THE AGB NEWSLETTER

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

Official publication of the IAU Working Group on Red Giants and Supergiants

No. 273 — 1 April 2020

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

Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

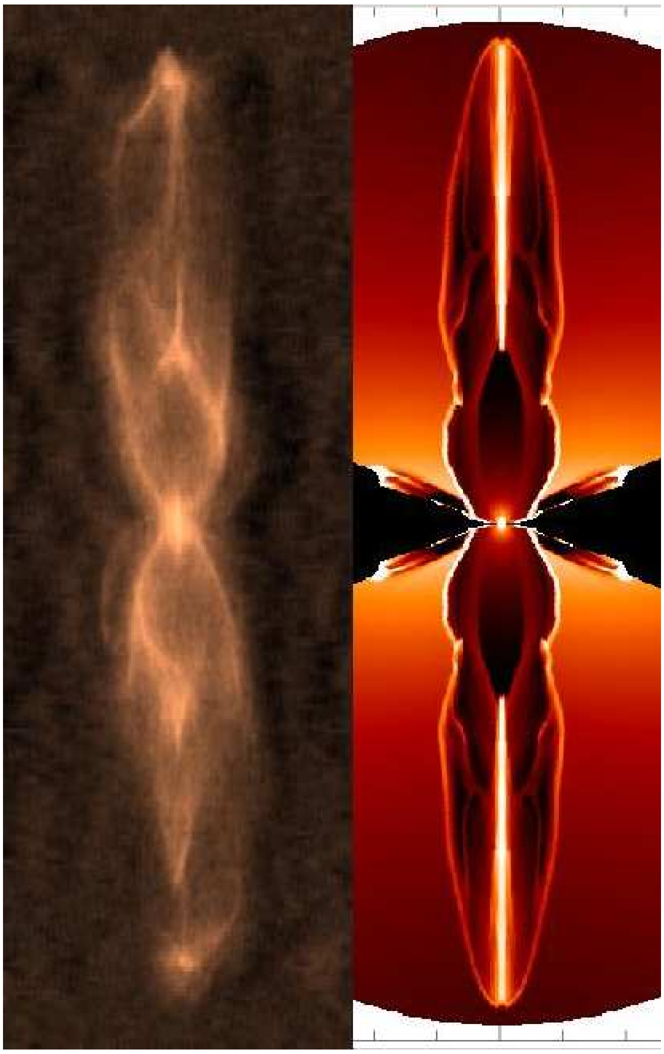

Figure 1: Comparison of HD 101584 (Olofsson et al. 2019) with model C in García-Segura et al. (2020; this Newsletter).

Editorial

Dear Colleagues,

It is a pleasure to present you the 273rd issue of the AGB Newsletter. Hopefully it cheers you up in this time of crisis (then again, at every moment in time there is a crisis somewhere on this planet, crises we do not always grant the same concern and responsiveness).

Some good news: there is a fantastic opportunity for a bright postdoctoral researcher to work in vibrant Hong Kong.

Further announcements pertain to the long-running Fizeau programme for interferometry knowledge transfer, the latest edition in the series of CLOUDY workshops – this time in Athens, Greece – and the postponement of that other great "institution" – the Cool Stars, Stellar Systems, and the Sun conference.

Last month's *Food for Thought* – "Spectral type does not directly yield effective temperature (and thus radius)" – provoked two responses. Elizabeth Griffin wrote:

"Absolutely. Completely. It never did, and it never can. A spectral type is a *description*, not a measurement. Spectral types are founded upon a set of spectra selected by the pundits as 'standards', and the types of other stars are determined by estimating likenesses to those standards, or by interpolating between them. Moreover, you cannot put real stars into 'boxes' (e.g., to suppose that if two stars have the same spectral types they are identical in $T_{\rm eff}$ and R). Putting stars into boxes is useful for statistics; actual practising astronomers know that no two stars are exactly alike (How many years has it taken us to identify *the* solar twin? Over 50? And we still haven't)."

While Ricardo Dorda (now at the IAC in Tenerife) explained:

"Some years ago, we observed a very large sample of RSGs (> 500) from the Magellanic Clouds (González-Fernández et al. 2015 – we made the spectra of this sample available for the whole community as an atlas recently, see Dorda et al. 2018), and we classified spectroscopically all the RSGs. Some time later, motivated for a hot topic by then (it was proposed that in RSG $T_{\rm eff}$s and spectral types (SpTs) are not correlated) we calculated the $T_{\rm eff}$s for most of that sample (Tabernero et al. 2018). From there, we found that SpT and $T_{\rm eff}$ are clearly correlated (confirming previous works, e.g., Levesque et al. 2006 and van Belle et al. 2009), and that there is a correlation between the variation of the SpT and the variation of the $T_{\rm eff}$, between two epochs of a given star.
However, the scenario is not as simple as considering that the $T_{\rm eff}$ of a RSG can be derived from its SpT. While the SpT is correlated to $T_{\rm eff}$, in our work the dispersion of the $T_{\rm eff}$s for a given SpT is $\sim \pm 120$ K, which is a significant value taking into account that the RSGs from a given environment (Galaxy) have a $T_{\rm eff}$ range of about 500 K (see figures below taken from Tabernero et al. 2018, where circles are for SMC and squares for LMC). This is probably because the SpTs are determined (for types later than K0, which correspond to the vast majority of RSGs) using the depth of TiO bands (see Dorda et al. 2018 for a full review on SpT classification), but Davies et al. (2013) showed that the TiO bands depend not only on $T_{\rm eff}$, but also on other factors (such as luminosity; and therefore, TiO-band fitting should not be used to obtain the $T_{\rm eff}$). In consequence a weak dependence of the SpT on other factors can be expected.
In conclusion, in my opinion the relation between $T_{\rm eff}$ and SpT must be considered as a statistical behaviour: typically an M2 should be cooler than an M0, but it is possible that a given M0 is cooler than a given M2. Therefore, the SpT can provide a very rough estimate of the $T_{\rm eff}$, but nothing else.

Glad there is some agreement! Unless someone wishes to challenge or nuance these views?

Don't miss this month's *What am I thinking?* by retiring gentle giant in our field, Thibaut LeBertre.

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

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

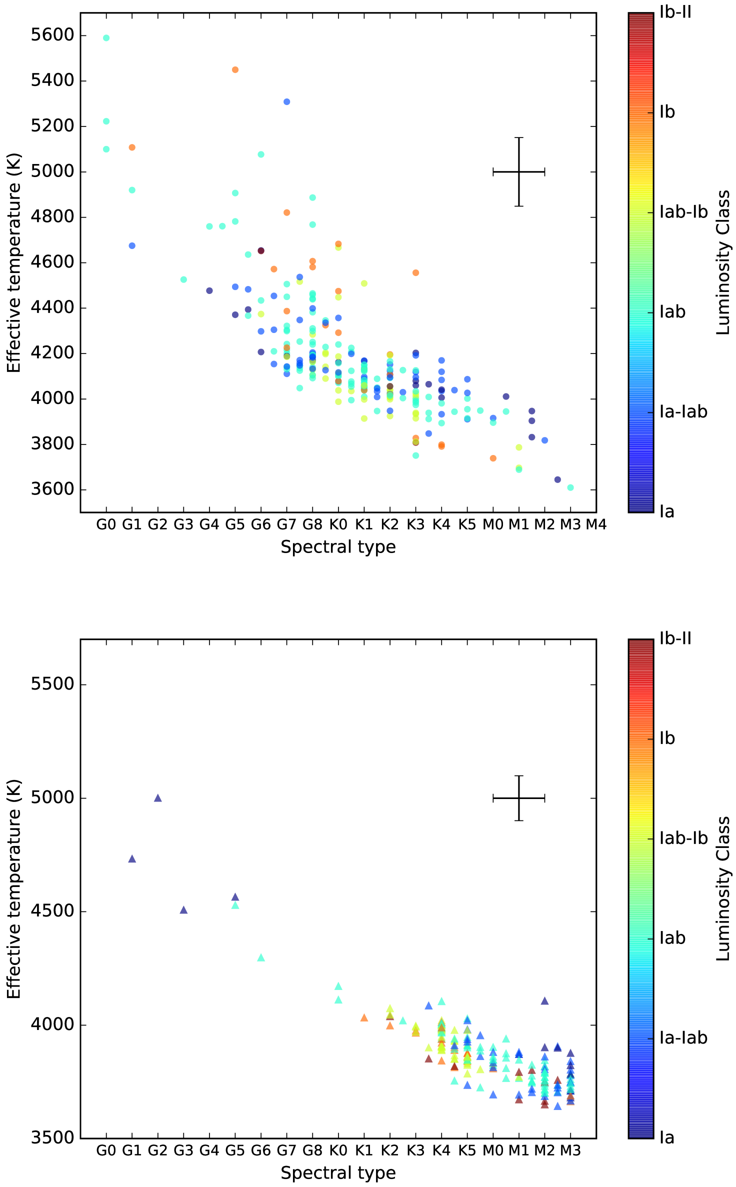

Figure 2: Effective temperature versus spectral type for samples of red supergiants in the Small (top) and Large (bottom) Magellanic Clouds (Dorda et al. 2018).

Food for Thought

This month's thought-provoking statement is:

Will we continue to replace face-to-face meetings by on-line meetings to save the planet?

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)

What am I thinking?

Thibaut LeBertre

CNRS

Paris, France

Atomic hydrogen: does it matter?

I am at the end of my 'academic' career, now at CNRS, and when I look back on my life I am contemplating what looks like a series of missed opportunities, but also of exceptional chances.

For the past 20 years, with my colleagues Eric Gérard and Lynn Matthews, we strove to detect and map atomic hydrogen in red giants and supergiants. We have been successful in a few cases. Our observations revealed the slowing down of circumstellar winds, building-up into detached shells of gas quasi at rest w.r.t. to their central stars.

The observations are extremely difficult, not so much because AGB stars are embedded in the ISM, but because the emission on the same line of sight dominates the weak signal from the red giant environment, although this difficulty can be alleviated when using an interferometer.

We found a dichotomy between "warm" and "cool" red giants, with warm meaning $\geq$ 2500 K, and cool $\leq$ 2500 K. Atomic hydrogen appears present only in the atmospheres of the former, a result that was predicted almost 40 years ago by Alfred Glassgold and Patrick Huggins.

On the other hand, atomic hydrogen appears present in all detached shells including those of cool stars, such as IRC $+10^{\circ}216$, where UV photons are dissociating molecular hydrogen, also a result predicted 40 years ago, by Mark Morris and Michael Jura.

However, we failed to convince the community about the relevance of these discoveries. Indeed, the presence of hydrogen in atomic rather than molecular form did not percolate much through models, neither hydrodynamic models of stellar winds, nor chemical models of the atmospheres, nor models describing dust formation, with all the processes of nucleation, sputtering, etc. In general, molecular hydrogen is only considered. Does it matter?

Whatever atomic hydrogen is there, it can be used as a tracer of circumstellar environments, and I had enjoyable relations with my colleagues Eric Gérard and Lynn Matthews who, never being tired of my naive (not to say stupid) questions, taught me a lot. Yet to work on data that are so difficult to obtain, and to see that almost nobody cares (perhaps for good reasons, I cannot say) is however frustrating. How can you motivate young colleagues to invest in a field that will not bring opportunities to increase their citation records?

Fortunately, my life working on AGB stars was not entirely a failure! I keep excellent memories of working at ESO and at the Paris Observatory.

During last century, I had an enjoyable time in Chile at the La Silla Observatory, meeting with fantastic people from all over the world and, primus inter pares, Lodewijk Woltjer who was insightful in every field of astronomy. He had always sharp remarks showing a real and deep understanding, was very helpful in his comments, with stimulating questions formulated in a typically 'innocent' manner: "what about your dust mass-loss rate estimates if the grain radius is changed?" To meet such a person in one's life is something you cannot forget, a circumstance that teaches you humility and at the same time gives a feeling of being privileged. As ESO Director General, he gave me the opportunity to do a programme (LPV monitoring in the IR range) that would not have been possible without his personal support. He entrustred me, a young and unknown fellow, that I would make something of it. In the end, the programme led to the establishment of relations between IR colors and dust mass-loss rate for C-rich and O-rich AGB stars.

Then I had also a good time at the Observatory of Paris in France with colleagues who helped me to switch to radio astronomy. IRAM was in full development, and I had excellent collaborations with Jan Martin Winters and many others. Recently ALMA came in. These millimeter interferometers, NOEMA and ALMA, allow us to access the morphology and the kinematics of stellar winds, something which looks granted today, but was unconceivable when I was a Ph.D. student.

Still more recently, I developed very nice relations with young vietnamese colleagues eager to learn, understand, and make their country progress, which is refreshing for someone who resides in an old country that conscientiously dismantles its universities and research centers. Fortunately international institutions do exist, scientific collaborations cross borders, and we are living in an exciting epoch, that sees ALMA, HST, VLA, VLT (with its magnificent suite of high spatial-resolution instruments), and soon JWST, ngVLA and SKA, that should be ideal to look for hydrogen in red giants – molecular *and* atomic!

Refereed Journal Papers

A 3D radiation-hydrodynamic AGB binary model

Zhuo Chen[1,2], *Natalia Ivanova*[1] *and Jonathan Carroll-Nellenback*[3]

[1]Department of Physics, University of Alberta, Canada
[2]CITA National Fellow
[3]Department of Physics and Astronomy, University of Rochester, USA

The origin of chemically peculiar stars and non-zero eccentricity in evolved close binaries have been long-standing problems in binary stellar evolution. Answers to these questions may trace back to an intense mass transfer during AGB binary phase. In this work, we use AstroBEAR to solve the 3D radiation-hydrodynamic equations and calculate the mass transfer rate in asymptotic-giant-branch (AGB) binaries that undergo the wind-Roche-lobe-overflow or Bondi–Hoyle–Lyttleton (BHL) accretion. mesa produces the density and temperature of the boundary condition of the AGB star. To improve the resolution of the dynamics of a circumbinary disk, we implement an azimuthal angle-dependent 3D radiation transfer. We consider optically thin cooling and obtain the number density of the coolants by solving the Saha equations. One of the goals of this work is to illustrate the transition from the wind-Roche-lobe-overflow to BHL accretion. Both circumbinary disks and spiral structure outflows can appear in the simulations. Circumbinary disks may form when the optical thickness in the equatorial region increases. The increase of the optical thickness is due to the deflected wind. The resulting mass transfer efficiency in our models is up to a factor of 8 times higher than what the standard BHL accretion scenario predicts, and the outflow gains up to 91% of its initial angular momentum when it reaches 1.3 binary separations. Consequently, some AGB binaries may undergo orbit shrinkage, and some will expand. The high mass transfer efficiency is closely related to the presence of the circumbinary disks.

Accepted for publication in The Astrophysical Journal
Available from https://arxiv.org/abs/1910.08027

Mirror principle and the red-giant bump: the battle of entropy in low-mass stars

S. Hekker[1,2], *G.C. Angelou*[3], *Y. Elsworth*[4,2] *and S. Basu*[5]

[1]Max Planck Institute for Solar System Research, Justus-von-Liebig Weg 3, D-37077 Göttingen, Germany
[2]Stellar Astrophysics Centre, Department of Physics and Astronomy, Ny Munkegade 120, DK-8000 Århus C, Denmark
[3]Max Planck Institute for Astrophysics, Karl-Schwarzschild-Str. 1, D-85741 Garching bei München, Germany
[4]School of Physics and Astronomy, University of Birmingham, Birmingham B15 2TT, UK
[5]Department of Astronomy, Yale University, New Haven, CT 06520, USA

The evolution of low-mass stars into red giants is still poorly understood. During this evolution the core of the star contracts and, simultaneously, the envelope expands – a process known as the 'mirror'. Additionally, there is a short phase where the trend for increasing luminosity is reversed. This is known as the red-giant-branch bump. We explore the underlying physical reasons for these two phenomena by considering the specific entropy distribution in the star and its temporal changes. We find that between the luminosity maximum and luminosity minimum of the bump there is no mirror present and the star is fully contracting. The contraction is halted and the star regains its mirror when the hydrogen-burning shell reaches the mean molecular weight discontinuity. This marks the luminosity minimum of the bump.

Published in MNRAS
Available from https://arxiv.org/abs/2001.06064
and from https://ui.adsabs.harvard.edu/link_gateway/2020MNRAS.492.5940H/PUB_PDF

Impact of convective boundary mixing on the TP-AGB

Graham Wagstaff[1], Marcelo M. Miller Bertolami[2] and Achim Weiß[1]

[1]Max Planck Institute for Astrophysics, Garching bei München, Germany

[2]Instituto de Astrofísica de La Plata, La Plata, Argentina

The treatment of convective boundaries remains an important source of uncertainty within stellar evolution, with drastic implications for the thermally-pulsing stars on the Asymptotic Giant Branch (AGB). Various sources are taken as motivation for the incorporation of convective boundary mixing during this phase, from s-process nucleosynthesis to hydrodynamical models. In spite of the considerable evidence in favour of the existence of convective boundary mixing on the pre-AGB evolution, this mixing is not universally included in models of TP-AGB stars. The aim of this investigation is to ascertain the extent of convective boundary mixing, which is compatible with observations when considering full evolutionary models. Additionally, we investigate a theoretical argument that has been made that momentum-driven overshooting at the base of the pulse-driven convection zone should be negligible. We show that, while the argument holds,estimations based on the picture of turbulent entrainment suggest that mixing is possible at both convective boundaries. We demonstrate that additional mixing at convective boundaries during core-burning phases prior to the thermally-pulsing Asymptotic Giant Branch has an impact on the later evolution, changing the mass range at which the third dredge-up and hot-bottom burning occur, and thus also the final surface composition. In addition, an effort has been made to constrain the efficiency of convective boundary mixing at the different convective boundaries, using observational constraints. Our study suggests a strong tension between different constraints that makes it impossible to reproduce all observables simultaneously within the framework of an exponentially decaying overshooting. This result calls for a reassessment of both the models of convective boundary mixing and the observational constraints.

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from https://arxiv.org/abs/2002.01860

Exploring the differences of integrated and spatially resolved analysis using integral field unit data: The case of Abell 14

Stavros Akras[1,2,3], Hektor Monteiro[4], Isabel Aleman[4], Marcos A.F. Farias[4], Daniel May[5] and Claudio B. Pereira[3]

[1]Instituto de Matemática, Estatística e Física, Universidade Federal do Rio Grande, Rio Grande, Brazil

[2]Observatório do Valongo, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

[3]Observatório Nacional/MCTIC, Rio de Janeiro, Brazil

[4]Universidade Federal de Itajubá, Instituto de Física e Química, Itajubá, Brazil

[5]Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, São Paulo, Brazil

We present a new approach to study planetary nebulae using integral field spectroscopy. VLT@VIMOS datacube of the planetary nebula Abell 14 is analysed in three different ways by extracting: (i) the integrated spectrum, (ii) 1-dimensional simulated long-slit spectra for different position angles and (iii) spaxel-by-spaxel spectra. These data are used to built emission-line diagnostic diagrams and explore the ionization structure and excitation mechanisms combining data from 1- and 3- dimensional photoionization models. The integrated and 1D simulated spectra are suitable for developing diagnostic diagrams, while the spaxel spectra can lead to misinterpretation of the observations. We find that the emission-line ratios of Abell 14 are consistent with UV photo-ionized emission; however, there are some pieces of evidence of an additional thermal mechanism. The chemical abundances confirm its previous classification as a Type I planetary nebula, without spatial variation. We find, though, variation in the ionization correction factors (ICFs) as a function of the slit position angle. The star at the geometric centre of Abell 14 has an A5 spectral type with an effective temperature of $T_{\rm eff} = 7909 \pm 135$ K and surface gravity $\log g = 1.4 \pm 0.1$ cm s^{-2}. Hence, this star cannot be responsible for the ionization state of the nebula. Gaia parallaxes of this star yield distances between 3.6 and 4.5 kpc in good agreement with the distance derived from a 3-dimensional photoionization modelling of Abell 14, indicating the presence of a binary system at the centre of the planetary nebula.

Published in MNRAS, 493, 2238 (2020)
Available from https://arxiv.org/abs/2002.12380

The Århus red giants challenge II. Stellar oscillations in the red giant branch phase

J. Christensen-Dalsgaard[1,2], *V. Silva Aguirre*[1], *S. Cassisi*[3,4], *M. Miller Bertolami*[5,6,7], *A. Serenelli*[8,9], *D. Stello*[14,15,1], *A. Weiss*[7], *G. Angelou*[7,10], *C. Jiang*[11], *Y. Lebreton*[12,13], *F. Spada*[10], *E.P. Bellinger*[1,10], *S. Deheuvels*[16], *R.M. Ouazzani*[12,1], *A. Pietrinferni*[3], *J.R. Mosumgaard*[1], *R.H.D. Townsend*[17], *T. Battich*[5,6], *D. Bossini*[18,19], *T. Constantino*[20], *P. Eggenberger*[21], *S. Hekker*[10,1], *A. Mazumdar*[22], *K.B. Nielsen*[1] *and M. Salaris*[23]

[1]Stellar Astrophysics Centre, Department of Physics and Astronomy, Århus University, Ny Munkegade 120, DK-8000 Århus C, Denmark
[2]Kavli Institute for Theoretical Physics, University of California Santa Barbara, CA 93106-4030, USA
[3]INAF–Astronomical Observatory of Abruzzo, Via M. Maggini sn, I-64100 Teramo, Italy
[4]INFN–Sezione di Pisa, Largo Pontecorvo 3, 56127 Pisa, Italy
[5]Instituto de Astrofísica de La Plata, UNLP–CONICET, La Plata, Paseo del Bosque s/n, B1900FWA, Argentina
[6]Facultad de Ciencias Astronómicas y Geofísicas, UNLP, La Plata, Paseo del Bosque s/n, B1900FWA, Argentina
[7]Max-Planck-Institut für Astrophysics, Karl Schwarzschild Straße 1, 85748, Garching bei München, Germany
[8]Instituto de Ciencias del Espacio (ICE–CSIC/IEEC), Campus UAB, Carrer de Can Magrans, s/n, 08193 Cerdanyola del Valles, Spain
[9]Institut d'Estudis Espacials de Catalunya (IEEC), Gran Capita 4, E-08034, Barcelona, Spain
[10]Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077, Göttingen, Germany
[11]School of Physics and Astronomy, Sun Yat-Sen University, Guangzhou, 510275, China
[12]LESIA, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Université, Univ. Paris Diderot, Sorbonne Paris Cité, Meudon 92195, France
[13]Univ. Rennes, CNRS, IPR (Institut de Physique de Rennes) – UMR 6251, F-35000 Rennes, France
[14]School of Physics, University of New South Wales, NSW, 2052, Australia
[15]Sydney Institute for Astronomy, School of Physics, University of Sydney, NSW 2006, Australia
[16]IRAP, Université de Toulouse, CNRS, CNES, UPS, Toulouse, France
[17]Department of Astronomy, 2535 Sterling Hall 475 N. Charter Street, Madison, WI 53706-1582, USA
[18]Instituto de Astrofísica e Ciências do Espaço, Universidade do Porto, CAUP, Rua das Estrelas, PT-4150-762 Porto, Portugal
[19]School of Physics and Astronomy, University of Birmingham, Birmingham, B15 2TT, UK
[20]Physics and Astronomy, University of Exeter, Exeter, EX4 4QL, United Kingdom
[21]Observatoire de Genève, Université de Genève, 51 Ch. des Maillettes, CH-1290 Sauverny, Switzerland
[22]Homi Bhabha Centre for Science Education, TIFR, V.N. Purav Marg, Mankhurd, Mumbai 400088, India
[23]Astrophysics Research Institute, Liverpool John Moores University, 146 Brownlow Hill, Liverpool L3 5RF, UK

Context: The large quantity of high-quality asteroseismic data that obtained from space-based photometric missions and the accuracy of the resulting frequencies motivate a careful consideration of the accuracy of computed oscillation frequencies of stellar models, when applied as diagnostics of the model properties.
Aims: Based on models of red-giant stars that have been independently calculated using different stellar evolution codes, we investigate the extent to which the differences in the model calculation affect the model oscillation frequencies.
Methods: For each of the models, which cover four different masses and different evolution stages on the red-giant branch, we computed full sets of low-degree oscillation frequencies using a single pulsation code and, from these frequencies, typical asteroseismic diagnostics. In addition, we carried out preliminary analyses to relate differences in the oscillation properties to the corresponding model differences.
Results: In general, the differences in asteroseismic properties between the different models greatly exceed the observational precision of these properties, in particular for the nonradial modes whose mixed acoustic and gravity-wave character makes them sensitive to the structure of the deep stellar interior. In some cases, identifying these differences led to improvements in the final models presented here and in Paper I; here we illustrate particular examples of this.
Conclusions: Further improvements in stellar modelling are required in order fully to utilise the observational accuracy to probe intrinsic limitations in the modelling. However, our analysis of the frequency differences and their relation to stellar internal properties provides a striking illustration of the potential of the mixed modes of red-giant stars for the diagnostics of stellar interiors.

Accepted for publication in Astronomy and Astrophysics
Available from https://arxiv.org/abs/2002.02816

The ELM survey. VIII. 98 double white dwarf binaries

Warren R. Brown[1], *Mukremin Kilic*[2], *Alekzander Kosakowski*[2] *et al*

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

[2]Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, 440 W. Brooks Street, Norman, OK 73019, USA

We present the final sample of 98 detached double white dwarf (WD) binaries found in the Extremely Low Mass (ELM) Survey, a spectroscopic survey targeting < 0.3 $M_\odot$ He-core WDs completed in the Sloan Digital Sky Survey footprint. Over the course of the survey we observed ancillary low mass WD candidates like GD 278, which we show is a $P = 0.19$ d double WD binary, as well as candidates that turn out to be field blue straggler/subdwarf A-type stars with luminosities too large to be WDs given their Gaia parallaxes. Here, we define a clean sample of ELM WDs that is complete within our target selection and magnitude range $15 < g_0 < 20$ mag. The measurements are consistent with 100% of ELM WDs being $0.0089 < P < 1.5$ d double WD binaries, 35% of which belong to the Galactic halo. We infer these are mostly He+CO WD binaries given the measurement constraints. The merger rate of the observed He+CO WD binaries exceeds the formation rate of stable mass transfer AM CVn binaries by a factor of 25, and so the majority of He+CO WD binaries must experience unstable mass transfer and merge. The shortest-period systems like J0651+2844 are signature LISA verification binaries that can be studied with gravitational waves and light.

Published in ApJ
Available from https://arxiv.org/abs/2002.00064
and from https://iopscience.iop.org/article/10.3847/1538-4357/ab63cd

H_2 emission in the low-ionisation structures of the planetary nebulæ NGC 7009 and NGC 6543

Stavros Akras[1,2,3], *Denise R. Gonçalves*[1], *Gerardo Ramos-Larios*[4] *and Isabel Aleman*[5]

[1]Observatório do Valongo, Universidade Federal do Rio de Janeiro, Ladeira Pedro Antonio 43, 20080-090, Rio de Janeiro, Brazil

[2]Instituto de Matemática, Estatística e Física, Universidade Federal do Rio Grande, Rio Grande 96203-900, Brazil

[3]Observatório Nacional/MCTIC, Rua Gen. Jose Cristino, 77, 20921-400, Rio de Janeiro, Brazil

[4]Instituto de Astronomía y Meteorología, CUCEI, Av. Vallarta No. 2602, Col. Arcos Vallarta, CP 44130, Guadalajara, Jalisco, México

[5]Universidade Federal de Itajubá, Instituto de Física e Química, Av. BPS 1303 Pinheirinho, 37500-903 Itajubá, MG, Brazil

Despite the many studies in the last decades, the low-ionization structures (LISs) of planetary nebulæ (PNe) still hold several mysteries. Recent imaging surveys have demonstrated that LISs are composed of molecular gas. Here, we report H_2 emission in the LISs of NGC 7009 and NGC 6543 by means of very deep narrow-band H_2 images taken with NIRI@Gemini. The surface brightness of the H_2 1–0 S(1) line is estimated to be (0.46–2.9)$\times10^{-4}$ erg s^{-1} cm^{-2} sr^{-1} in NGC 7009 and (0.29–0.48)$\times10^{-4}$ erg s^{-1} cm^{-2} sr^{-1} in NGC 6543, with signal-to-noise ratios of 10–42 and 3–4, respectively. These findings provide further confirmation of hidden H_2 gas in LISs. The emission is discussed in terms of the recent proposed diagnostic diagram $R(H_2) = H_2$ 1–0 S(1)/H_2 2–1 S(1) versus $R(Br\gamma) = H_2$ 1–0 S(1)/Brγ, which was suggested to trace the mechanism responsible for the H_2 excitation. Comparing our observations to shock and ultraviolet (UV) molecular excitation models, as well as a number of observations compiled from the literature showed that we cannot conclude for either UV or shocks as the mechanism behind the molecular emission.

Published in MNRAS
Available from https://arxiv.org/abs/2003.01737

Annual parallax measurement of the Mira variable star BX Cam with VERA

Masako Matsuno[1], *Akiharu Nakagawa*[1], *Atsushi Morita*[1], *Tomoharu Kurayama*[2], *Toshihiro Omodaka*[1], *Takumi Nagayama*[3], *Mareki Honma*[3,4], *Katsunori M. Shibata*[3,4], *Yuji Ueno*[3], *Takaaki Jike*[3,4] *and Yoshiaki Tamura*[3,4]

[1]Graduate School of Science and Engineering, Kagoshima University, 1-21-35 Korimoto, Kagoshima-shi, Kagoshima 890-0065, Japan

[2]Teikyo University of Science, 2-2-1 Sakuragi, Senju, Adachi-ku, Tokyo 120-0045, Japan

[3]Mizusawa VLBI Observatory, National Astronomical Observatory of Japan, 2-12 Hoshi-ga-oka, Mizusawa-ku, Oshu-shi, Iwate 023-0861, Japan

[4]Department of Astronomy, School of Physical Sciences, The Graduate University for Advanced Studies, Sokendai, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan

We report results of astrometric VLBI observations toward the Mira variable star BX Cam using the VLBI array VERA. The observations were performed from February 2012 to November 2014. Obtained parallax is 1.73 ± 0.03 mas corresponding to a distance of 0.58 ± 0.01 kpc. Parallax of this source was also reported in Gaia DR2 as 4.13 ± 0.25 mas, and there is a 240% difference between these two measurements. Astrometric results from our VLBI observations show that we exactly traced angular motions of the seven maser spots in BX Cam. We calculated stellar luminosities using both parallaxes, and obtained luminosities of $L_*^{\rm VERA} = 4950 \pm 170$ $L_\odot$ and $L_*^{\rm Gaia} = 870 \pm 110$ $L_\odot$. Deduced luminosities also support a validity of the parallax that we determined with VERA. Evaluating the two parallaxes, we concluded that the parallax of 1.73 ± 0.03 mas from the VERA observations is correct for BX Cam. We obtained a systemic motion of BX Cam as $(\mu_\alpha \cos\delta^{\rm sys},\ \mu_\delta^{\rm sys}) = (13.48 \pm 0.14,\ -34.30 \pm 0.18)$ mas yr^{-1}. A total of 73 H_2O maser spots detected from our VLBI observations show a spatial distribution of 30 au $\times$ 80 au with a strong elongation along North–South direction. They show outflows with a three-dimensional velocity of 14.79 ± 1.40 km s^{-1}. From a comparison between time variations of V-band magnitudes and H_2O maser, we found that variation of the H_2O maser is relevant to that seen in V-band even though the H_2O maser does not recover its maximum flux in each cycle.

Accepted for publication in PASJ
Available from https://arxiv.org/abs/2003.03038

Asteroseismology of evolved stars to constrain the internal transport of angular momentum. II. Test of a revised prescription for transport by the Tayler instability

P. Eggenberger[1], *J.W. den Hartogh*[2], *G. Buldgen*[1], *G. Meynet*[1], *S.J.A.J. Salmon*[3] *and S. Deheuvels*[4]

[1]Observatoire de Genève, Université de Genève, Switzerland

[2]Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Hungary

[3]STAR Institute, Université de Liège, Belgium

[4]IRAP, Université de Toulouse, France

Context: Asteroseismic observations enable the characterisation of the internal rotation of evolved stars. These measurements reveal that an unknown efficient angular momentum (AM) transport mechanism is needed for subgiant and red giant stars in addition to hydrodynamic transport processes. A revised prescription for AM transport by the magnetic Tayler instability has been recently proposed as a possible candidate for such a missing mechanism.
Aims: We compare the rotational properties predicted by this magnetic AM transport to asteroseismic constraints obtained for evolved stars with a particular focus on the subgiant phase.
Methods: We computed models accounting for the recent prescription for AM transport by the Tayler instability with the Geneva stellar evolution code for subgiant and red giant stars, for which an asteroseismic determination of both core and surface rotation rates is available.
Results: The revised prescription for the transport by the Tayler instability leads to low core rotation rates after the main sequence that are in better global agreement with asteroseismic measurements than those predicted by models with purely hydrodynamic processes or with the original Tayler–Spruit dynamo. A detailed comparison with asteroseismic data shows that the rotational properties of at most two of the six subgiants can be correctly reproduced by models accounting for this revised magnetic transport process. This result is obtained independently of the value

adopted for the calibration parameter in this prescription. We also find that this transport by the Tayler instability faces difficulties in simultaneously reproducing asteroseismic measurements available for subgiant and red giant stars. The low values of the calibration parameter needed to correctly reproduce the rotational properties of two of the six subgiants lead to core rotation rates during the red giant phase that are too high. Inversely, the higher values of this parameter needed to reproduce the core rotation rates of red giants lead to a very low degree of radial differential rotation before the red giant phase, which is in contradiction with the internal rotation of subgiant stars.
Conclusions: In its present form, the revised prescription for the transport by the Tayler instability does not provide a complete solution to the missing AM transport revealed by asteroseismology of evolved stars.

Published in A&A
Available from https://arxiv.org/abs/2001.11525

An ALMA view of SO and SO_2 around oxygen-rich AGB stars

T. Danilovich[1], A.M.S. Richards[2], L. Decin[1,3], M. Van de Sande[1] and C.A. Gottlieb[4]

[1]Department of Physics and Astronomy, Institute of Astronomy, K.U. Leuven, Celestijnenlaan 200D, 3001 Leuven, Belgium
[2]JBCA, Department Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK
[3]School of Chemistry, University of Leeds, Leeds LS2 9JT, UK
[4]Harvard–Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA

We present and analyse SO and SO_2, recently observed with high angular resolution and sensitivity in a spectral line survey with ALMA, for two oxygen-rich AGB stars: the low mass-loss rate R Dor and high mass-loss rate IK Tau. We analyse 8 lines of SO detected towards both stars, 78 lines of SO_2 detected towards R Dor and 52 lines of SO_2 detected towards IK Tau. We detect several lines of ^{34}SO, ^{33}SO and $^{34}SO_2$ towards both stars, and tentatively $S^{18}O$ towards R Dor, and hence derive isotopic ratios for these species. The spatially resolved observations show us that the two sulphur oxides are co-located towards R Dor and trace out the same wind structures in the circumstellar envelope (CSE). Much of the emission is well reproduced with a Gaussian abundance distribution spatially centred on the star. Emission from the higher energy levels of SO and SO_2 towards R Dor provide evidence in support of a rotating inner region of gas identified in earlier work. The new observations allow us to refine the abundance distribution of SO in IK Tau derived from prior observations with single antennas, and confirm the distribution is shell-like with the peak in the fractional abundance not centred on the star. The confirmation of different types of SO abundance distributions will help fine-tune chemical models and allows for an additional method to discriminate between low and high mass-loss rates for oxygen-rich AGB stars.

Accepted for publication in MNRAS
Available from https://arxiv.org/abs/2003.04334

PORTAL: three-dimensional polarized (sub)millimeter line radiative transfer

Boy Lankhaar[1] and Wouter Vlemmings[1]

[1]Chalmers University of Technology, Sweden

Context: Magnetic fields are important to the dynamics of many astrophysical processes and can typically be studied through polarization observations. Polarimetric interferometry capabilities of modern (sub)millimeter telescope facilities have made it possible to obtain detailed velocity resolved maps of molecular line polarization. To properly analyze these for the information they carry regarding the magnetic field, the development of adaptive three-dimensional polarized line radiative transfer models is necessary.
Aims: We aim to develop an easy-to-use program to simulate the polarization maps of molecular and atomic (sub)millimeter lines in magnetized astrophysical regions, such as protostellar disks, circumstellar envelopes, or molecular clouds.

Methods: By considering the local anisotropy of the radiation field as the only alignment mechanism, we can model the alignment of molecular or atomic species inside a regular line radiative transfer simulation by only making use of the converged output of this simulation. Calculations of the aligned molecular or atomic states can subsequently be used to ray trace the polarized maps of the three-dimensional simulation.
Results: We present a three-dimensional radiative transfer code, POlarized Radiative Transfer Adapted to Lines (PORTAL), that can simulate the emergence of polarization in line emission through a magnetic field of arbitrary morphology. Our model can be used in stand-alone mode, assuming LTE excitation, but it is best used when processing the output of regular three-dimensional (nonpolarized) line radiative transfer modeling codes. We present the spectral polarization map of test cases of a collapsing sphere and protoplanetary disk for multiple three-dimensional magnetic field morphologies.

Accepted for publication in A&A
Available from https://arxiv.org/abs/2003.04331

Discovery of extended structures around two evolved planetary nebulæ M 2-55 and Abell 2

Chih-Hao Hsia[1], *Yong Zhang*[2], *Xi-Liang Zhang*[3] *and Tao Luo*[1]

[1]State Key Laboratory of Lunar and Planetary Sciences, Macau University of Science and Technology, Taipa, Macau, China
[2]School of Physics and Astronomy, Sun Yat-Sen University Zhuhai Campus, Tangjia, Zhuhai, China
[3]Yunnan Observatories, Chinese Academy of Sciences, Kunming 650216, China

We report a multi-wavelength study of two evolved planetary nebulæ (PNe) M 2-55 and Abell 2. Deep optical narrow-band images ([O III], Hα, and [N II]) of M 2-55 reveal two pairs of bipolar lobes and a new faint arc-like structure. This arc-shaped filament around M 2-55 appears a well-defined boundary from South-West to South-East, strongly suggesting that this nebula is in interaction with its surrounding interstellar medium. From the imaging data of Wide-field Infrared Survey Explorer (WISE) all-sky survey, we discovered extensive mid-infrared halos around these PNe, which are approximately twice larger than their main nebulæ seen in the visible. We also present a mid-resolution optical spectrum of M 2-55, which shows that it is a high-excitation evolved PN with a low electron density of 250 cm^{-3}. Furthermore, we investigate the properties of these nebulæ from their spectral energy distributions (SEDs) by means of archival data.

Accepted for publication in Research in Astronomy & Astrophysics
Available from https://arxiv.org/abs/2003.05616

Inner dusty envelope of the AGB stars W Hydræ, SW Virginis and R Crateris using SPHERE/ZIMPOL

T. Khouri[1], *W.H.T. Vlemmings*[1], *C. Paladini*[2], *C. Ginski*[3,4], *E. Lagadec*[5], *M. Maercker*[1], *P. Kervella*[6], *E. De Beck*[1], *L. Decin*[7], *A. de Koter*[3,7] *and L.B.F.M. Waters*[8]

[1]Department of Space, Earth and Environment, Chalmers University of Technology, Onsala Space Observatory, 439 92 Onsala, Sweden
[2]European Southern Observatory, Alonso de Córdova 3107, Vitacura, Santiago, Chile
[3]Astronomical Institute "Anton Pannekoek", University of Amsterdam, P.O. Box 94249, 1090 GE Amsterdam, The Netherlands
[4]Sterrewacht Leiden, P.O. Box 9513, Niels Bohrweg 2, 2300 RA Leiden, The Netherlands
[5]Laboratoire Lagrange, Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Blvd. de l'Observatoire, CS 34229, 06304 Nice cedex 4, France
[6]LESIA, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université, Univ. Paris Diderot, Sorbonne Paris Cité, 5 place Jules Janssen, 92195 Meudon, France
[7]Instituut voor Sterrenkunde, K.U. Leuven, Celestijnenlaan 200D B-2401, 3001 Leuven, Belgium
[8]SRON Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands

The asymptotic giant branch (AGB) marks the final evolutionary stage of stars with initial masses between ~ 0.8

and 8 $M_\odot$. During this phase, stars undergo copious mass loss. The well-accepted mass-loss mechanism requires radiation pressure acting on dust grains that form in the density-enhanced and extended AGB stellar atmospheres. The details of the mass-loss process are not yet well understood, however. We aim to study the spatial distribution and properties of the first grains that form around AGB stars. Using the extreme-adaptive-optics imager and polarimeter SPHERE/ZIMPOL, we observed light polarised by grains around the AGB stars W Hya, SW Vir, and R Crt, which have mass-los rates between 10^{-7} and 10^{-6} $M_\odot$ yr^{-1}. We find the distribution of dust to be asymmetric around the three targets. A biconical morphology is seen for R Crt, with a position angle that is very similar to those inferred from interferometric observations of maser emission and of mid-infrared continuum emission. The cause of the biconical outflow cannot be directly inferred from the ZIMPOL data. The dust grains polarise light more efficiently at 0.65 μm for R Crt and SW Vir and at 0.82 μm for W Hya. This indicates that at the time of the observations, the grains around SW Vir and R Crt had sizes < 0.1 μm, while those around W Hya were larger, with sizes $\gtrsim 0.1$ μm. The asymmetric distribution of dust around R Crt makes the interpretation more uncertain for this star, however. We find that polarised light is produced already from within the visible photosphere of W Hya, which we reproduce using models with an inner dust shell that is optically thick to scattering. The radial profile of the polarised light observed around W Hya reveal a steep dust density profile. We find the wind-acceleration region of W Hya to extend to at least ~ 7 $R_\star$, in agreement with theoretical predictions of wind acceleration up to ~ 12 $R_\star$.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/2003.06195

Common envelope shaping of planetary nebulæ. II. Magnetic solutions and self-collimated outflows

Guillermo García-Segura[1], *Ronald E. Taam*[2] *and Paul M. Ricker*[3]

[1]Instituto de Astronomía, Universidad Nacional Autónoma de México, México
[2]Center for Interdisciplinary Exploration and Research in Astrophysics (CIERA), Department of Physics and Astronomy, Northwestern University, USA
[3]Department of Astronomy, University of Illinois, USA

Magnetic fields of order 10^1-—10^2 gauß that are present in the envelopes of red giant stars are ejected in common envelope scenarios. These fields could be responsible for the launching of magnetically driven winds in proto-planetary nebulæ. Using 2D simulations of magnetized winds interacting with an envelope drawn from a 3D simulation of the common envelope phase, we study the confinement, heating, and magnetic field development of post-common envelope winds. We find that the ejected magnetic field can be enhanced via compression by factors up to $\sim 10^4$ in circumbinary disks during the self-regulated phases. We find values for the kinetic energy of the order of 10^{46} erg that explain the large values inferred in proto-planetary nebula outflows. We show that the interaction of the formed circumbinary disk with a spherical, stellar wind produces a "tapered" flow that is almost indistinguishable from an imposed tapered flow. This increases the uncertainty of the origin of proto-planetary nebula winds, which could be either stellar, circumstellar (stellar accretion disk), circumbinary (circumbinary accretion disk), or a combination of all three. Within this framework, a scenario for self-collimation of weakly magnetized winds is discussed, which can explain the two objects where the collimation process is observationally resolved, HD 101584 and Hen 3-1475. An explanation for the equatorial, molecular hydrogen emission in CRL 2688 is also presented.

Accepted for publication in ApJ
Available from https://arxiv.org/abs/2003.06073

Spitzer's perspective of polycyclic aromatic hydrocarbons in galaxies

Aigen Li[1]

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

Polycyclic aromatic hydrocarbon (PAH) molecules, as revealed by the distinctive set of emission bands at 3.3, 6.2, 7.7, 8.6, 11.3 and 12.7 μm characteristic of their vibrational modes, are abundant and widespread throughout the Universe.

They are ubiquitously seen in a wide variety of astrophysical regions, ranging from planet-forming disks around young stars to the interstellar medium (ISM) of the Milky Way and external galaxies out to high redshifts at $z \gtrsim 4$.
PAHs profoundly influence the thermal budget and chemistry of the ISM by dominating the photoelectric heating of the gas and controlling the ionization balance.
Here, I review the current state of knowledge of the astrophysics of PAHs, focusing on their observational characteristics obtained from the *Spitzer* Space Telescope and their diagnostic power for probing the local physical and chemical conditions and processes. Special attention is paid to the spectral properties of PAHs and their variations revealed by the Infrared Spectrograph (IRS) on board *Spitzer* across a much broader range of extragalactic environments (e.g., distant galaxies, early-type galaxies, galactic halos, active galactic nuclei, and low-metallicity galaxies) than was previously possible with the Infrared Space Observatory (ISO) or any other telescope facilities. Also highlighted is the relation between the PAH abundance and the galaxy metallicity established for the first time by *Spitzer*.
This article is dedicated to the $60^{\rm th}$ *anniversary of the Department of Astronomy of Beijing Normal University, the* $2^{\rm nd}$ *astronomy program in the modern history of China.*

Published in Nature Astronomy
Available from https://arxiv.org/abs/2003.10489
and from http://www.nature.com/articles/s41550-020-1051-1

A mystery in Chamæleon: serendipitous discovery of a Galactic symbiotic nova

Lachlan Lancaster[1], *Jenny E. Greene*[1], *Yuan-Sen Ting*[2,1,3,4], *Sergey E. Koposov*[5,6,7], *Benjamin J.S. Pope*[8,9] *and Rachael L. Beaton*[1,3]

[1]Department of Astrophysical Sciences, Princeton University, 4 Ivy Lane, 08544, Princeton, NJ, USA
[2]Institute for Advanced Study, Princeton, NJ 08540, USA
[3]Observatories of the Carnegie Institution of Washington, 813 Santa Barbara Street, Pasadena, CA 91101, USA
[4]Research School of Astronomy and Astrophysics, Mount Stromlo Observatory, Cotter Road, Weston Creek, ACT 2611, Australia
[5]McWilliams Center for Cosmology, Carnegie Mellon University, 5000 Forbes Avenue, 15213, Pittsburgh, PA, USA
[6]Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge, CB3 0HA, UK
[7]Kavli Institute for Cosmology, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK
[8]Center for Cosmology and Particle Physics, Department of Physics, New York University, 726 Broadway, New York, NY 10003, USA
[9]Center for Data Science, New York University, 60 Fifth Ave, New York, NY 10011, USA

We present the serendipitous discovery of a low luminosity nova occurring in a symbiotic binary star system in the Milky Way. We lay out the extensive archival data alongside new follow-up observations related to the stellar object $V^{\star}$ CN Cha in the constellation of Chamæleon. The object had long period ($\sim$ 250 day), high amplitude ($\sim$ 3 mag) optical variability in its recent past, preceding an increase in optical brightness by $\sim$ 8 magnitudes and a persistence at this luminosity for about 3 years, followed by a period of $\sim$ 1.4 mag yr^{-1} dimming. The object's current optical luminosity seems to be dominated by Hα emission, which also exhibits blue-shifted absorption (a P-Cygni-like profile). After consideration of a number of theories to explain these myriad observations, we determine that $V^{\star}$ CN Cha is most likely a symbiotic (an evolved star-white dwarf binary) system which has undergone a long-duration, low luminosity, nova. Interpreted in this way, the outburst in $V^{\star}$ CN Cha is among the lowest luminosity novæ ever observed.

Submitted to The Astronomical Journal
Available from https://arxiv.org/abs/2002.07852

Betelgeuse just is not that cool: effective temperature alone cannot explain the recent dimming of Betelgeuse

Emily M. Levesque[1] *and Philip Massey*[2]

[1]University of Washington, USA

[2]Lowell Observatory, USA

We present optical spectrophotometry of the red supergiant (RSG) Betelgeuse from 2020 February 15, during its recent unprecedented dimming episode. By comparing this spectrum to stellar atmosphere models for cool supergiants, as well as spectrophotometry of other Milky Way RSGs, we conclude that Betelgeuse has a current effective temperature of 3600 ± 25 K. While this is slightly cooler than previous measurements taken prior to Betelgeuse's recent lightcurve evolution, this drop in effective temperature is insufficient to explain Betelgeuse's recent optical dimming. We propose that episodic mass loss and an increase in the amount of large-grain circumstellar dust along our sightline to Betelgeuse is the most likely explanation for its recent photometric evolution.

Published in ApJ Letters
Available from https://arxiv.org/abs/2002.10463

An ultra-massive white dwarf with a mixed hydrogen–carbon atmosphere as a likely merger remnant

Mark A. Hollands[1], *Pier-Emmanuel Tremblay*[1], *Boris T. Gänsicke*[1], *María E. Camisassa*[2,3], *Detlev Koester*[4], *Amornrat Aungwrojwit*[5], *Paul Chote*[1], *Alejandro H. Córsico*[2,3], *Vik S. Dhillon*[6,7], *Nicola P. Gentile-Fusillo*[1,8], *Matthew J. Hoskin*[1], *Paula Izquierdo*[7,9], *Tom R. Marsh*[1] *and Danny Steeghs*[1]

[1]Deparment of Physics, The University of Warwick, Coventry, UK

[2]Facultad de Ciencias Astrónomicas y Geofísicas, Universidad Nacional de La Plata, La Plata, Argentina

[3]Instituto de Astrofísica de La Plata, UNLP–CONICET, La Plata, Argentina

[4]Institut für Theoretische Physik und Astrophysik, University of Kiel, Kiel, Germany

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

[6]Department of Physics and Astronomy, University of Sheffield, Sheffield, UK

[7]Instituto de Astrofísica de Canarias, Tenerife, Spain

[8]European Southern Observatory, Garching bei München, Germany

[9]Departamento de Astrofísica, Universidad de La Laguna, La Laguna, Spain

White dwarfs are dense, cooling stellar embers consisting mostly of carbon and oxygen, or oxygen and neon (with a few percent carbon) at higher initial stellar masses. These stellar cores are enveloped by a shell of helium which in turn is usually surrounded by a layer of hydrogen, generally prohibiting direct observation of the interior composition. However, carbon is observed at the surface of a sizeable fraction of white dwarfs, sometimes with traces of oxygen, and it is thought to be dredged-up from the core by a deep helium convection zone. In these objects only traces of hydrogen are found as large masses of hydrogen are predicted to inhibit hydrogen/helium convective mixing within the envelope. We report the identification of WD J055134.612+413531.09, an ultra-massive (1.14 $M_\odot$) white dwarf with a unique hydrogen/carbon mixed atmosphere (C/H = 0.15 in number ratio). Our analysis of the envelope and interior indicates that the total hydrogen and helium mass fractions must be several orders of magnitude lower than predictions of single star evolution: less than $10^{-9.5}$ and $10^{-7.0}$, respectively. Due to the fast kinematics ($v_{\rm tot} = 129 \pm 5$ km s^{-1}), large mass, and peculiar envelope composition, we argue that WD J0551+4135 is consistent with formation from the merger of two white dwarfs in a tight binary system.

Published in Nature Astronomy Letters
Available from https://arxiv.org/abs/2003.00028
and from https://www.nature.com/articles/s41550-020-1028-0

Carbon- and oxygen-rich asymptotic giant branch (AGB) stars in the Bulge Asymmetries and Dynamical Evolution (BAaDE) survey

Megan O. Lewis[1,2], *Ylva M. Pihlström*[1], *Loránt O. Sjouwerman*[2], *Michael C. Stroh*[3], *Mark R. Morris*[4] *and The BAaDE Collaboration*

[1]University of New Mexico, USA

[2]National Radio Astronomy Observatory, USA

[3]Northwestern University, USA

[4]University of California, Los Angeles, USA

Detections of SiO masers from the Bulge Asymmetries and Dynamical Evolution (BAaDE) survey more tightly define the region where Oxygen-rich (O) Asymptotic Giant Branch (AGB) stars reside in multiple infrared (IR) color–color diagrams. Using Midcourse Space eXperiment (MSX) and Two Micron All Sky Survey (2MASS) data along with radio spectra from the BAaDE survey, we find that three main populations were observed in the BAaDE survey: O-rich AGB stars of which about 73% host SiO masers, carbon-rich (C) AGB stars that do not host these masers, and a small contaminating set of possible Young Stellar Objects (YSOs). The distinction between YSOs and AGB stars can be drawn using only MSX data, specifically the [D]–[E] color, while the shorter wavelengths provided by 2MASS are necessary to divide potential C- and O-rich AGB stars. Divisions similar to these have been seen in multiple earlier IR-studies, but BAaDE currently provides a sample of $\sim 15,000$ sources, which far exceeds previous studies in sample size, and, therefore, provides much more distinct divisions. With these IR distinctions in place, we discuss the sources that are exceptions in either their molecular detections or IR colors, as well as the distribution of the three populations in Galactic coordinates.

Published in The Astrophysical Journal
Available from https://arxiv.org/abs/2002.11095
and from https://iopscience.iop.org/article/10.3847/1538-4357/ab7920

An AGB star with a thick circumstellar shell

Jeremy Mould[1], *Mark Durré*[1], *Syed Uddin*[2] *and Lifan Wang*[3,4]

[1]Centre for Astrophysics & Supercomputing, Swinburne University, P.O. Box 218, Hawthorn, Vic 3122, Australia

[2]Carnegie Observatories, 813 Santa Barbara St., Pasadena, CA, USA

[3]Mitchell Institute for Fundamental Physics and Astronomy, Texas A&M University, College Station, TX 77843, USA

[4]Purple Mountain Observatory, Nanjing, 201008, Jiangsu, People's Republic of China

The Asymptotic Giant Branch is the terminal phase of red giant evolution with timescales of millions of years and a total mass lost from the star that is a significant fraction of the initial mass. Investigation of one of these stars, WISEA J173046.10−344455.5, a kpc in the direction of the center of the Galaxy, reveals a cool oxygen rich star with a dust shell of blackbody temperature 1305 K.

Published in PASP, 132, 044201 (2020)
Available from https://arxiv.org/abs/2002.08588
and from https://iopscience.iop.org/article/10.1088/1538-3873/ab77d8

The path to Z And-type outbursts: The case of V426 Sagittæ (HBHA 1704−05)

A. Skopal[1], *S.Yu. Shugarov*[1,2], *U. Munari*[3], *N. Masetti*[4,5], *E. Marchesini*[4,6,7,8,9], *R. M. Komžík*[1], *E. Kundra*[1], *N. Shagatova*[1], *T.N. Tarasova*[10], *C. Buil*[11], *C. Boussin*[12], *V.I. Shenavrin*[2], *F.-J. Hambsch*[13], *S. Dallaporta*[13], *A. Frigo*[13], *O. Garde*[14], *A. Zubareva*[2,15], *P.A. Dubovský*[16] *and P. Kroll*[17]

[1]Astronomical Institute, Slovak Academy of Sciences, 05960 Tatranská Lomnica, Slovakia
[2]Sternberg Astronomical Institute, Moscow State University, Universitetskij pr., 13, Moscow, 119991, Russia
[3]INAF–Osservatorio Astronomico di Padova, 36012 Asiago (VI), Italy
[4]INAF–Osservatorio di Astrofisica e Scienza dello Spazio, via Gobetti 93/3, I-40129, Bologna, Italy
[5]Departamento de Ciencias Físicas, Universidad Andrés Bello, Fernández Concha 700, Las Condes, Santiago, Chile
[6]Dipartimento di Fisica, Università degli Studi di Torino, via Pietro Giuria 1, I-10125 Torino, Italy
[7]INFN–Istituto Nazionale di Fisica Nucleare, Sezione di Torino, via Pietro Giuria 1, I-10125 Turin, Italy
[8]Facultad de Ciencias Astronómicas y Geofísicas, Universidad Nacional de La Plata, Paseo del Bosque, B1900FWA, La Plata, Argentina
[9]Instituto de Astrofísica de La Plata, CONICET–UNLP, CCT La Plata, Paseo del Bosque, B1900FWA, La Plata, Argentina
[10]Scientific Research Institute, Crimean Astrophysical Observatory, 298409 Nauchny, Crimea
[11]Castanet Tolosan Observatory, 6 place Clemence Isaure, 31320 Castanet Tolosan, France
[12]Observatoire de l'Eridan et de la Chevelure de Bérénice, 02400 Epaux-Bézu, France
[13]ANS Collaboration, c/o Astronomical Observatory, 36012 Asiago (VI), Italy
[14]Observatoire de la Tourbière, 38690 Chabons, France
[15]Institute of Astronomy, Russian Academy of Sciences, Russia
[16]Vihorlat Astronomical Observatory, Mierová 4, 066 01 Humenné, Slovakia
[17]Sonneberg Observatory, Sternwartestr. 32, 96515 Sonneberg, Germany

The star V426 Sge (HBHA 1704−05), originally classified as an emission-line object and a semi-regular variable, brightened at the beginning of August 2018, showing signatures of a symbiotic star outburst. We re-constructed an historical light curve (LC) of V426 Sge from approximately the year 1900, and used original low- and high-resolution spectroscopy complemented with Swift-XRT and UVOT, optical $UBVR_cI_c$ and near-infrared JHKL photometry obtained during the 2018 outburst and the following quiescence. The historical LC reveals no symbiotic-like activity from 1900 to 1967. In 1968, V426 Sge experienced a symbiotic nova outburst that ceased around 1990. From approximately 1972, a wave-like orbitally related variation with a period of 493.4 ± 0.7 days developed in the LC. This was interrupted by a Z And-type outburst from the beginning of August 2018 to the middle of February 2019. At the maximum of the 2018 outburst, the burning white dwarf (WD) increased its temperature to $> 2 \times 10^5$ K, generated a luminosity of $\sim 7 \times 10^{37} (d/3.3\ \mathrm{kpc})^2$ erg s^{-1}, and blew a wind at the rate of $\sim 3 \times 10^{-6}$ $M_\odot$ yr^{-1}. The donor is a normal M4–5 III giant and the accretor is a low-mass ~ 0.5 $M_\odot$ WD. During the transition from the symbiotic nova outburst to the quiescent phase, a pronounced sinusoidal variation along the orbit develops in the LC of most symbiotic novæ. The following eventual outburst is of Z And-type, when the accretion by the WD temporarily exceeds the upper limit of the stable burning. At this point the system becomes a classical symbiotic star.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/2003.10135

Conference Papers

Nebulosities of the symbiotic binary R Aquarii – a short review

T. Liimets[1,2], *R.L.M. Corradi*[3,4], *D. Jones*[4,5], *I. Kolka*[2], *M. Santander-García*[6], *M. Sidonio*[7] *and K. Verro*[8]

[1]Astronomický ústav, Akademie věd České republiky, v.v.i., Fričova 298, 251 65 Ondřejov, Czech Republic
[2]Tartu Observatory, University of Tartu, Observatooriumi 1, 61602 Tõravere, Estonia
[3]Instituto de Astrofísica de Canarias, E-38200 La Laguna, Tenerife, 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]Observatorio Astronómico Nacional (OAN–IGN), C/ Alfonso XII, 3, 28014, Madrid, Spain
[7]Terroux Observatory, Canberra, Australia
[8]Kapteyn Instituut, Rijksuniversiteit Groningen, Landleven 12, 9747AD Groningen, The Netherlands

In this proceeding, we present a short review of the fascinating nebulosities of symbiotic binary R Aquarii. The R Aquarii system, comprising the central binary and surrounding nebular material, has been the subject of near-continuous study since its discovery, with a few hundred papers listed in ADS. As such, it is impossible to provide here the comprehensive review that R Aquarii deserves, instead we chose to focus on the nebulosities – covering both our own research and other relevant results from the literature.

Oral contribution, published in "The Golden Age of Cataclysmic Variables and Related Objects V", Proceedings of Science
Available from https://arxiv.org/abs/2003.10753

The "second solar spectrum" of the post-AGB binary 89 Herculis

Manuele Gangi[1] *and Francesco Leone*[2,3]

[1]INAF–Osservatorio Astronomico di Roma, Via Frascati 33, I-00078 Monte Porzio Catone, Italy
[2]INAF–Osservatorio Astrofisico di Catania, Via S. Sofia 78, I-95123 Catania, Italy
[3]Università di Catania, Dipartimento di Fisica e Astronomia, Sezione Astrofisica Via S. Sofia 78, I-95123 Catania, Italy

We report a spectropolarimetric study of the post-AGB binary system 89 Herculis, based on data acquired with the high-resolution Catania Astrophysical Observatory Spectropolarimeter, the HArps-North POlarimeter and the Échelle SpectroPolarimetric Device for the Observation of Stars. The linear polarization clearly detected across single atmospheric lines in absorption is characterized by complex Q and U morphologies that are variable with the orbital period of the system. Gauß-level magnetic fields, continuum depolarization due to pulsations, hot spots and scattering in the circumstellar environment were excluded as possible origin of the observed polarization. In the context of the optical pumping mechanism, we suggest that the anisotropy of the stellar radiation field, fuelled by the close binary companion, can be responsible of the observed periodic properties of the spectral line polarization. We conclude that high resolution linear spectropolarimetry could be an important diagnostic tool in the study of aspherical envelopes of cool and evolved stars.

Oral contribution, published in the 9$^{\text{th}}$ Solar Polarization Workshop SPW9
Available from https://arxiv.org/abs/2002.12112
and from https://pure.mpg.de/pubman/faces/ViewItemOverviewPage.jsp?itemId=item_3195750

Lithium abundances in globular clusters

N. Sanna[1], *E. Franciosini*[1], *E. Pancino*[1,2] *and A. Mucciarelli*[3]

[1]INAF–Osservatorio Astrofisico di Arcetri, Italy
[2]Space Science Data Center, ASI, Italy
[3]Università degli Studi di Bologna, Italy

Lithium is created during the Big Bang nucleosynthesis and it is destroyed in stellar interiors at relatively low temperatures. However, it should be preserved in the stellar envelopes of unevolved stars and progressively diluted during mixing processes. In particular, after the first dredge-up along the RGB, lithium should be completely destroyed, but this is not what we observe today in globular clusters. This element allows to test stellar evolutionary models, as well as different types of polluters for second population stars in the multiple population scenarios. Due to the difficulty in the measurement of the small available lithium line, few GCs have been studied in details so far. Literature results are not homogeneous for what concerns type of stars, sample sizes, and chemical analysis methods. The Gaia–ESO survey allows us to study the largest sample of GCs stars (about 2000, both dwarfs and giants) for which the lithium has been analysed homogeneously.

Oral contribution, published in the Conference "Lithium in the Universe: To Be or not to Be?"
Available from https://arxiv.org/abs/2002.12866

Job Advert

3 year postdoctoral fellowship

Applications are invited for appointment as Post-doctoral Fellow in the Department of Physics and the Laboratory for Space Research (Ref.: 499704), to commence as soon as possible for three years.

The Department of Physics is committed to excellence in teaching and research. The staff of the Physics Department are engaged in active research in many areas of physics. There are five major areas of researches that are being conducted in the Department, including the Astronomy and Astrophysics Group, Atomic, Optical and Quantum Physics Group, Experimental Condensed Matter and Material Science Group, Theoretical and Computational Condensed Matter Group, and the Experimental Nuclear and Particle Physics Group. The Laboratory for Space Research (LSR) is a rapidly expanding multidisciplinary research group under the Faculty of Science at the University of Hong Kong (HKU) with members across 5 departments and 2 faculties. The LSR focuses on the analysis and interpretation of a wide variety of existing and planned space-based data in the public domain, supplemented by specific missions to which HKU scientists have privileged access. Information about the Department of Physics and LSR can be obtained at https://www.physics.hku.hk and https://www.lsr.hku.hk respectively.

Applicants should possess a Ph.D. degree in Physics or equivalent, and be able to demonstrate a strong research track record including refereed publications in top journals. Excellent communication skills, interpersonal skills and research leadership, the ability to work independently and in a team, and supervise Ph.D. students are essential. Those with experience in space-astronomy missions and large ground based facilities in terms of winning telescope time, and publishing related papers would have an advantage. Our existing astrophysics expertise is mainly in studies of late stage stellar evolution, including post-AGB stars and planetary nebulæ, supernova remnants and pulsars. The appointee is expected to work on the late stage stellar evolution under the supervision of Professor Parker in the Department of Physics. Enquiries about the post and the existing research activities should be sent to Professor Quentin Parker, Director, Laboratory for Space Research at quentinp@hku.hk.

A highly competitive salary commensurate with qualifications and experience will be offered, in addition to annual leave and medical benefits. At current rates, salaries tax does not exceed 15% of gross income.

The University only accepts online application for the above post. Applicants should apply online and upload a cover letter, an up-to-date C.V., a detailed publication list and a research proposal. Review of applications will commence as soon as possible and continue until April 30, 2020.

See also https://www.google.com/search?client=firefox-b-d&q=HKU+physics+department+vacancies&ibp=htl;jobs&sa=X&ved=2ahUKEwigyNWqy_vnAhUJmhQKHQmAAIgQp4wCMAF6BAgMEAE#htidocid=_Zf2ziP4OVLEJxfrAAAAAA%3D%3D&sxsrf=ACYBGNSnexGLyCKVCHGYFU-ksvXPRwMRGg:1583145167453&htivrt=jobs&fpstate=tldetail

Announcements

Cloudy workshop Athens, Greece

Registration is now open for the Cloudy workshop to be held 2020 June 15 to 19 at the Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) in Athens Greece. https://www.astro.noa.gr/en/main/. The science part of the workshop is described at https://cloud9.pa.uky.edu/~gary/cloudy/CloudySummerSchool/ while instructions for registering and local information will be posted on the forum https://groups/io/g/CloudyAthens2020. Please join it to get updates on the workshop.

Cloudy is a large-scale code that simulates the microphysics of matter exposed to ionizing radiation. It calculates the atomic physics, chemistry, radiation transport, and dynamics problems simultaneously and self-consistently, building from a foundation of individual atomic and molecular processes. The result is a first-principles prediction of the conditions in the material and its observed spectrum.

The workshop will cover observation, theory, and application of Cloudy to a wide variety of astronomical environments. This includes the theory of diffuse matter and quantitative spectroscopy, the science of using spectra to make physical measurements. We will use Cloudy to simulate such objects as AGB stars, Active Galactic Nuclei, Starburst galaxies, and the intergalactic medium. The sessions will consist of a mix of textbook study, using Osterbrock & Ferland, "Astrophysics of Gaseous Nebulæ and Active Galactic Nuclei", application of Cloudy to a variety of astrophysical problems, and projects organized by the participants. No prior experience with Cloudy is assumed although some knowledge of spectroscopy and the physics of the interstellar medium is useful.

See also https://groups.io/g/CloudyAthens2020

CS21: postponed to $5^{\rm th}$–$9^{\rm th}$ July 2021

Dear Colleagues,

We regret to announce that the Cool Stars, Stellar Systems, and the Sun $21^{\rm st}$ Conference, originally planned to be held on June 22–26, 2020, in Toulouse, France, has to be postponed due to the current Covid-19 pandemic. The decision was discussed within the SOC and LOC, and agreed by all members of the organizing committees. We plan to reschedule CS21 in Summer 2021.

Preliminary dates (tbc) for CS21 would be 5–9 July 2021, at the same location in Toulouse, France. We foresee that the program that was designed for CS21 this year, including the planned invited talks and the scheduled splinter sessions, will still be largely relevant next year, unless other hot topics emerge till then. We will continue to provide updated information on the current CS21 website.

As chairs of the SOC and LOC, we would like to express our gratitude to all the members of the organizing committees, especially to the members of the LOC for the efforts they deployed in this uncertain context. We extend our thanks to the chairs of the proposed Splinter sessions, to the speakers who accepted our invitation for the plenary sessions, and to all of you who had registered for the conference.

Take care, and we hope to see you next year!

S. Brun, J. Bouvier, P. Petit

Fizeau exchange visitors program in optical interferometry call for applications

Dear colleagues!

The Fizeau exchange visitors program in optical interferometry funds (travel and accommodation) visits of researchers to an institute of their choice (within the European Community) to perform collaborative work and training on one of the active topics of the European Interferometry Initiative. The visits will typically last for one month, and strengthen the network of astronomers engaged in technical, scientific and training work on optical/infrared interferometry. The program is open for all levels of astronomers (Ph.D. students to tenured staff), with priority given to Ph.D. students and young postdocs. Non-EU based missions will only be funded if considered essential by the Fizeau Committee. Applicants are strongly encouraged to seek also partial support from their home or host institutions.

The deadline for applications is May 15. Fellowships can be awarded for missions to be carried out between July 2020 and December 2020!

Note: requests for support for the Fizeau VLTI school in September are NOT part of this call. Such requests will be handled by the school organizers.

Further informations and application forms can be found at www.european-interferometry.eu

The program is funded by OPTICON/H2020.

Please distribute this message also to potentially interested colleagues outside of your community!

Looking forward to your applications,
Josef Hron & Péter Ábrahám
(for the European Interferometry Initiative)

See also www.european-interferometry.eu