium

Xiuhui Chen[1,2], *Aigen Li*[1] *and Ke Zhang*[3]

[1]University of Missouri, USA
[2]Xiangtan University, China
[3]University of Michigan, USA

The possible detection of C_{24}, a planar graphene, recently reported in several planetary nebulæ by García-Hernández et al. (2011, 2012) inspires us to explore whether and how much graphene could exist in the interstellar medium (ISM) and how it would reveal its presence through its ultraviolet (UV) extinction and infrared (IR) emission. In principle, interstellar graphene could arise from the photochemical processing of polycyclic aromatic hydrocarbon (PAH) molecules which are abundant in the ISM through a complete loss of their hydrogen atoms, and/or from graphite which is thought to be a major dust species in the ISM through fragmentation caused by grain–grain collisional shattering. Both quantum-chemical computations and laboratory experiments have shown that the exciton-dominated electronic transitions in graphene cause a strong absorption band near 2755 Å. We calculate the UV absorption of graphene and place an upper limit of ~ 5 ppm of C/H (i.e., $\sim 1.9\%$ of the total interstellar C) on the interstellar graphene abundance. We also model the stochastic heating of graphene C_{24} excited by single starlight photons of the interstellar radiation field in the ISM and calculate its IR emission spectra. We also derive the abundance of graphene in the ISM to be < 5 ppm of C/H by comparing the model emission spectra with that observed in the ISM.

Published in ApJ, 850, 104 (2017)
Available from https://arxiv.org/abs/1710.05081
and from http://iopscience.iop.org/article/10.3847/1538-4357/aa93d5/meta

The red supergiant population in the Perseus arm

Ricardo Dorda[1]*, Ignacio Negueruela*[1] *and Carlos González-Fernández*[2]

[1]Departamento de Física, Ingeniería de Sistemas y Teoría de la Señal, Universidad de Alicante, Carretera de San Vicente s/n, San Vicente del Raspeig E03690, Alicante, Spain

[2]Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, United Kingdom

We present a new catalogue of cool supergiants in a section of the Perseus arm, most of which had not been previously identified. To generate it, we have used a set of well-defined photometric criteria to select a large number of candidates (637) that were later observed at intermediate resolution in the the Infrared Calcium Triplet spectral range, using a long-slit spectrograph. To separate red supergiants from luminous red giants, we used a statistical method, developed in previous works and improved in the present paper. We present a method to assign probabilities of being a red supergiant to a given spectrum and use the properties of a population to generate clean samples, without contamination from lower-luminosity stars. We compare our identification with a classification done using classical criteria and discuss their respective efficiencies and contaminations as identification methods. We confirm that our method is as efficient at finding supergiants as the best classical methods, but with a far lower contamination by red giants than any other method. The result is a catalogue with 197 cool supergiants, 191 of which did not appear in previous lists of red supergiants. This is the largest coherent catalogue of cool supergiants in the Galaxy.

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from https://arxiv.org/abs/1712.08176
and from https://academic.oup.com/mnras/advance-article-abstract/doi/10.1093/mnras/stx3317/4775137

The interaction of the halo around the butterfly planetary nebula NGC 650-1 with the interstellar medium

G. Ramos-Larios[1]*, M.A. Guerrero*[2]*, A. Nigoche-Netro*[1]*, L. Olguín*[3]*, M.A. Gómez-Muñoz*[4,5]*, L. Sabin*[6]*, R. Vázquez*[6]*, S. Akras*[7]*, J.C. Ramírez Vélez*[6] *and M. Chávez*[8]

[1]Instituto de Astronomía y Meteorología, Dpto. Física, CUCEI, Universidad de Guadalajara, Av. Vallarta No. 2602, CP 44130, Guadalajara, Jalisco, México

[2]Instituto de Astrofísica de Andalucía, IAA–CSIC, C/Glorieta de la Astronomía s/n, 18008 Granada, Spain

[3]Departamento de Investigación en Física, Universidad de Sonora, Blvd. Rosales-Colosio, Ed. 3H, 83190, Hermosillo, Sonora, México

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

[5]Departamento de Astrofísica, Universidad de La Laguna, E-38206, La Laguna, Tenerife, Spain

[6]Instituto de Astronomía, Universidad Nacional Autónoma de México, Apdo. Postal 877, 22860, Ensenada, B.C., México

[7]Observatório Nacional/MCTI, Rua Gen. José Cristino, 77, 20921-400, Rio de Janeiro, Brazil

[8]Instituto Nacional de Astrofísica Óptica y Electrónica, Luis Enrique Erro No. 1, 72840, Tonantzintla, Puebla, México

With its bright and wide equatorial waist seen almost edge-on (the butterfly body) and the faint and broad bipolar extensions (the butterfly wings), NGC 650-1 is the archetypical example of bipolar planetary nebula (PN) with butterfly morphology. We present here deep high-resolution broad- and narrow-band optical images that expose the rich and intricate fine structure of this bipolar PN, with small-scale bubble-like features and collimated outflows. A SHAPE spatio–kinematical model indicates that NGC 650-1 has a broad central torus with an inclination angle of 75° with respect to the line of sight, whereas that of the bipolar lobes, which are clearly seen in the position–velocity maps, is 85°. Large field of view deep images show, for first time, an arc-like diffuse envelope in low- and high-excitation emission lines located up to 180″ towards the East–Southeast of the central star, well outside the main nebula. This morphological component is confirmed by *Spitzer* MIPS and WISE infrared imaging, as well as by long-slit low- and high-dispersion optical spectroscopic observations. HST images of NGC 650-1 obtained at two different epochs (14 yrs apart), reveal the proper motion of the central star along this direction. We propose that this motion of the star through the interstellar medium compresses the remnant material of a slow Asymptotic Giant Branch wind, producing this bow-shock-like feature

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from https://arxiv.org/abs/1801.01215

Photospheric diagnostics of core helium burning in giant stars

Keith Hawkins[1], *Yuan-Sen Ting*[2] *and Hans-Walter Rix*[3]

[1]Department of Astronomy, Columbia University, 550 W 120$^{\text{th}}$ St, New York, NY 10027, USA

[2]Department of Astrophysical Sciences, Princeton University, Princeton, NJ 08544, USA

[3]Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany

Core helium burning primary red clump (RC) stars are evolved red giant stars which are excellent standard candles. As such, these stars are routinely used to map the Milky Way or determine the distance to other galaxies among other things. However distinguishing RC stars from their less evolved precursors, namely red giant branch (RGB) stars, is still a difficult challenge and has been deemed the domain of asteroseismology. In this letter, we use a sample of 1,676 RGB and RC stars which have both single epoch infrared spectra from the APOGEE survey and asteroseismic parameters and classification to show that the spectra alone can be used to (1) predict asteroseismic parameters with precision high enough to (2) distinguish core helium burning RC from other giant stars with less than 2% contamination. This will not only allow for a clean selection of a large number of standard candles across our own and other galaxies from spectroscopic surveys, but also will remove one of the primary roadblocks for stellar evolution studies of mixing and mass loss in red giant stars.

Accepted for publication in ApJ
Available from https://arxiv.org/abs/1712.02405

Evidence for eccentric, precessing gaseous debris in the circumstellar absorption toward WD 1145+017

P. Wilson Cauley[1,3], *Jay Farihi*[2], *Seth Redfield*[3], *Steven G. Parsons*[4], *Stephanie Bachman*[3,5] *and Boris T. Gänsicke*[6]

[1]Arizona State University, USA

[2]University College London, UK

[3]Wesleyan University, USA

[4]University of Sheffield, UK

[5]Indiana University of Pennsylvania, USA

[6]University of Warwick, UK

We present time-series spectra revealing changes in the circumstellar line profiles for the white dwarf WD 1145+017. Over the course of 2.2 years, the spectra show complete velocity reversals in the circumstellar absorption, moving from strongly redshifted in 2015 April to strongly blueshifted in 2017 June. The depth of the absorption also varies, increasing by a factor of two over the same period. The dramatic changes in the line profiles are consistent with eccentric circumstellar gas rings undergoing general relativistic precession. As the argument of periapsis of the rings changes relative to the line of sight, the transiting gas shifts from receding in 2016 to approaching in 2017. Based on the precession timescales in the favored model, we make predictions for the line profiles over the next few years. Spectroscopic monitoring of WD 1145+017 will test these projections and aid in developing more accurate white dwarf accretion disk models.

Published in The Astrophysical Journal Letters (2018)
Available from https://arxiv.org/abs/1712.08681
and from http://adsabs.harvard.edu/abs/2018ApJ...852L..22C

Models of the mass-ejection histories of pre-planetary nebulæ. II. The formation of the Butterfly and its proboscis in M 2–9

Bruce Balick[1], *Adam Frank*[2], *Baowei Liu*[2] *and Romano Corradi*[3]

[1]Department of Astronomy, University of Washington, Seattle, WA 98195-1580, USA; balick@uw.edu

[2]Department of Physics and Astronomy, University of Rochester, Rochester, NY 14627, USA

[3]Gran Telescopio de Canarias, S/C de Tenerife, La Palma, E38712, Spain

M 2–9, or the "Butterfly Nebula", is one of the most iconic outflow sources from an evolved star. In this paper we present a hydrodynamic model of M 2–9 in which the nebula is formed and shaped by a steady, low-density ("light"), mildly collimated "spray" of gas injected at 200 km s^{-1} that interacts with a far denser, intrinsically simple pre-existing AGB wind has slowly formed all of the complex features within M 2–9's lobes (including the knot pairs N3/S3 and N4/S4 at their respective leading edges, and the radial gradient of Doppler shifts within 20$''$ of the nucleus). We emphasize that the knot pairs are not ejected from the star but formed in situ. In addition, the observed radial speed of the knots is only indirectly related to the speed of the gas injected by the star. The model allows us to probe the early history of the wind geometry and lobe formation. We also formulate a new estimate of the nebular distance $D = 1.3$ kpc. The physical mechanism that accounts for the linear radial speed gradient in M 2–9 applies generally to many other pre planetary nebulæ whose hollow lobes exhibit similar gradients along their edges.

Accepted for publication in ApJ

Available from https://arxiv.org/abs/1712.00056

GTC/CanariCam mid-IR imaging of the fullerene-rich planetary nebula IC 418: searching for the spatial distribution of fullerene-like molecules

J.J. Díaz-Luis[1,2,3], *D.A. García-Hernández*[1,2], *A. Manchado*[1,2,4], *P. García-Lario*[5], *E. Villaver*[6] *and G. García-Segura*[7]

[1]Instituto de Astrofísica de Canarias, C/ Via Láctea s/n, E -38205 La Laguna, Spain

[2]Departamento de Astrofísica, Universidad de La Laguna (ULL), E-38206 La Laguna, Spain

[3]Observatorio Astronómico Nacional (IGN), Alfonso XII, 3 y 5, E-28014 Madrid, Spain

[4]Consejo Superior de Investigaciones Científicas, Madrid, Spain

[5]Herschel Science Centre, European Space Astronomy Centre, European Space Agency, Postbus 78, E-28691 Villanueva de la Cañada, Madrid, Spain

[6]Department of Theoretical Physics, Universidad Autónoma de Madrid, Cantoblanco, E-28049 Madrid, Spain

[7]Instituto de Astronomía, Universidad Nacional Autónoma de México, Km. 103 Carr. Tijuana–Ensenada, 22860, Ensenada, B.C., México

We present seeing-limited narrow-band mid-IR GTC/CanariCam images of the spatially extended fullerene-containing planetary nebula (PN) IC 418. The narrow-band images cover the C_{60} fullerene band at 17.4 μm, the polycyclic aromatic hydrocarbon like (PAH-like) feature at 11.3 μm, the broad 9–13 μm feature, and their adjacent continua at 9.8 and 20.5 μm. We study the relative spatial distribution of these complex species, all detected in the *Spitzer* and Infrared Space Observatory (ISO) spectra of IC 418, with the aim of getting observational constraints to the formation process of fullerenes in H-rich circumstellar environments. A similar ring-like extended structure is seen in all narrow-band filters, except in the dust continuum emission at 9.8 μm, which peaks closer to the central star. The continuum-subtracted images display a clear ring-like extended structure for the carrier of the broad 9–13 μm emission, while the spatial distribution of the (PAH-like) 11.3 μm emission is not so well defined. Interestingly, a residual C_{60} 17.4 μm emission (at about 4-σ from the sky background) is seen when subtracting the dust continuum emission at 20.5 μm. This residual C_{60} emission, if real, might have several interpretations; the most exciting being perhaps that other fullerene-based species like hydrogenated fullerenes with very low H-content may contribute to the observed 17.4 μm emission. We conclude that higher sensitivity mid-IR images and spatially resolved spectroscopic observations (especially in the Q-band) are necessary to get some clues about fullerene formation in PNe.

Accepted for publication in The Astronomical Journal

Available from https://arxiv.org/abs/1801.03722

Large granulation cells on the surface of the giant star π^1 Gruis

C. Paladini[1,2], *F. Baron*[3], *A. Jorissen*[1], *J.-B. Le Bouquin*[4], *B. Freytag*[5], *S. Van Eck*[1], *M. Wittkowski*[6], *J. Hron*[7], *A. Chiavassa*[8], *J.-P. Berger*[4], *C. Siopis*[1], *A. Mayer*[7], *G. Sadowski*[1], *K. Kravchenko*[1], *S. Shetye*[1], *F. Kerschbaum*[7], *J. Kluska*[9] *and S. Ramstedt*[5]

[1]Institut d'Astronomie et d'Astrophysique, Université libre de Bruxelles, CP. 226, 1050 Bruxelles, Belgium

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

[3]Department of Physics and Astronomy, Georgia State University, P.O. Box 5060 Atlanta, Georgia 30302-5060, USA

[4]Université Grenoble Alpes, CNRS, IPAG, 38000 Grenoble, France

[5]Department of Physics and Astronomy, Uppsala University, Box 516, 75120 Uppsala, Sweden

[6]European Southern Observatory, Karl-Schwarzschild-Straße 2, 85748 Garching bei München, Germany

[7]Department of Astrophysics, University of Vienna, Türkenschanzstraße 17, 1180 Vienna, Austria

[8]Laboratoire Lagrange, UMR 7293, Université de Nice Sophia-Antipolis, CNRS, Observatoire de la Côte d'Azur, BP 4229, 06304 Nice Cedex 4, France

[9]University of Exeter, Department of Physics and Astronomy, Stocker Road, Exeter EX4 4QL, UK

Convection plays a major part in many astrophysical processes, including energy transport, pulsation, dynamos and winds on evolved stars, in dust clouds and on brown dwarfs. Most of our knowledge about stellar convection has come from studying the Sun: about two million convective cells with typical sizes of around 2,000 kilometres across are present on the surface of the Sun a phenomenon known as granulation. But on the surfaces of giant and supergiant stars there should be only a few large (several tens of thousands of times larger than those on the Sun) convective cells, owing to low surface gravity. Deriving the characteristic properties of convection (such as granule size and contrast) for the most evolved giant and supergiant stars is challenging because their photospheres are obscured by dust, which partially masks the convective patterns. These properties can be inferred from geometric model fitting, but this indirect method does not provide information about the physical origin of the convective cells. Here we report interferometric images of the surface of the evolved giant star π^1 Gruis, of spectral type S5,7. Our images show a nearly circular, dust-free atmosphere, which is very compact and only weakly affected by molecular opacity. We find that the stellar surface has a complex convective pattern with an average intensity contrast of 12 per cent, which increases towards shorter wavelengths. We derive a characteristic horizontal granule size of about 1.2×10^11 metres, which corresponds to 27 per cent of the diameter of the star. Our measurements fall along the scaling relations between granule size, effective temperature and surface gravity that are predicted by simulations of stellar surface convection.

Accepted for publication in Nature

Available from https://www.nature.com/articles/nature25001

The Stagger-grid: A grid of 3D stellar atmosphere models V. Synthetic stellar spectra and broad-band photometry

A. Chiavassa[1], *L. Casagrande*[2], *R. Collet*[3], *Z. Magic*[4,5], *L. Bigot*[1], *F. Thevenin*[1] *and M. Asplund*[2]

[1]Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Lagrange, CS 34229, Nice, France

[2]Research School of Astronomy & Astrophysics, Australian National University, Cotter Road, Weston ACT 2611, Australia

[3]Stellar Astrophysics Centre, Department of Physics and Astronomy, Ny Munkegade 120, Århus University, DK-8000 Århus C, Denmark

[4]Niels Bohr Institute, University of Copenhagen, Juliane Maries Vej 30, DK-2100 Copenhagen, Denmark

[5]Centre for Star and Planet Formation, Natural History Museum of Denmark, University of Copenhagen, Øster Voldgade 5-7, DK-1350 Copenhagen, Denmark

Context: The surface structures and dynamics of cool stars are characterised by the presence of convective motions and turbulent flows which shape the emergent spectrum.

Aims: We used realistic three-dimensional (3D) radiative hydrodynamical simulations from the Stagger-grid to calculate synthetic spectra with the radiative transfer code Optim3D for stars with different stellar parameters to predict photometric colours and convective velocity shifts.

Methods: We calculated spectra from 1000 to 200 000 Å with a constant resolving power of $\lambda/\Delta\lambda = 20\,000$ and from 8470 and 8710 Å (Gaia Radial Velocity Spectrometer – RVS – spectral range) with a constant resolving power of $\lambda/\Delta\lambda = 300\,000$.

Results: We used synthetic spectra to compute theoretical colours in the Johnson–Cousins UBV(RI)C, SDSS, 2MASS, Gaia, SkyMap- per, Strömgren systems, and HST-WFC3. Our synthetic magnitudes are compared with those obtained using 1D hydrostatic models. We showed that 1D versus 3D differences are limited to a small percent except for the narrow filters that span the optical and UV region of the spectrum. In addition, we derived the effect of the convective velocity fields on selected Fe I lines. We found the overall convective shift for 3D simulations with respect to the reference 1D hydrostatic models, revealing line shifts of between -0.235 and $+0.361$ km s^{-1}. We showed a net correlation of the convective shifts with the effective temperature: lower effective temperatures denote redshifts and higher effective temperatures denote blueshifts. We conclude that the extraction of accurate radial velocities from RVS spectra need an appropriate wavelength correction from convection shifts.
Conclusions: The use of realistic 3D hydrodynamical stellar atmosphere simulations has a small but significant impact on the predicted photometry compared with classical 1D hydrostatic models for late-type stars. We make all the spectra publicly available for the community through the POLLUX database.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1801.01895

Mapping excitation in the inner regions of the planetary nebula NGC 5189 using HST WFC3 imaging

Ashkbiz Danehkar[1], Margarita Karovska[1], W. Peter Maksym[1] and Rodolfo Montez Jr.[1]

[1]Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, MA 02138, USA

The planetary nebula (PN) NGC 5189 around a Wolf–Rayet [WO] central star demonstrates one of the most remarkable complex morphologies among PNe with many multi-scale structures, showing evidence of multiple outbursts from an AGB progenitor. In this study we use multi-wavelength *Hubble* Space Telescope Wide Field Camera 3 (WFC3) observations to study the morphology of the inner 0.3 pc $\times$0.2 pc region surrounding the central binary that appears to be a relic of a more recent outburst of the progenitor AGB star. We applied diagnostic diagrams based on emission line ratios of Hα λ6563, [O III] λ5007, and [S II] $\lambda\lambda$6717,6731 images to identify the location and morphology of low-ionization structures within the inner nebula. We distinguished two inner, low-ionization envelopes from the ionized gas, within a radius of 55 arcsec ($\sim$ 0.15 pc) extending from the central star: a large envelope expanding toward the northeast, and its smaller counterpart envelope in the opposite direction toward the southwest of the nebula. These low-ionization envelopes are surrounded by a highly-ionized gaseous environment. We believe that these low-ionization expanding envelopes are a result of a powerful outburst from the post-AGB star that created shocked wind regions as they propagate through the previously expelled material along a symmetric axis. Our diagnostic mapping using high-angular resolution line emission imaging can provide a novel approach to detection of low-ionization regions in other PNe, especially those showing a complex multi-scale morphology.

Published in ApJ 852, 87 (2018)
Available from https://arxiv.org/abs/1711.11111
and from http://dx.doi.org/10.3847/1538-4357/aa9e8c

A search for radio emission from exoplanets around evolved stars

Eamon O'Gorman[1,2], Colm P. Coughlan[1], Wouter Vlemmings[2], Eskil Varenius[2], Sandeep Sirothia[3,4,5], Tom P. Ray[1] and Hans Olofsson[2]

[1]Dublin Institute for Advanced Studies, 31 Fitzwilliam Place, Dublin 2, Ireland
[2]Department of Space, Earth and Environment, Chalmers University of Technology, Onsala Space Observatory, 43992 Onsala, Sweden
[3]National Centre for Radio Astrophysics, TIFR, Post Bag 3, Ganeshkhind, Pune 411007, India
[4]Square Kilometre Array South Africa, 3rd Floor, The Park, Park Road, 7405, Pinelands, South Africa
[5]Department of Physics and Electronics, Rhodes University, P.O. Box 94, Grahamstown 6140, South Africa

The majority of searches for radio emission from exoplanets have to date focused on short period planets, i.e., the so-called hot Jupiter type planets. However, these planets are likely to be tidally locked to their host stars and may not generate sufficiently strong magnetic fields to emit electron cyclotron maser emission at the low frequencies used in observations (typically > 150 MHz). In comparison, the large mass-loss rates of evolved stars could enable exoplanets at larger orbital distances to emit detectable radio emission. Here, we first show that the large ionized mass-loss rates of certain evolved stars relative to the solar value could make them detectable with the Low Frequency Array (LOFAR) at 150 MHz ($\lambda = 2$ m), provided they have surface magnetic field strengths > 50 G. We then report radio observations of three long period (> 1 au) planets that orbit the evolved stars β Gem, ι Dra, and β UMi using LOFAR at 150 MHz. We do not detect radio emission from any system but place tight 3-σ upper limits of 0.98, 0.87, and 0.57 mJy on the flux density at 150 MHz for β Gem, ι Dra, and β UMi, respectively. Despite our non-detections these stringent upper limits highlight the potential of LOFAR as a tool to search for exoplanetary radio emission at meter wavelengths.

Accepted for publication in Astronomy and Astrophysics

New PARSEC database of α-enhanced stellar evolutionary tracks and isochrones I. Calibration with 47 Tuc (NGC 104) and the improvement on RGB bump

Xiaoting Fu[1], *Alessandro Bressan*[1], *Paola Marigo*[2], *Léo Girardi*[3], *Josefina Montalbán*[2], *Yang Chen*[2] *and Ambra Nanni*[2]

[1]SISSA – International School for Advanced Studies, Italy

[2]Dipartimento di Fisica e Astronomia Galileo Galilei, Università di Padova, Italy

[3]INAF – Osservatorio Astronomico di Padova, Italy

Precise studies on the Galactic bulge, globular cluster, Galactic halo and Galactic thick disk require stellar models with α enhancement and various values of helium content. These models are also important for extra-Galactic population synthesis studies. For this purpose, we complement the existing PARSEC models, which are based on the solar partition of heavy elements, with α-enhanced partitions. We collect detailed measurements on the metal mixture and helium abundance for the two populations of 47 Tuc (NGC 104) from the literature, and calculate stellar tracks and isochrones with these α-enhanced compositions. By fitting the precise color–magnitude diagram with HST ACS/WFC data, from low main sequence till horizontal branch, we calibrate some free parameters that are important for the evolution of low mass stars like the mixing at the bottom of the convective envelope. This new calibration significantly improves the prediction of the RGB bump brightness. Comparison with the observed RGB and HB luminosity functions also shows that the evolutionary lifetimes are correctly predicted. As a further result of this calibration process, we derive the age, distance modulus, reddening, and the red giant branch mass loss for 47 Tuc. We apply the new calibration and α-enhanced mixtures of the two 47 Tuc populations ($[\alpha/\mathrm{Fe}] \sim 0.4$ and 0.2) to other metallicities. The new models reproduce the RGB bump observations much better than previous models. This new PARSEC database, with the newly updated α-enhanced stellar evolutionary tracks and isochrones, will also be part of the new stellar products for Gaia.

Accepted for publication in MNRAS
Available from https://arxiv.org/abs/1801.07137

Near-infrared stellar populations in the metal-poor, dwarf irregular galaxies Sextans A and Leo A

Olivia Jones[1,2], *Matthew Maclay*[1,3], *Martha Boyer*[1], *Margaret Meixner*[1], *Iain McDonald*[4] *and Helen Meskhidze*[1,5]

[1]STScI, USA

[2]UK ATC, UK

[3]Carleton College, USA

[4]JBCA, UK

[5]Elon University, USA

We present $\mathrm{JHK_s}$ observations of the metal-poor ($[\mathrm{Fe/H}] < -1.40$) dwarf-irregular galaxies, Leo A and Sextans A obtained with the WIYN High-Resolution Infrared Camera at Kitt Peak. Their near-IR stellar populations are characterized by using a combination of colour–magnitude diagrams and by identifying long-period variable stars. We

detected red giant and asymptotic giant branch stars, consistent with membership of the galaxy's intermediate-age populations (2–8 Gyr old). Matching our data to broadband optical and mid-IR photometry we determine luminosities, temperatures and dust-production rates (DPR) for each star. We identify 32 stars in Leo A and 101 stars in Sextans A with a DPR $> 10^{-11}$ $M_\odot$ yr^{-1}, confirming that metal-poor stars can form substantial amounts of dust. We also find tentative evidence for oxygen-rich dust formation at low metallicity, contradicting previous models that suggest oxygen-rich dust production is inhibited in metal-poor environments. The total rates of dust injection into the interstellar medium of Leo A and Sextans A are $(8.2 \pm 1.8) \times 10^{-9}$ $M_\odot$ yr^{-1} and $(6.2 \pm 0.2) \times 10^{-7}$ $M_\odot$ yr^{-1}, respectively. The majority of this dust is produced by a few very dusty evolved stars, and does not vary strongly with metallicity.

Accepted for publication in ApJ
Available from https://arxiv.org/abs/1712.06594

Circumstellar environment of the M-type AGB star R Doradus. APEX spectral scan at 159.0–368.5 GHz

E. De Beck[1] *and H. Olofsson*[1]

[1]Department of Space, Earth and Environment, Chalmers University of Technology, Onsala Space Observatory, 43992, Onsala, Sweden

Our current insights into the circumstellar chemistry of asymptotic giant branch (AGB) stars are largely based on studies of carbon-rich stars and stars with high mass-loss rates. In order to expand the current molecular inventory of evolved stars we present a spectral scan of the nearby, oxygen-rich star R Dor, a star with a low mass-loss rate ($\sim 2 \times 10^{-7}$ $M_\odot$ yr^{-1}). We carried out a spectral scan in the frequency ranges 159.0–321.5 GHz and 338.5–368.5 GHz (wavelength range 0.8–1.9 mm) using the SEPIA/Band-5 and SHeFI instruments on the APEX telescope and we compare it to previous surveys, including one of the oxygen-rich AGB star IK Tau, which has a high mass-loss rate ($\sim 5 \times 10^{-6}$ $M_\odot$ yr^{-1}). The spectrum of R Dor is dominated by emission lines of SO_2 and the different isotopologues of SiO. We also detect CO, H_2O, HCN, CN, PO, PN, SO, and tentatively TiO_2, AlO, and NaCl. Sixteen out of approximately 320 spectral features remain unidentified. Among these is a strong but previously unknown maser at 354.2 GHz, which we suggest could pertain to H_2SiO, silanone. With the exception of one, none of these unidentified lines are found in a similarly sensitive survey of IK Tau performed with the IRAM 30m telescope. We present radiative transfer models for five isotopologues of SiO (^{28}SiO, ^{29}SiO, ^{30}SiO, $Si^{17}O$, $Si^{18}O$), providing constraints on their fractional abundance and radial extent. We derive isotopic ratios for C, O, Si, and S and estimate that, based on our results for $^{17}O/^{18}O$, R Dor likely had an initial mass in the range 1.3–1.6 $M_\odot$, in agreement with earlier findings based on models of H_2O line emission. From the presence of spectral features recurring in many of the measured thermal and maser emission lines we tentatively identify up to five kinematical components in the outflow of R Dor, indicating deviations from a smooth, spherical wind.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1801.07984
and from https://www.aanda.org/articles/aa/pdf/forth/aa32470-17.pdf

Abundance patterns of the light neutron-capture elements in very and extremely metal-poor stars

F. Spite[1]*, M. Spite*[1]*, B. Barbuy*[2]*, P. Bonifacio*[1]*, E. Caffau*[1] *and P. François*[1,3]

[1]GEPI, Observatoire de Paris, PSL University, CNRS, Place Jules Janssen, 92190 Meudon, France
[2]Universidade de São Paulo, IAG, Rua do Matão 1226, Cidade Universitária, 05508-900, São Paulo, Brazil
[3]Université de Picardie Jules Verne, 33 rue St-Leu, 80080, Amiens, France

The abundance patterns of the neutron-capture elements in metal-poor stars provide a unique record of the nucleosynthesis products of the earlier massive primitive objects. We measured new abundances of so-called light neutron-capture of first peak elements using local thermodynamic equilibrium (LTE) 1D analysis; this analysis resulted in a sample of 11 very metal-poor stars, from [Fe/H] $= -2.5$ to [Fe/H] $= -3.4$, and one carbon-rich star, CS 22949-037 with [Fe/H] $= -4.0$. The abundances were compared to those observed in two classical metal-poor stars: the typical r-rich star CS 31082-001 ([Eu/Fe] $> +1.0$) and the r-poor star HD 122563 ([Eu/Fe] < 0.0), which are known to present a strong

enrichment of the first peak neutron-capture elements relative to the second peak. Within the first peak, the abundances are well correlated in analogy to the well-known correlation inside the abundances of the second-peak elements. In contrast, there is no correlation between any first peak element with any second peak element. We show that the scatter of the ratio of the first peak abundance over second peak abundance increases when the mean abundance of the second peak elements decreases from r-rich to r-poor stars. We found two new r-poor stars that are very similar to HD 122563. A third r-poor star, CS 22897-008, is even more extreme; this star shows the most extreme example of first peak elements enrichment to date. On the contrary, another r-poor star (BD $-18°5550$) has a pattern of first peak elements that is similar to the typical r-rich stars CS 31082-001, however this star has some Mo enrichment. The distribution of the neutron-capture elements in our very metal-poor stars can be understood as the combination of at least two mechanisms: one that enriches the forming stars cloud homogeneously through the main r-process and leads to an element pattern similar to the r-rich stars, such as CS 31082-001; and another that forms mainly lighter, first peak elements.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1801.01304

The globular cluster NGC 6402 (M 14). II. Variable stars

C. Contreras Peña[1,2,3], M. Catelan[1,4], F. Grundahl[2], A.W. Stephens[5] and H.A. Smith[6]

[1]Pontificia Universidad Católica de Chile, Instituto de Astrofísica, Av. Vicuña Mackenna 4860, 782-0436 Macul, Santiago, Chile
[2]Danish AsteroSeismology center (DASC), Department of Physics and Astronomy, Århus University, DK-8000 Århus C, Denmark
[3]School of Physics, Astrophysics Group, University of Exeter, Stocker Road, Exeter EX4 4QL, UK
[4]Millennium Institute of Astrophysics, Santiago, Chile
[5]Gemini Observatory, 670 North A'ohoku Place, Hilo, HI 96720 , USA
[6]Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824, USA

We present time-series BVI photometry for the Galactic globular cluster NGC 6402 (M 14). The data consists of ~ 137 images per filter, obtained using the 0.9m and 1.0m SMARTS telescopes at the Cerro Tololo Inter-American Observatory. The images were obtained during two observing runs in 2006–2007. The image-subtraction package ISIS, along with DAOPHOT II/ALLFRAME, were used to perform crowded-field photometry and search for variable stars. We identified 130 variables, 8 of which are new discoveries. The variable star population is comprised of 56 ab-type RR Lyræ stars, 54 c-type RR Lyræ, 6 type II Cepheids, 1 W UMa star, 1 detached eclipsing binary, and 12 long-period variables. We provide Fourier decomposition parameters for the RR Lyræ, and discuss the physical parameters and photometric metallicity derived therefrom. The M 14 distance modulus is also discussed, based on different approaches for the calibration of the absolute magnitudes of RR Lyræ stars. The possible presence of second-overtone RR Lyræ in M 14 is critically addressed, with our results arguing against this possibility. By considering all of the RR Lyræ stars as members of the cluster, we derive $\langle P_{\rm ab} \rangle = 0.589$ d. This, together with the position of the RR Lyræ stars of both Bailey types in the period–amplitude diagram, suggests an Oosterhoff-intermediate classification for the cluster. Such an intermediate Oosterhoff type is much more commonly found in nearby extragalactic systems, and we critically discuss several other possible indications that may point to an extragalactic origin for this cluster.

Accepted for publication in The Astronomical Journal
Available from https://arxiv.org/abs/1801.06372

Gravity mode offset and properties of the evanescent zone in red-giant stars

S. Hekker[1,2], Y. Elsworth[3,2] and G.C. Angelou[1,2]

[1]Max Planck Institute for Solar System Research, Göttingen, Germany
[2]Stellar Astrophysics Centre, Århus, Denmark
[3]School of Physics and Astronomy, Univeristy of Birmingham, Birmingham, UK

Context: The wealth of asteroseismic data for red-giant stars and the precision with which these data have been observed over the last decade calls for investigations to further understand the internal structures of these stars.

Aims: The aim of this work is to validate a method to measure the underlying period spacing, coupling term and mode offset of pure gravity modes that are present in the deep interiors of red-giant stars. We subsequently investigate the physical conditions of the evanescent zone between the gravity mode cavity and the pressure mode cavity.
Methods: We implement an alternative mathematical description, compared to what is used in the literature, to analyse observational data and to extract the underlying physical parameters that determine the frequencies of mixed modes. This description takes the radial order of the modes explicitly into account, which reduces its sensitivity to aliases. Additionally, and for the first time, this method allows us to constrain the gravity mode offset $\epsilon_{\rm g}$ for red-giant stars.
Results: We find that this alternative mathematical description allows us to determine the period spacing $\Delta\Pi$ and the coupling term q for the dipole modes within a few percent of literature values. Additionally, we find that $\epsilon_{\rm g}$ varies on a star by star basis and should not be kept fixed in the analysis. Furthermore, we find that the coupling factor is logarithmically related to the physical width of the evanescent region normalised by the radius at which the evanescent zone is located. Finally, the local density contrast at the edge of the core of red giant branch models shows a tentative correlation with the offset $\epsilon_{\rm g}$.
Conclusions: We are continuing to exploit the full potential of the mixed modes to investigate the internal structures of red-giant stars; in this case we focus on the evanescent zone. It remains, however, important to perform comparisons between observations and models with great care as the methods employed are sensitive to the range of input frequencies.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1712.05430

The ^{87}rubidium atomic clock maser in giant stars

Jeremy Darling[1]

[1]University of Colorado, USA

We conducted a Green Bank Telescope search for the ground state 6.8 GHz hyperfine transition of rubidium (^{87}Rb) toward giant stars detected in Rb I optical resonance lines. The spin-flip transition of ^{87}Rb is one of the principal transitions used in atomic clocks, in addition to the hydrogen 21 cm maser and the ^{133}Cs hyperfine transition (which defines the second). The optical lines of ^{87}Rb and ^{85}Rb can together pump the 6.8 GHz transition to form a maser, and the same optical pumping used in atomic clocks may occur in the atmospheres of evolved stars. No 6.8 GHz ^{87}Rb lines were detected above 3.8 σ.

Published in Res. Notes AAS, 2, 15 (2018)
Available from https://arxiv.org/abs/1801.06937

A new look inside planetary nebula LoTr 5: A long-period binary with hints of a possible third component

A. Aller[1]*, J. Lillo-Box*[2]*, M. Vučković*[1]*, H. Van Winckel*[3]*, D. Jones*[4,5]*, B. Montesinos*[6]*, M. Zorotovic*[1] *and L.F. Miranda*[7]

[1]Instituto de Física y Astronomía, Facultad de Ciencias, Universidad de Valparaíso, Gran Bretaña 1111, Playa Ancha, Valparaíso, 2360102, Chile

[2]European Southern Observatory (ESO), Alonso de Córdova 3107, Vitacura, Casilla 19001, Santiago de Chile, Chile

[3]Instituut voor Sterrenkunde, K.U. Leuven, Celestijnenlaan 200D bus 2401, 3001, Leuven, Belgium

[4]Instituto de Astrofísica de Canarias, 38205 La Laguna, Tenerife, Spain

[5]Departamento de Astrofísica, Universidad de La Laguna, 38206 La Laguna, Tenerife, Spain

[6]Departamento de Astrofísica, Centro de Astrobiología (INTA–CSIC), P.O. Box 78, E-28691 Villanueva de la Cañada (Madrid), Spain

[7]Instituto de Astrofísica de Andalucía – CSIC, C/ Glorieta de la Astronomía s/n, E-18008 Granada, Spain

LoTr 5 is a planetary nebula with an unusual long-period binary central star. As far as we know, the pair consists of a rapidly rotating G-type star and a hot star, which is responsible for the ionization of the nebula. The rotation period

of the G-type star is 5.95 days and the orbital period of the binary is now known to be ~ 2700 days, one of the longest in central star of planetary nebulæ. The spectrum of the G central star shows a complex Hα double-peaked profile which varies with very short time scales, also reported in other central stars of planetary nebulæ and whose origin is still unknown. We present new radial velocity observations of the central star which allow us to confirm the orbital period for the long-period binary and discuss the possibility of a third component in the system at ~ 129 days to the G star. This is complemented with the analysis of archival light curves from SuperWASP, ASAS and OMC. From the spectral fitting of the G-type star, we obtain a effective temperature of $T_{\rm eff} = 5410 \pm 250$ K and surface gravity of $\log g = 2.7 \pm 0.5$, consistent with both giant and subgiant stars. We also present a detailed analysis of the Hα double-peaked profile and conclude that it does not present correlation with the rotation period and that the presence of an accretion disk via Roche lobe overflow is unlikely.

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from https://arxiv.org/abs/1801.06032
and from 10.1093/mnras/sty174

Carbon stars identified from LAMOST DR4 using machine learning

Yin-Bi Li[1] *and A-Li Luo*[1]

[1]Key Laboratory of Optical Astronomy, National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012, China

In this work, we present a catalog of 2651 carbon stars from the fourth Data Release (DR4) of the Large Sky Area Multi-Object Fiber Spectroscopy Telescope (LAMOST). Using an efficient machine-learning algorithm, we find out these stars from more than seven million spectra. As a by-product, 17 carbon-enhanced metal-poor(CEMP) turnoff star candidates are also reported in this paper, and they are preliminarily identified by their atmospheric parameters. Except for 176 stars that could not be given spectral types, we classify the other 2475 carbon stars into five subtypes including 864 C-H, 226 C-R, 400 C-J, 266 C-N, and 719 barium stars based on a series of spectral features. Furthermore, we divide the C-J stars into three subtypes of C-J(H), C-J(R), C-J(N), and about 90% of them are cool N-type stars as expected from previous literature. Beside spectroscopic classification, we also match these carbon stars to multiple broadband photometries. Using ultraviolet photometry data, we find that 25 carbon stars have FUV detections and they are likely to be in binary systems with compact white dwarf companions.

Accepted for publication in ApJS
Available from https://arxiv.org/abs/1712.09779

Bi-abundance ionization structure of the Wolf–Rayet planetary nebula PB 8

A. Danehkar[1,2]

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

[2]Harvard–Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA

The planetary nebula (PN) PB 8 around a [WN/WC]-hybrid central star is one of PNe with moderate abundance discrepancy factors (ADFs $\sim$ 2–3), which could be an indication of a tiny fraction of metal-rich inclusions embedded in the nebula (bi-abundance). In this work, we have constructed photoionization models to reproduce the optical and infrared observations of the PN PB 8 using a non-LTE stellar model atmosphere ionizing source. A chemically homogeneous model initially used cannot predict the optical recombination lines (ORLs). However, a bi-abundance model provides a better fit to most of the observed ORLs from N and O ions. The metal-rich inclusions in the bi-abundance model occupy 5.6 percent of the total volume of the nebula, and are roughly 1.7 times cooler and denser than the mean values of the surrounding nebula. The N/H and O/H abundance ratios in the metal-rich inclusions are ~ 1.0 and 1.7 dex larger than the diffuse warm nebula, respectively. To reproduce the *Spitzer* spectral energy distribution of PB 8, dust grains with a dust-to-gas ratio of 0.01 (by mass) were also included. It is found that the presence of metal-rich inclusions can explain the heavy element ORLs, while a dual-dust chemistry with different grain

species and discrete grain sizes likely produces the infrared continuum of this PN. This study demonstrates that the bi-abundance hypothesis, which was examined in a few PNe with large abundance discrepancies (ADFs > 10), could also be applied to those typical PNe with moderate abundance discrepancies.

Published in PASA, 35, e005 (2018)
Available from https://arxiv.org/abs/1801.00892
and from http://dx.doi.org/10.1017/pasa.2018.1

New insights into the outflows from R Aquarii

T. Liimets[1,2], R.L.M. Corradi[3,4], D. Jones[4,5], K. Verro[1,6], M. Santander-García[7], I. Kolka[1], M. Sidonio[8], E. Kankare[9], J. Kankare[9], T. Pursimo[10] and P.A. Wilson[11,12]

[1]Tartu Observatory, Tõravere, 61602, Estonia
[2]Institute of Physics, University of Tartu, Ravila 14c, 50411, Estonia
[3]GRANTECAN, Cuesta de San José s/n, E-38712, Breña Baja, La Palma, Spain
[4]Instituto de Astrofísica de Canarias, E-38200 La Laguna, Tenerife, Spain
[5]Departamento de Astrofísica, Universidad de La Laguna, E-38206 La Laguna, Tenerife, Spain
[6]Kapteyn Instituut, Rijksuniversiteit Groningen, Landleven 12, 9747AD Groningen, The Netherlands
[7]Observatorio Astronómico Nacional (OAN–IGN), C/ Alfonso XII, 3, 28014, Madrid, Spain
[8]Terroux Observatory, Canberra, Australia
[9]Astrophysics Research Centre, School of Mathematics and Physics, Queen's University Belfast, Belfast BT7 1NN, UK
[10]Nordic Optical Telescope, Apartado 474, ES-38700 Santa Cruz de La Palma, Spain
[11]Leiden Observatory, Leiden University, Postbus 9513, 2300 RA Leiden, The Netherlands
[12]CNRS, UMR 7095, Institut d'Astrophysique de Paris, 98$^{\rm bis}$ Boulevard Arago, F-75014 Paris, France

R Aquarii is a symbiotic binary surrounded by a large and complex nebula with a prominent curved jet. It is one of the closest known symbiotic systems, and therefore offers a unique opportunity to study the central regions of these systems and the formation and evolution of astrophysical jets. We studied the evolution of the central jet and outer nebula of R Aqr taking advantage of a long term monitoring campaign of optical imaging, as well as of high-resolution integral field spectroscopy. Narrow-band images acquired over a period of more than 21 years are compared in order to study the expansion and evolution of all components of the R Aqr nebula. The magnification method is used to derive the kinematic ages of the features that appear to expand radially. Integral field spectroscopy of the O III 5007Å emission is used to study the velocity structure of the central regions of the jet. New extended features, further out than the previously known hourglass nebula, are detected. The kinematic distance to R Aqr is calculated to be 178 pc using the expansion of the large hourglass nebula. This nebula of R Aqr is found to be roughly 650 years old, while the inner regions have ages ranging from 125 to 290 years. The outer nebula is found to be well described by a ballistic expansion, while for most components of the jet strong deviations from such behaviour are found. We find that the Northern jet is mostly red-shifted while its Southern part is blue-shifted, apparently at odds with findings from previous studies but almost certainly a consequence of the complex nature of the jet and variations in ionisation and illumination between observations.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1801.08209

Orbital radius during the grazing envelope evolution

Abedallah Abu-Backer[1], Avishai Gilkis[2] and Noam Soker[1]

[1]Technion – Israel Institute of Technology, Haifa 3200003, Israel
[2]Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge, CB3 0HA, UK

We use the binary module of the MESA code to study the evolution of an evolved binary system where we assume that a main sequence companion removes the outskirts of the envelope of an asymptotic giant branch (AGB) star by launching jets, and explore the characteristics of this grazing envelope evolution (GEE). We base our assumption that jets launched by the secondary star remove a substantial fraction of the outskirts of the envelope of an AGB star on earlier hydrodynamical simulations. We find that in many cases that we study, but not in all cases, the binary system experiences the GEE rather than entering the common envelope phase, under our assumptions of jet-driven mass removal. To prevent the common envelope phase the secondary star has to accrete a relatively large amount of mass. Because of our simplifying assumptions we cannot yet present the parameter space for the GEE. Although the incorporation of the GEE into population synthesis numerical codes requires further studies of the GEE, we conclude that analyses of population synthesis studies of evolved binary stars should include the GEE.

Submitted to MNRAS
Available from https://arxiv.org/abs/1801.09112

Cool DZ white dwarfs II: Compositions and evolution of old remnant planetary systems

Mark Hollands[1], Boris Gänsicke[1,2] and Detlev Koester[3]

[1]Department of Physics, University of Warwick, Coventry CV4 7AL, UK
[2]Centre for Exoplanets and Habitability, University of Warwick, Coventry CV4 7AL, UK
[3]Institut für Theoretische Physik und Astrophysik, University of Kiel, 24098 Kiel, Germany

In a previous study, we analysed the spectra of 230 cool ($T_{\rm eff} < 9000$ K) white dwarfs exhibiting strong metal contamination, measuring abundances for Ca, Mg, Fe and in some cases Na, Cr, Ti, or Ni. Here we interpret these abundances in terms of the accretion of debris from extrasolar planetesimals, and infer parent body compositions ranging from crust-like (rich in Ca and Ti) to core-like (rich in Fe and Ni). In particular, two white dwarfs, SDSS J0823+0546 and SDSS J0741+3146, which show log[Fe/Ca] > 1.9 dex, and Fe to Ni ratios similar to the bulk Earth, have accreted by far the most core-like exoplanetesimals discovered to date. With cooling ages in the range 1–8 Gyr, these white dwarfs are among the oldest stellar remnants in the Milky Way, making it possible to probe the long-term evolution of their ancient planetary systems. From the decrease in maximum abundances as a function of cooling age, we find evidence that the arrival rate of material on to the white dwarfs decreases by 3 orders of magnitude over a $\simeq 6.5$ Gyr span in white dwarf cooling ages, indicating that the mass-reservoirs of post-main sequence planetary systems are depleted on a $\simeq 1$ Gyr e-folding time-scale. Finally, we find that two white dwarfs in our sample are members of wide binaries, and both exhibit atypically high abundances, thus providing strong evidence that distant binary companions can dynamically perturb white dwarf planetary systems.

Submitted to MNRAS
Available from https://arxiv.org/abs/1801.07714

Conference Papers

Missing flux in VLBI observations of SiO maser at 7mm in IRC +10°011

J.-F. Desmurs[1], J. Alcolea[1], V. Bujarrabal[1], F. Colomer[1,2] and R. Soria-Ruiz[1]

[1]Observatorio Astronómico Nacional (OAN/IGN), Spain
[2]JIVE, The Netherlands

VLBI observations of SiO masers recover at most 40–50% of the total flux obtained by single dish observations at any spectral channel. Some previous studies seems to indicate that, at least, part of the lost flux is divided up into many weak components rather than in a large resolved emission area. Taking benefit of the high sensitivity and resolution of the HSA, we investigate the problem of the missing flux in VLBI observations of SiO maser emission at 7mm in

the AGB stars and obtain a high dynamic range map of IRC +10°011. We conclude that the missing flux is mostly contained in many very weak maser components.

Poster contribution, published in IAU Symposium 336: "Astrophysical Masers: Unlocking the Mysteries of the Universe", eds. A. Tarchi, M.J. Reid & P. Castangia
Available from https://arxiv.org/abs/1712.07380

AGB stars as tracers to IC 1613 evolution

Seyed Azim Hashemi[1], *Atefeh Javadi*[2] *and Jacco Th. van Loon*[3]

[1]Physics Department, Sharif University of Technology, Tehran 111559161, Iran

[2]School of Astronomy, Institute for Research in Fundamental Sciences (IPM), Tehran, 19395-5531, Iran

[3]Lennard-Jones Laboratories, Keele University, ST5 5BG, UK

We are going to apply AGB stars to find star formation history for IC 1613 galaxy; this a new and simple method that works well for nearby galaxies. IC 1613 is a Local Group dwarf irregular galaxy that is located at distance of 750 kpc, a gas rich and isolated dwarf galaxy that has a low foreground extinction. We use the long period variable stars (LPVs) that represent the very final stage of evolution of stars with low and intermediate mass at the AGB phase and are very luminous and cool so that they emit maximum brightness in near-infrared bands. Thus near-infrared photometry with using stellar evolutionary models help us to convert brightness to birth mass and age and from this drive star formation history of the galaxy. We will use the luminosity distribution of the LPVs to reconstruct the star formation history – a method we have successfully applied in other Local Group galaxies. Our analysis shows that the IC 1613 has had a nearly constant star formation rate, without any dominant star formation episode.

Poster contribution, published in "The AGB–Supernovæ Mass Transition", March 2017, Rome Observatory, Italy
Available from https://arxiv.org/abs/1712.05963
and from http://sait.oat.ts.astro.it/MSAIt880317/PDF/2017MmSAI..88..436A.pdf

Job Adverts

Research fellow in stellar astrophysics

Applications are invited for a Research Fellow position in the Astrophysics Research Group of the University of Surrey. The post is funded by the Science and Technology Facilities Council. The Research Fellow will undertake research to improve the BINARY_C framework for stellar population modelling, development of which is led in Surrey. BINARY_C with be extended to include evolution of very massive single and binary stars, and algorithms to model ongoing accretion onto very massive stars. This will then be applied to stellar population statistics of very massive single and binary stars with applications to stellar clusters, supernova statistics, close binary evolution and galactic chemical evolution.

This is a three year fixed-term position to start from April 2018 with salary £30,688 to £34,520 per year.

Further details can be found at the weblink below.

See also https://jobs.surrey.ac.uk/vacancy.aspx?ref=003818

Ph.D. positions

The department of Astronomy at the University of Cape Town (UCT) invites applications for a Ph.D. position in astronomy. This position is funded through a Ph.D. scholarship of the Faculty of Science at UCT. Funding is aligned to the SKA standard for Ph.D. scholarships in South Africa. The deadline for applications is 26 February 2018, and we envisage a starting date of 1 July 2018.

Potential supervisors are: Shazrene Mohamed, Retha Pretorius and Patricia Whitelock.

See also http://www.ast.uct.ac.za/news/phd-position-available-astronomy

Announcements

2018 NASA Laboratory Astrophysics Workshop

Announcing the 2018 NASA Laboratory Astrophysics Workshop (LAW) to be held April 8–11, 2018, at the University of Georgia, Athens, GA, USA.

Important Deadlines:
Hotel: March 11, 2018
Registration: March 16, 2018
Abstracts: March 22, 2018

Confirmed Invited Speakers:
Keith Arnaud (NASA GSFC)
Peter Bernath (Old Dom. U.)
Adam Foster (SAO)
Robert Petre (NASA GSFC)
Klaus Pontoppidan (STScI)
Farid Salama (NASA Ames)
Frank Timmes (Ariz. State U.)

The purpose of NASA LAW 2018 is focused on identifying and prioritizing critical laboratory astrophysics data needs to meet the demands of NASA's current and near- term astrophysics missions. The meeting will also provide a forum within which the community can present and review the current state of knowledge in laboratory astrophysics and identify challenges and opportunities for the field. The agenda will include 17 invited talks, posters, panel discussions, and break-out sessions.

Registration is $250 with a reduced rate of $125 for students and those who received their Ph.D. after April 1, 2016.

With best wishes from the co-chairs,
Phillip Stancil (UGA)
Doug Hudgins (NASA HQ)

Scientific Organizing Committee:
Gary Ferland (U. Kentucky)
Bill Latter (NASA HQ)
Stefanie Milam (NASA GSFC)
David Neufeld (Johns Hopkins U.)
Ella Sciamma-O'Brien (NASA Ames)
Alan Smale (NASA GSFC)

Randall Smith (SAO)
Artemis Spyrou (Michigan State U.)
Lisa Storrie-Lombardi (JPL)
Glenn Wahlgren (STScI)

See also www.physast.uga.edu/workshops/law

ESO Workshop
"A revolution in stellar physics with Gaia and large surveys"

Second Announcement
https://indico.camk.edu.pl/e/revolution
September 3–7, 2018, Warsaw, Poland
contact: revolution@camk.edu.pl

The workshop will focus on discussions about the advances in our understanding of stellar physical processes made possible by combining the exquisite astrometry and photometry of Gaia with data of other large photometric, spectroscopic, and asteroseismic stellar surveys. These combined data will permit detailed studies of stellar physics to a level that is unprecedented in the history of stellar astrophysics.

The second release (DR2) of Gaia data is planned for April 2018. With the DR2 data available, the workshop will be a perfect moment to showcase Gaia's synergy with other surveys, discuss early science achievements and future developments.

REGISTRATION and ABSTRACT SUBMISSION:

Registration and abstract submission are now open with deadline April 15, 2018. Registration fee is 1050 PLN ($\sim$ 250 EUR) for payment before June 01, 2018. Notification of talk selection is expected by mid-May.

FINANCIAL SUPPORT:

Partial financial support can be offered for a small number of early-career researchers (Ph.D. students and young post-docs). A justification for the financial request has to be sent together with the registration by the same deadline of April 15, 2018. Notification of financial support is expected by mid-May.

VENUE:

The workshop will take place at the building of the Library of the Warsaw University (Dobra street 56/66, Warsaw, Poland). The Library is located between the Vistula river and the Royal route (Krakowskie Przedmieście street). Hotels and restaurants can be found within walking distance.

ACCOMMODATION:

Participants are asked to arrange their own accommodation. There are many hotels located in the center of Warsaw including most international chains.

INVITED SPEAKERS:

- Carine Babusiaux (Université Grenoble Alpes, France);
- Maria Bergemann (Max-Planck Institute for Astronomy, Germany);

- Corinne Charbonnel (Geneva Observatory, Switzerland);
- Kevin Covey (Western Washington University, USA);
- Laurent Eyer (University of Geneva, Switzerland);
- Gregory Feiden (University of North Georgia, USA);
- Boris Gänsicke (University of Warwick, UK);
- Léo Girardi (Padova Observatory, Italy);
- Lynne Hillenbrand (Caltech, USA);
- Daniel Huber (University of Hawai'i, USA);
- Amanda Karakas (Monash University, Australia);
- Andreas Korn (Uppsala University, Sweden);
- Marco Limongi (Rome Observatory, Italy);
- Igor Soszyński (University of Warsaw, Poland);
- Silvia Toonen (University of Amsterdam, Netherlands).

SOC: Sylvia Ekström (Geneva Observatory, Switzerland); Gerald Handler (CAMK, Poland); Gaitee Hussain (ESO Garching); Scilla Degl'Innocenti (University of Pisa, Italy); Rob Jeffries (Keele University, UK); Danny Lennon (ESA); Andrea Miglio (University of Birmingham, UK); Luca Pasquini (ESO Garching); Sofia Randich (INAF/Arcetri, Italy); Rodolfo Smiljanic (CAMK, Poland); Andrzej Udalski (University of Warsaw, Poland).

See also https://indico.camk.edu.pl/e/revolution