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. 262 — 1 May 2019

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

Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

Figure 1: Planetary nebula We 5-1 imaged by the CHART32 team, suggested by Sakib Rasool. For more details see http://www.chart32.de/index.php/component/k2/item/183.

Editorial

Dear Colleagues,

It is a pleasure to present you the 262nd issue of the AGB Newsletter. Don't miss several White Papers written on topics of our community's interest, in the "Review Papers" section.

Sadly two of our best known and most wonderful colleagues are no longer physically among us. But they are in our memories, in our work and in what we are. Thus they are still with us, immortal. Michael Dopita and Michael Feast. Please read the obituaries on the following pages, supplemented with your own thoughts.

Under "Announcements" you will find an advertisement for a meeting about high-resolution spectroscopy in the era of ALMA, JWST and ELT; how to freely access the proceedings of the VIIth asymmetric planetary nebulæ meeting; and a reminder of the AGB meeting in honour of Hans Olofsson.

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

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

Food for Thought

This month's thought-provoking statement is:

How does entropy apply to gravity?

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)

Michael Andrew Dopita, 28 October 1946 – 22 December 2018

Mike Dopita was born 28 October 1946, in Kraslice, Czechoslovakia. He did his undergraduate degree in Oxford and moved to Manchester for his Ph.D., working with John Meaburn. After a postdoc in Manchester he moved to Australia to work with the new AAT. Soon after he joined Mount Stromlo at the ANU and here he would remain for the rest of his life. He became professor in 1994. In recent years he continued to hold an emeritus position, and he remained highly active during his retirement and later his illness.

Mike Dopita is known for his work in atomic and interstellar astrophysics. He applied his models on plasma diagnostics to an extraordinary variety of topics, including galaxies, planetary nebulæ, supernova remnants, active galactic nuclei and radio jets. In his research he was utterly brilliant, always able to pick out the important questions in whatever topic he was studying. His interest went far beyond theoretical models: he was also a consumate observer and developed the WiFeS IFU. He was active in the Australian Academy of Sciences where he was Treasurer for 6 years and in the International Astronomical Union where he was President of Division VI for 3 years (1997–2000). He was passionate about science, and left a substantial legacy to the Australian Academy of Sciences. His wider interests showed in an editorship of a book on renewable energy in Australia.

Mike was a wine connoisseur too. During an IAU Symposium on Planetary nebulæ in the Shine Dome in 2001, he co-hosted a "red Belly Black Cafe" wine tasting event with Brian Schmidt. He was an amusing and knowledgeable co-host and certainly knew and enjoyed his wine – red of course! He had also a great sense of humour. Mike was a great imitator of certain accents from Monty Python that his infectious laugh was sure to follow. One interesting aspect of his character was his interest in the stock market and all his strategies and buy/sell opportunities that he would share with other observers at the SSO lodge.

In April 2018, Mike Dopita's career was honoured in a meeting, entitled "A Star Was Born". The meeting was highly deserved; the breadth of the topics showed the diversity of research interests of Mike. Just 8 months later, his star went out.

Quentin Parker and Albert Zijlstra

See also https://twitter.com/matthewcolless/status/1076709912615374849?lang=en

Michael Feast, 29 December 1926 – 1 April 2019

Michael William Feast died peacefully on 1 April 2019, aged 92. He is survived by his wife Connie, three children and eight grand-children.

Michael was an Honorary Professor in the Astronomy Department at the University of Cape Town, a former Director of the South African Astronomical Observatory (SAAO), a Founding Member of the Academy of Science of South Africa, a Vice-President of the Executive Committee of the International Astronomical Union, an Honorary Fellow of the Royal Astronomical Society, a Fellow of the Royal Society of South Africa and the South African Institute of Physics (SAIP).

Born and raised in England, as a young boy he was removed from his family in the South of England, and with the other village children, was sent to live with host families in Wales for the duration of the war for security reasons. He obtained his Ph.D. at Imperial College, London in 1949, and came to South Africa in 1952 after a postdoc position in Canada, to work at the Radcliffe Observatory in Pretoria. In 1974 he moved to the SAAO in Cape Town, where

he served as Director from 1976 to 1992. In 1992 he took South African Nationality so as to participate fully in the transformation of South Africa. He was passionate about astronomy and continued to do research up to a few months before his death. His last first author paper appeared three months before his death. He read widely, enjoyed talking to students and was an Editor of Monthly Notices of the Royal Astronomical Society, from 1993 until 2018.

Using the 1.9-m telescope, first in Pretoria and later at Sutherland, Michael did pioneering work on the Magellanic Clouds, our nearest extragalactic neighbours. His measurements enabled the first estimate of the mass of the Large Magellanic Cloud, which allowed us to understand how it was formed. He also established that the history of the Small Cloud must have been quite different. Many of his papers from the 1950s and 60s continue to be quoted. He established that luminous stars were losing mass and that this set a limit to stellar masses, which is crucial to many things from stellar evolution to the formation of planets.

Michael has also made major contributions to the understanding of our own Milky Way Galaxy. A pioneer of multi-wavelength techniques in South Africa, between 1958 and 1965 he made the first comparison of optical data on young stars with radio measurements of the hydrogen gas. These led him to a new determination of the distance to the Galactic centre and an improved understanding of Galactic rotation. Much more recently, from 1997 to 2015, he combined data from the *Hipparcos* satellite with observations from the *Hubble* Space Telescope and from various SAAO telescopes at Sutherland to investigate the structure of our own Galaxy and to derive a new calibration of the extragalactic distance scale. He has also used the Southern African Large Telescope (SALT) to good effect, discovering Cepheid variables at large distance behind the Galactic Centre. He published over 300 refereed papers, the first in 1948 and the latest in 2019. He also supervised one of the AGB newsletter editors as a young postdoc, a time the editor recalls with fondness, and gratitude for how much was learned about how to do astronomy and how to go after the important questions in astrophysics.

At the time of his death, Michael was a National Research Foundation (NRF) recognized research leader. He has won the Gill Medal of the Astronomical Society of South Africa, the de Beers Gold Medal of the SAIP, JFW Herschel Medal from the Royal Society of South Africa, and in 2014 was presented with the NRF Lifetime Achievement award. He was responsible for the development of SAAO as a major national and international facility. Initially a joint enterprise with the British Science Research Council, this developed into an entirely South African operation under his leadership. The telescope time was available to anyone who had a good enough project and this attracted international visitors. This also led to fruitful exchanges of scientific and technical knowledge and was highly stimulating to the SAAO staff, both scientific and technical. He took a strong personal interest in all research done at the SAAO and critically read every paper written by a staff member before it was submitted for publication. He encouraged international collaborations and insisted that publication was in first rank international journals.

The work carried out at SAAO by staff and by astronomers from South African and international universities and institutions during the time of Michael's directorship of SAAO has not only led to the recognition of South Africa as a major component in world astronomy, it has shown that South Africa's geography, climate and its technical development makes it an excellent place to establish astronomical facilities. It is clear that these factors were significant in convincing international partners to join with South Africa in SALT at SAAO, Sutherland. That in turn positioned South Africa to bid to host the Square Kilometre Array.

When SAAO and UCT held a conference to celebrate Michael's 90^{th} birthday he insisted that it must not look back, but focus on the future and the wonderful opportunities that astronomy and South Africa offered each other. He lived a life of integrity and dedication to work, whilst still enjoying the simple pleasures of family dinners, listening to music, reading poetry, and walking deep in conversation with friends. He read widely on a broad range of subjects, especially history, art, music, philosophy and religion. He was an Anglican and was especially interested in what lay beyond and outside of the concepts of space and time as we know them. He was a source of wisdom and good council to many who loved him, and an inspiration and help to many who worked with him. His is a life worth celebrating in so many ways.

Patricia Whitelock and Albert Zijlstra

See also https://www.news.uct.ac.za/article/-2019-04-01-professor-michael-feast-19262019

Refereed Journal Papers

Searching for stable fullerenes in space with computational chemistry

A. Candian[1], *M. Gomez Rachid*[1,2], *H. MacIsaac*[3,4,5], *V.N. Staroverov*[6], *E. Peeters*[3,4,7] *and J. Cami*[3,4,7]

[1]Leiden Observatory, Leiden University, Niels Bohrweg 2, 2333CA, Leiden, The Netherlands

[2]Universidade do Vale do Paraíba, Laboratorio de Astroquímica e Astrobiologia, 2911, Urbanova, São José dos Campos, SP, Brazil

[3]Department of Physics and Astronomy, The University of Western Ontario, London, ON N6A 3K7, Canada

[4]Centre for Planetary Science and Exploration (CPSX), The University of Western Ontario, London, ON N6A 3K7, Canada

[5]Physics Department, St. Francis Xavier University, 5005 Chapel Square, Antigonish, NS B2G 2W5, Canada

[6]Department of Chemistry, The University of Western Ontario, London, ON N6A 5B7, Canada

[7]SETI Institute, 189 Bernardo Avenue, Suite 100, Mountain View, CA 94043, USA

We report a computational study of the stability and infrared (IR) vibrational spectra of neutral and singly ionised fullerene cages containing between 44 and 70 carbon atoms. The stability is characterised in terms of the standard enthalpy of formation per CC bond, the HOMO–LUMO gap, and the energy required to eliminate a C_2 fragment. We compare the simulated IR spectra of these fullerene species to the observed emission spectra of several planetary nebulæ (Tc 1, SMP SMC 16, and SMP LMC 56) where strong C_{60} emission has been detected. Although we could not conclusively identify fullerenes other than C_{60} and C_{70}, our results point to the possible presence of smaller (44, 50, and 56-atom) cages in those astronomical objects. Observational confirmation of our prediction should become possible when the *James Webb* Space Telescope comes online.

Published in Monthly Notices of the Royal Astronomical Society, 485, 1137 (2019)
Available from https://arxiv.org/abs/1902.03090
and from https://doi.org/10.1093/mnras/stz450

The period–luminosity relations of red supergiants in M 33 and M 31

Yi Ren[1], *B.W. Jiang*[1], *Ming Yang*[2] *and Jian Gao*[1]

[1]Department of Astronomy, Beijing Normal University, China

[2]Institute for Astronomy, Astrophysics, Space Applications & Remote Sensing, National Observatory of Athens, Greece

Based on previously selected preliminary samples of Red Supergiants (RSGs) in M 33 and M 31, the foreground stars and luminous Asymptotic Giant Branch stars (AGBs) are further excluded, which leads to the samples of 717 RSGs in M 33 and 420 RSGs in M 31. With the time-series data from the iPTF survey spanning nearly 2000 days, the period and amplitude of RSGs are analyzed. According to the lightcurves characteristics, they are classified into four categories in which 84 and 56 objects in M 33 and M 31 respectively are semi-regular variables. For these semi-regular variables, the pulsation mode is identified by comparing with the theoretical model, which yielded 19 (7) sources in the first overtone mode in M 33 (M 31), and the other 65 (49) RSGs in M 33 (M 31) in the fundamental mode. The period–luminosity (P–L) relation is analyzed for the RSGs in the fundamental mode. It is found the P–L relation is tight in the infrared, i.e. the 2MASS JHK_s bands and the short-wavelength bands of *Spitzer*. Meanwhile, the inhomogeneous extinction causes the P–L relation scattering in the V band, and the dust emission causes the less tight P–L relation in the *Spitzer*/[8.0] and [24] bands. The derived P–L relations in the 2MASS/K_s band are in agreement with those of RSGs in SMC, LMC and the Milky Way within the uncertainty range. It is found that the number ratio of RSGs pulsating in the fundamental mode to the first overtone mode increases with metallicity.

Accepted for publication in ApJS
Available from https://arxiv.org/abs/1902.07597

RAMSES II: RAMan Search for Extragalactic Symbiotic stars project concept, commissioning, and early results from the science verification phase

Rodolfo Angeloni[1,2]*, Denise R. Gonçalves*[3]*, Stavros Akras*[3] *and the RAMSES II Team*

[1]Instituto de Investigación Multidisciplinar en Ciencia y Tecnología, Universidad de La Serena, Av. R. Bitrán 1305, La Serena, Chile

[2]Departamento de Física y Astronomía, Universidad de La Serena, Av. J. Cisternas 1200, La Serena, Chile

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

Symbiotic stars (SySts) are long-period interacting binaries composed of a hot compact star, an evolved giant star, and a tangled network of gas and dust nebulæ. They represent unique laboratories for studying a variety of important astrophysical problems, and have also been proposed as possible progenitors of SNe Ia. Presently, we know of 257 SySts in the Milky Way and 69 in external galaxies. However, these numbers are still in striking contrast with the predicted population of SySts in our Galaxy. Because of other astrophysical sources that mimic SySt colors, no photometric diagnostic tool has so far demonstrated the power to unambiguously identify a SySt, thus making the recourse to costly spectroscopic follow-up still inescapable. In this paper we present the concept, commissioning, and science verification phases, as well as the first scientific results, of RAMSES II – Gemini Observatory Instrument Upgrade Project that has provided each GMOS instrument at both Gemini telescopes with a set of narrow-band filters centered on the Raman O VI 6830 Å band. Continuum-subtracted images using these new filters clearly revealed known SySts with a range of Raman O VI line strengths, even in crowed fields. RAMSES II observations also produced the first detection of Raman O VI emission from the SySt LMC 1 and confirmed Hen 3-1768 as a new SySt – the first photometric confirmation of a SySt. Via Raman O VI narrow-band imaging, RAMSES II provides the astronomical community with the first purely photometric tool for hunting SySts in the local universe.

Published in AJ, 157, 156A (2019)

Available from https://arxiv.org/abs/1903.03225

Gas phase SiO in the circumstellar environment of the recurrent nova T Coronæ Borealis

A. Evans[1]*, Ya.V. Pavlenko*[2]*, U. Munari*[3]*, R.D. Gehrz*[4]*, C.E. Woodward*[4]*, S. Starrfield*[5]*, L.A. Helton*[6]*, M. Shahbandeh*[7]*, S. Davis*[7]*, S. Dallaporta*[8] *and G. Cherini*[8]

[1]Astrophysics Group, Lennard Jones Laboratory, Keele University, Keele, Staffordshire, ST5 5BG, UK

[2]Main Astronomical Observatory, Academy of Sciences of the Ukraine, Golosiiv Woods, Kyiv-127, 03680 Ukraine

[3]INAF Astronomical Observatory of Padova, I-36012 Asiago (VI), Italy

[4]Minnesota Institute for Astrophysics, School of Physics & Astronomy, 116 Church Street SE, University of Minnesota, Minneapolis, MN 55455, USA

[5]School of Earth and Space Exploration, Arizona State University, Box 871404, Tempe, AZ 85287-1404, USA

[6]USRA–SOFIA Science Center, NASA Ames Research Center, Moffett Field, CA 94035, USA

[7]Department of Physics, Florida State University, 77 Chieftan Way, Tallahassee, FL 32306, USA

[8]ANS Collaboration, Astronomical Observatory, 36012 Asiago (VI), Italy

We report the discovery of the diatomic molecule SiO in the gas phase in the environment of the recurrent nova T Coronæ Borealis. While some of the SiO is photospheric, a substantial portion must arise in the wind from the red giant component of T CrB. A simple fit to the SiO feature, assuming local thermodynamic equilibrium, suggests a SiO column density of 2.8×10^{17} cm^{-2} and temperature $\sim 1,000$ K; the SiO column density is similar to that present in the winds of field red giants. A search for SiO maser emission is encouraged both before and after the next anticipated eruption. We find that the ^{12}C/^{13}C ratio in the red giant is < 9, with a best fit value of ~ 5, a factor ~ 18 times lower than the solar value of 89. We find no convincing evidence for the presence of dust in the environment of T CrB, which we attribute to the destructive effects on nucleation sites of hard X-ray emission. When the next eruption of T CrB occurs, the ejected material will shock the wind, producing X-ray and coronal line emission, as is the case for the recurrent nova RS Oph. T CrB is also a good candidate for very high energy γ-ray emission, as first observed during the 2010 outburst of V407 Cyg. We include in the paper a wide variety of infrared spectroscopic and photometric data.

Accepted for publication in Monthly Notices of the RAS

Available from https://arxiv.org/abs/1904.04731

Observational evidence of third dredge-up occurrence in S-type stars with initial masses around 1 $M_\odot$

Shreeya Shetye[1,2], Stephane Goriely[1], Lionel Siess[1], Sophie Van Eck[1], Alain Jorissen[1] and Hans Van Winckel[2]

[1]Institute of Astronomy and Astrophysics (IAA), Université libre de Bruxelles (ULB), C.P. 226, Boulevard du Triomphe, B-1050 Bruxelles, Belgium

[2]Institute of Astronomy, K.U. Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgium

Context: S stars are late-type giants with spectra showing characteristic molecular bands of ZrO in addition to the TiO bands typical of M stars. Their overabundance pattern shows the signature of *s*-process nucleosynthesis. Intrinsic, technetium (Tc)-rich S stars are the first objects, on the Asymptotic Giant Branch (AGB), to undergo third dredge-up (TDU) events. Gaia exquisite parallaxes now allow to precisely locate these stars in the Hertzsprung–Russell (HR) diagram. Here we report on a population of low-mass, Tc-rich S stars, previously unaccounted for by stellar evolution models.

Aims: Our aim is to derive parameters of a sample of low-mass Tc-rich S stars and then, by comparing their location in the HR diagram with stellar evolution tracks, to derive their masses and to compare their measured *s*-process abundance profiles with recently derived STAREVOL nucleosynthetic predictions for low-mass AGB stars.

Methods: The stellar parameters were obtained using a combination of HERMES high-resolution spectra, accurate Gaia Data Release 2 (Gaia-DR2) parallaxes, stellar-evolution models and newly-designed MARCS model atmospheres for S-type stars.

Results: We report on 6 Tc-rich S stars lying close to the 1 $M_\odot$ (initial mass) tracks of AGB stars of the corresponding metallicity and above the predicted onset of TDU, as expected. This provides direct evidence for TDUs occurring in AGB stars with initial masses as low as ~ 1 $M_\odot$ and at low luminosity, i.e. at the start of the thermally-pulsing AGB. We present AGB models producing TDU in those stars with [Fe/H] in the range -0.25 to -0.5. There is a reasonable agreement between the measured and predicted *s*-process abundance profiles. For 2 objects however (CD $-29°5912$ and BD $+34°1698$), the predicted C/O ratio and *s*-process enhancements do not match simultaneously the measured ones.

Accepted for publication in A&A Letters
Available from https://arxiv.org/abs/1904.04039

A catalogue of oxygen-rich pulsating giants in the Galactic halo and the Sagittarius stream

Nicolas Mauron[1], Luc P.A. Maurin[2] and Tim R. Kendall[3]

[1]Laboratoire Univers et Particules de Montpellier, France

[2]Observatoire des Ifs, Avignon, France

[3]18 Market Square, Northampton NN1 2DL, United Kingdom

In order to construct a catalogue of oxygen-rich (noted M) asymptotic giant branch (AGB) stars in the halo, complementing those of carbon-rich (C) stars, previous lists of Miras and SRa semi-regulars located in the Northern hemisphere are merged and cleaned of various defects. After putting aside known C stars, characteristics like colours and periods indicate that most of the remaining objects are M stars. Distances are obtained through the period–luminosity relation. By considering their position in the sky, stars lying at $|Z| > 5$ kpc are confirmed to be in majority in the Sgr tidal arms. The M stars are more numerous than C ones. Our distance scale is supported by two cool variables located in the Pal 4 globular cluster. Along the Sgr arms, there is reasonable agreement on distances of our objects with recent RR Lyræ distances. A few stars may be as distant as 150 kpc, with possibly four at the trailing arm apocenter, and two in the A16 substructure, angularly close to two C stars. Ninety radial velocities are collected from *Gaia* and other sources. A catalogue with 417 M pulsating AGB stars is provided. It contains ~ 260 stars in the halo with $|Z| > 5$ kpc. Their K_s magnitudes range from 8 up to 13. For comparison, the catalogue also provides ~ 150 stars in the disc having $5 < K_s < 8$. *The catalogue is available on request (NM) before being on CDS.*

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1903.12163

Investigation of long-period variables in the Catalina Southern catalog: new carbon stars and false objects

Nicolas Mauron[1], *Kamo S. Gigoyan*[2], *Karen K. Gigoyan*[2], *Luc P.A. Maurin*[3] *and Tim R. Kendall*[4]

[1]Laboratoire Univers et Particules, Université de Montpellier, France

[2]NAS RA V.A. Ambartsumian Byurakan Astrophysical Observatory, Armenia

[3]Observatoire des Ifs, Avignon, France

[4]18 Market Square, Northampton NN1 2DL, United Kingdom

As part of our ongoing study of the evolved giants in the galactic halo, we consider the sample of 1286 long-period variables (LPVs) in the Southern hemisphere provided by the Catalina Sky Survey experiment. These LPVs have periods $P > 80$ days and amplitudes > 0.2 mag. First, by using the Hamburg–ESO spectral survey, we aim to determine the spectral type as either M-type or C-type for objects located in the imprint of this survey, $|b| > 30°$. Of 135 LPVs obeying this selection, we classified 93, and found only 2 new carbon stars. Secondly, we consider faint LPVs. We discovered that many lie at $\sim 1'$ from a bright Mira catalogued in the General Catalog of Variable Stars, with identical period. We study these suspicious cases in detail, and conclude that, for as many as 56 faint Catalina LPVs, their variability is due to contamination by light from the bright, neighbouring GCVS Mira: an instrumental artefact. We conclude that when dealing with distant, faint Miras in the Catalina catalog, researchers should pay attention to the polluting effects of neighbouring bright and variable objects.

Accepted for publication in Astrophysics
Available from https://arxiv.org/abs/1901.11427

Photo-dissociation of CO in the outflow of evolved stars

Maryam Saberi[1], *Wouter Vlemmings*[1] *and Elvire De Beck*[1]

[1]Chalmers University of Technology, Onsala Space Observatory, Sweden

Context: Ultraviolet (UV) photo-dissociation of carbon monoxide (CO) controls the abundances and distribution of CO and its photo-dissociation products. This significantly influences the gas-phase chemistry in the circumstellar material around evolved stars. A better understanding of CO photo-dissociation in outflows also provides a more precise estimate of mass-loss rates.
Aims: We aim to update the CO photo-dissociation rate in an expanding spherical envelope assuming that the interstellar radiation field (ISRF) photons penetrate through the envelope. This will allow us to precisely estimate the CO abundance distributions in circumstellar envelope around evolved stars.
Methods: We used the most recent CO spectroscopic data to precisely calculate the depth dependency of the photo-dissociation rate of each CO dissociating line. We calculated the CO self- and mutual-shielding functions in an expanding envelope. We investigated the dependence of the CO profile on the five fundamental parameters mass-loss rate, the expansion velocity, the CO initial abundance, the CO excitation temperature, and the strength of the ISRF.
Results: Our derived CO envelope size is smaller than the commonly used radius derived by Mamon et al. (1988). The difference between results varies from 1% to 39% and depends on the H_2 and CO densities of the envelope. We list two fitting parameters for a large grid of models to estimate the CO abundance distribution. We demonstrate that the CO envelope size can differ between outflows with the same effective content of CO, but different CO abundance, mass-loss rate, and the expansion velocity as a consequence of differing amounts of shielding by H_2 and CO.
Conclusions: Our study is based on a large grid of models employing an updated treatment of the CO photo-dissociation, and in it we find that the abundance of CO close to the star and the outflow density both can have a significant effect on the size of the molecular envelope. We also demonstrate that modest variations in the ISRF can cause measurable differences in the envelope extent.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1904.05425

Companion-launched jets and their effect on the dynamics of common envelope interaction simulations

Sagiv Shiber[1], *Roberto Iaconi*[4,2,3], *Orsola De Marco*[2,3] *and Noam Soker*[1]

[1]Physics Department, Technion, Israel Institute of Technology, Technion City, Haifa 3200003, Israel

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

[3]Astronomy, Astrophysics and Astrophotonics Research Centre, Macquarie University, Sydney, NSW 2109, Australia

[4]Department of Astronomy, Kyoto University, Kitashirakawa-Oiwake-cho, Sakyo-ku, Kyoto 606-8502, Japan 0000-0002-1940-1950

We conduct three-dimensional hydrodynamic simulations of the common envelope binary interaction and show that if the companion were to launch jets while interacting with the giant primary star's envelope, the jets would remove a substantial fraction of the envelope's gas. We use the setup and numerical code of an earlier common envelope study that did not include jets, with a 0.88-$M_\odot$, 83-$R_\odot$ red giant star and a 0.3-$M_\odot$ companion. The assumption is that the companion star accretes mass via an accretion disk that is responsible for launching the jets which, in the simulations, are injected numerically. For the first time we conduct simulations that include jets as well as the gravitational energy released by the inspiraling core-companion system. We find that simulations with jets unbind approximately three times as much envelope mass than identical simulations that do not include jets, though the total fraction of unbound gas remains below 50% for these particular simulations. The jets generate high velocity outflows in the polar directions. The jets also increase the final core–companion orbital separation and lead to a kick velocity of the core–companion binary system. Our results show that, if able to form, jets could play a crucial role in ejecting the envelope and in shaping the outflow.

Submitted to Monthly Notices of the Royal Astronomical Society
Available from https://arxiv.org/abs/1902.03931

Slowly, slowly in the wind: 3D hydrodynamical simulations of wind mass transfer and angular-momentum loss in AGB binary systems

M.I. Saladino[1,2], *O.R. Pols*[1] *and C. Abate*[3]

[1]Department of Astrophysics/IMAPP, Radboud University, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands

[2]Leiden Observatory, Leiden University, P.O. Box 9513, 2300, RA, Leiden, The Netherlands

[3]Argelander-Institute für Astronomie (AIfA), University of Bonn, Auf dem Hügel 71, 53121 Bonn, Germany

Wind mass transfer in binary systems with asymptotic giant branch (AGB) donor stars plays a fundamental role in the formation of a variety of objects, including barium stars and carbon-enhanced metal-poor (CEMP) stars. In an attempt to better understand the properties of these systems, we carry out a comprehensive set of smoothed-particle hydrodynamics (SPH) simulations of wind-losing AGB stars in binaries, for a variety of binary mass ratios, orbital separations, initial wind velocities and rotation rates of the donor star. The initial parameters of the simulated systems are chosen to match the expected progenitors of CEMP stars. We find that the strength of interaction between the wind and the stars depends on both the wind-velocity-to-orbital-velocity ratio ($v_\infty/v_{\rm orb}$) and the binary mass ratio. Strong interaction occurs for close systems and comparable mass ratios, and gives rise to a complex morphology of the outflow and substantial angular-momentum loss, which leads to a shrinking of the orbit. As the orbital separation increases and the mass of the companion star decreases, the morphology of the outflow, as well as the angular-momentum loss, become more similar to the spherically symmetric wind case. We also explore the effects of tidal interaction and find that for orbital separations up to 7–10 au, depending on mass ratio, spin–orbit coupling of the donor star occurs at some point during the AGB phase. If the initial wind velocity is relatively low, we find that co-rotation of the donor star results in a modified outflow morphology that resembles wind Roche-lobe overflow. In this case the mass-accretion efficiency and angular-momentum loss differ from those found for a non-rotating donor. Finally, we provide a relation for both the mass-accretion efficiency and angular-momentum loss as a function of $v_\infty/v_{\rm orb}$ and the binary mass ratio that can be easily implemented in a population synthesis code to study populations of barium stars, CEMP stars and other products of interaction in AGB binaries, such as cataclysmic binaries and supernovæ type Ia.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1903.04515

AGB dust and gas ejecta in extremely metal-poor environments

F. Dell'Agli[1,2], R. Valiante[3], D. Kamath[4,5], P. Ventura[3] and D.A. García–Hernández[1,2]

[1]Instituto de Astrofísica de Canarias (IAC), E-38200 La Laguna, Tenerife, Spain

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

[3]INAF – Osservatorio Astronomico di Roma, Via Frascati 33, 00040, Monte Porzio Catone (RM), Italy

[4]Department of Physics & Astronomy, Macquarie University, Sydney, NSW 2109, Australia

[5]Astronomy, Astrophysics and Astrophotonics Research Centre, Macquarie University, Sydney, NSW 2109, Australia

We present asymptotic giant branch (AGB) models of metallicity $Z = 10^{-4}$ and $Z = 3 \times 10^{-4}$, with the aim of understanding how the gas enrichment and the dust production change in very metal-poor environments and to assess the general contribution of AGB stars to the cosmic dust yield. The stellar yields and the dust produced are determined by the change in the surface chemical composition, with a transition occurring at ~ 2.5 $M_\odot$. Stars of mass $M < 2.5$ $M_\odot$ reach the carbon stage and produce carbon dust, whereas their higher mass counterparts produce mainly silicates and alumina dust; in both cases the amount of dust manufactured decreases towards lower metallicities. The $Z = 10^{-4}$ models show a complex and interesting behaviour on this side, because the efficient destruction of the surface oxygen favours the achievement of the C-star stage, independently of the initial mass. The present results might indicate that the contribution from this class of stars to the overall dust enrichment in metal-poor environments is negligible at redshifts $z > 5$.

Accepted for publication in MNRAS
Available from https://arxiv.org/abs/1904.11734

The difficulty of inferring progenitor masses from Type II-Plateau supernova light curves

Luc Dessart[1] and D. John Hillier[2]

[1]Laboratoire Franco–Chilien d'Astronomie, UMI3386, CNRS, Universidad de Chile, Chile

[2]Department of Physics and Astronomy, University of Pittsburgh, USA

Much controversy surrounds the inferred progenitor masses of Type II-Plateau (II-P) supernovæ (SNe). The debate is nourished by the discrepant results from radiation-hydrodynamics simulations, from pre-explosion imaging, and from studies of host stellar populations. Here, we present a controlled experiment using four solar metallicity models with zero-age main-sequence masses of 12, 15, 20, and 25 $M_\odot$. Because of the effects of core burning and surface mass loss, these models reach core collapse as red supergiant (RSG) stars with a similar H-rich envelope mass of 8 to 9 $M_\odot$ but with final masses in the range 11 to 16 $M_\odot$. We explode the progenitors using a thermal bomb, adjusting the energy deposition to yield an asymptotic ejecta kinetic energy of 1.25×10^{51} erg and an initial ^{56}Ni mass of 0.04 $M_\odot$. The resulting SNe produce similar photometric and spectroscopic properties from 10 to 200 d. The spectral characteristics are degenerate. The scatter in early-time color results from the range in progenitor radii, while the differences in late-time spectra reflect the larger oxygen yields in more massive progenitors. Because the progenitors have a comparable H-rich envelope mass, the photospheric phase duration is comparable for all models; the difference in He-core mass is invisible. As different main-sequence masses can produce progenitors with a similar H-rich envelope mass, light curve modeling cannot provide a robust and unique solution for the ejecta mass of Type II-P SNe. The numerous uncertainties in massive star evolution and wind mass loss also prevent a robust association with a main-sequence star mass. Light curve modeling can at best propose compatibility.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1903.04840

Two's a crowd? Characterising the effect of photometric contamination on the extraction of the global asteroseismic parameter $\nu_{\rm max}$ in red-giant binaries

Sanjay Sekaran[1], *Cole Johnston*[1], *Andrew Tkachenko*[1], *Paul G. Beck*[2,3], *Andrej Prsa*[4] *and Kelly M. Hambleton*[4]

[1]Instituut voor Sterrenkunde (IvS), K.U. Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgium

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

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

[4]Villanova University, Dept. of Astrophysics and Planetary Science, 800 Lancaster Ave, Villanova PA 19085, USA

Theoretical scaling relations for solar-like oscillators and red giants are widely used to estimate fundamental stellar parameters. The accuracy and precision of these relations have often been questioned in the literature, with studies often utilising binarity for model-independent validation. However, it has not been tested if the photometric effects of binarity introduce a systematic effect on the extraction of the seismic properties of the pulsating component(s). In this paper, we present an estimation of the impact of a contaminating photometric signal with a distinct background profile on the global asteroseismic parameter $\nu_{\rm max}$ through the analysis of synthetic red-giant binary light curves. We generate the pulsational and granulation parameters for single red giants with different masses, radii and effective temperatures from theoretical scaling relations and use them to simulate single red-giant light curves with the characteristics of *Kepler* long-cadence photometric data. These are subsequently blended together according to their light ratio to generate binary red-giant light curves of various configurations. We then perform a differential analysis to characterise the systematic effects of binarity on the extraction of $\nu_{\rm max}$. We find that the $\nu_{\rm max}$ extraction for red-giant power spectra featuring overlapping power excesses is unreliable if unconstrained priors are used. Outside of this scenario, we obtain results that are nearly identical to single-star case. We conclude that i) the photometric effects of binarity on the extraction of $\nu_{\rm max}$ are largely negligible as long as the power excesses of the individual components do not overlap, and that ii) there is minimal advantage to using more than two super-Lorentzian components to model the granulation signal of a binary red-giant.

Accepted for publication in Astronomy and Astrophysics
Available from https://arxiv.org/abs/1903.09146

The unexpected spectrum of the innermost ejecta of the red hypergiant VY CMa

R.M. Humphreys[1], *L.M. Ziurys*[2], *J.J. Bernal*[2], *M.S. Gordon*[3], *L.A. Helton*[3], *K. Ishibashi*[4], *T.J. Jones*[1], *A.M.S. Richards*[5] *and W. Vlemmings*[6]

[1]University of Minnesota, USA

[2]University of Arizona, USA

[3]USRA–SOFIA Science Center, USA

[4]Nagoya University, Japan

[5]Jodrell Bank, University of Manchester, UK

[6]Chalmers University of Technology, Onsala, Sweden

HST/STIS spectra of the small clumps and filaments closest to the central star in VY CMa reveal that the very strong K I emission and TiO and VO molecular emission, long thought to form in a dusty circumstellar shell, actually originate in a few small clumps 100s of au from the star. The K I lines are 10 to 20 times stronger in these nearest ejecta than on the star. The observations also confirm VO as a circumstellar molecule. In this letter we discuss the spectra of the features, their motions and ages, and the identification of the molecular emission. The strength of the atomic and molecular features in the small clumps present an astrophysical problem for the excitation process. We show that the clumps must have a nearly clear line of sight to the star's radiation.

Published in The Astrophysical Journal, 874, L26, (2019)
Available from https://arxiv.org/abs/1903.08744
and from https://iopscience.iop.org/article/10.3847/2041-8213/ab11e5/meta

Constant light element abundances suggest that the extended P1 in NGC 2808 is not a consequence of CNO-cycle nucleosynthesis

Ivan Cabrera-Ziri[1], *Carmela Lardo*[2] *and Alessio Mucciarelli*[3,4]

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

[2]Laboratoire d'Astrophysique, École Polytechnique Fédérale de Lausanne, Observatoire de Sauverny, CH-1290 Versoix, Switzerland

[3]Dipartimento di Fisica e Astronomia, Università degli Studi di Bologna, via Piero Gobetti 93/2, I-40129, Bologna, Italy

[4]INAF–Astrophysics and Space Science Observatory Bologna, via Piero Gobetti 93/3, I-40129, Bologna, Italy

Recent photometric results have identified a new population among globular cluster stars. This population, referred to as the 'extended P1', has been suggested to be the manifestation of a new abundance pattern where the initial mass fraction of He changes among cluster stars that share the same CNO values. The current paradigm for the formation of the multiple stellar populations in globular clusters assumes that variations in He are the product of chemical 'enrichment' by the ashes of the CNO-cycle (which changes He and other elements like C, N and O simultaneously). We obtained MIKE@Magellan spectra of six giant stars in NGC 2808, a cluster with one of the strongest examples of the extended P1 population. We provide the first complete characterization of the light elements abundances for the stars along a significant range of the extended P1 photometric group. The stars from our sample appear to be homogeneous in C, N, O, Na, Mg and Al. The lack of a significant change in these products of the CNO-cycle suggests that unlike the rest of the populations identified to date, the photometric changes responsible for the extended P1 feature are a consequence of an alternative mechanism. Our measurements are consistent with the interpretations where the changes of the He mass fraction among these stars could be a consequence of p–p chain nucleosynthesis (which could increase the He in stars without affecting heavier elements). Having said that, direct measurements of He are necessary to conclude if variations of this element are present among extended P1 stars.

Accepted for publication in MNRAS
Available from https://arxiv.org/abs/1903.03621

The survey of planetary nebulæ in Andromeda (M 31) I. Imaging the disc and halo with MegaCam at the CFHT

Souradeep Bhattacharya[1], *Magda Arnaboldi*[1], *Johanna Hartke*[1,2], *Ortwin Gerhard*[3], *Valentin Comte*[1,4], *Alan McConnachie*[5] *and Nelson Caldwell*[6]

[1]European Southern Observatory, Karl-Schwarzschild-Str. 2, 85748 Garching bei München, Germany

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

[3]Max-Planck-Institut für Extraterrestrische Physik, Gießenbachstraße, 85748 Garching bei München, Germany

[4]Aix Marseille Université, CNRS, LAM–Laboratoire d'Astrophysique de Marseille, 38 rue F. Joliot-Curie, 13388 Marseille, France

[5]NRC Herzberg Institute of Astrophysics, 5071 West Saanich Road, Victoria, BC V9E 2E7, Canada

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

Context: The Andromeda (M 31) galaxy subtends nearly 100 square degrees on the sky. Any study of its halo must therefore account for the severe contamination from the Milky Way halo stars whose surface density displays a steep gradient across the entire M 31 field of view.
Aims: Our goal is to identify a population of stars firmly associated with the M 31 galaxy. Planetary nebulæ (PNe) are one such population that are excellent tracers of light, chemistry, and motion in galaxies. We present a 16 square degree survey of the disc and inner halo of M 31 with the MegaCam wide-field imager at the CFHT to identify PNe, and characterise the luminosity-specific PN number and PN luminosity function (PNLF) in M 31. *Methods:* PNe were identified via automated detection techniques based on their bright [O III] 5007Å emission and absence of a continuum. Subsamples of the faint PNe were independently confirmed by matching with resolved *Hubble* Space Telescope sources from the Panchromatic Hubble Andromeda Treasury and spectroscopic follow-up observations with HectoSpec at the MMT.
Results: The current survey reaches two magnitudes fainter than the previous most sensitive survey. We thus identify 4289 PNe, of which only 1099 were previously known. By comparing the PN number density with the surface brightness profile of M 31 out to $\sim$ 30 kpc along the minor axis, we find that the stellar population in the inner halo has a luminosity-specific PN number value that is seven times higher than that of the disc. We measure the

luminosity function of the PN population and find a bright cut-off and a slope consistent with previous determinations. Interestingly, it shows a significant rise at the faint end, present in all radial bins covered by the survey. This rise in the M 31 PNLF is much steeper than that observed for the Magellanic clouds and Milky Way bulge.
Conclusions: The significant radial variation of the PN specific frequency value indicates that the stellar population at deprojected minor-axis radii larger than ~ 10 kpc is different from that in the disc of M 31. The rise at the faint end of the PNLF is a property of the late phases of the stellar population. M 31 shows two major episodes of star formation and the rise at the faint end of the PNLF is possibly associated with the older stellar population. It may also be a result of varying opacity of the PNe.

Published in A&A, 624, A132 (2019)
Available from https://arxiv.org/abs/1903.02597
and from https://doi.org/10.1051/0004-6361/201834579

A search for red giant solar-like oscillations in all *Kepler* data

Marc Hon[1], *Dennis Stello*[1,2,3], *Rafael A. García*[4,5], *Savita Mathur*[6,7,8], *Sanjib Sharma*[2], *Isabel L. Colman*[2,3] *and Lisa Bugnet*[4,5]

[1]School of Physics, The University of New South Wales, Sydney NSW 2052, Australia
[2]Sydney Institute for Astronomy (SIfA), School of Physics, University of Sydney, NSW 2006, Australia
[3]Stellar Astrophysics Centre, Department of Physics and Astronomy, Århus University, Ny Munkegade 120, DK-8000 Århus C, Denmark
[4]IRFU, CEA, Université Paris–Saclay, F-91191 Gif-sur-Yvette, France
[5]Université Paris Diderot, AIM, Sorbonne Paris Cité, CEA, CNRS, F-91191 Gif-sur-Yvette, France
[6]Instituto de Astrofísica de Canarias, E-38200, La Laguna, Tenerife, Spain
[7]Universidad de La Laguna, Departamento de Astrofísica, E-38205, La Laguna, Tenerife, Spain
[8]Space Science Institute, 4750 Walnut Street Suite 205, Boulder, CO 80301, USA

The recently published *Kepler* mission Data Release 25 (DR25) reported on $\sim 197,000$ targets observed during the mission. Despite this, no wide search for red giants showing solar-like oscillations have been made across all stars observed in *Kepler*'s long-cadence mode. In this work, we perform this task using custom apertures on the *Kepler* pixel files and detect oscillations in 21,914 stars, representing the largest sample of solar-like oscillating stars to date. We measure their frequency at maximum power, $\nu_{\rm max}$, down to $\nu_{\rm max} \simeq 4$ μHz and obtain $\log g$ estimates with a typical uncertainty below 0.05 dex, which is superior to typical measurements from spectroscopy. Additionally, the $\nu_{\rm max}$ distribution of our detections show good agreement with results from a simulated model of the Milky Way, with a ratio of observed to predicted stars of 0.992 for stars with 10 μHz $< \nu_{\rm max} <$ 270 μHz. Among our red giant detections, we find 909 to be dwarf/subgiant stars whose flux signal is polluted by a neighbouring giant as a result of using larger photometric apertures than those used by the NASA *Kepler* Science Processing Pipeline. We further find that only 293 of the polluting giants are known *Kepler* targets. The remainder comprises over 600 newly identified oscillating red giants, with many expected to belong to the Galactic halo, serendipitously falling within the *Kepler* pixel files of targeted stars.

Published in Monthly Notices of the Royal Astronomical Society
Available from https://arxiv.org/abs/1903.00115
and from 10.1093/mnras/stz622

An extensive grid of DARWIN models for M-type AGB stars I. Mass-loss rates and other properties of dust-driven winds

Sara Bladh[1,2], *Sofie Liljegren*[1,3], *Susanne Höfner*[1], *Bernhard Aringer*[2] *and Paola Marigo*[2]

[1]Theoretical Astrophysics, Department of Physics and Astronomy, Uppsala University, Box 516, SE-751 20 Uppsala, Sweden
[2]Dipartimento di Fisica e Astronomia Galileo Galilei, Università di Padova, Vicolo dell'Osservatorio 3, 35122 Padova, Italy
[3]Department of Astronomy, Stockholm University, Oscar Klein Centre, AlbaNova University Centre, 106 91 Stockholm, Sweden

The stellar winds of asymptotic giant branch (AGB) stars are commonly attributed to radiation pressure on dust

grains, formed in the wake of shock waves that arise in the stellar atmospheres. The mass loss due to these outflows is substantial, and modelling the dynamical properties of the winds is essential both for studies of individual stars and for understanding the evolution of stellar populations with low to intermediate mass. The purpose of this work is to present an extensive grid of dynamical atmosphere and wind models for M-type AGB stars, covering a wide range of relevant stellar parameters. We used the DARWIN code, which includes frequency-dependent radiation-hydrodynamics and a time-dependent description of dust condensation and evaporation, to simulate the dynamical atmosphere. The wind-driving mechanism is photon scattering on sub-μm-sized Mg_2SiO_4 grains. The grid consists of ~ 4000 models, with luminosities from $L = 890$ $L_\odot$ to $L = 40\,000$ $L_\odot$ and effective temperatures from 2200 K to 3400 K. For the first time different current stellar masses are explored with M-type DARWIN models, ranging from 0.75 $M_\odot$ to 3 $M_\odot$. The modelling results are radial atmospheric structures, dynamical properties such as mass-loss rates and wind velocities, and dust properties (e.g., grain sizes, dust-to-gas ratios, and degree of condensed Si). We find that the mass-loss rates of the models correlate strongly with luminosity. They also correlate with the ratio L/M: increasing L/M by an order of magnitude increases the mass-loss rates by about three orders of magnitude, which may naturally create a superwind regime in evolution models. There is, however, no discernible trend of mass-loss rate with effective temperature, in contrast to what is found for C-type AGB stars. We also find that the mass-loss rates level off at luminosities higher than $\sim 14\,000$ $L_\odot$, and consequently at pulsation periods longer than ~ 800 days. The final grain radii range from 0.25 μm to 0.6 μm. The amount of condensed Si is typically between 10% and 40%, with gas-to-dust mass ratios between 500 and 4000.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1904.10943

NOEMA maps the CO $J = 2$–1 environment of the red supergiant μ Cep

M. Montargès[1], *W. Homan*[1], *D. Keller*[1], *N. Clementel*[1], *S. Shetye*[2,1], *L. Decin*[1], *G.M. Harper*[3], *P. Royer*[1], *J.M. Winters*[4], *T. Le Bertre*[5,6] *and A.M.S. Richards*[7]

[1]Institute of Astronomy, K.U. Leuven, Celestijnenlaan 200D B2401, 3001 Leuven, Belgium
[2]Institute of Astronomy and Astrophysics, Université libre de Bruxelles, B-1050 Bruxelles, Belgium
[3]Center for Astrophysics and Space Astronomy, University of Colorado, Boulder, CO 80309, USA
[4]Institut de Radioastronomie Millimétrique, 300 rue de la Piscine, 38406, Saint Martin d'Hères, France
[5]LERMA, Observatoire de Paris, PSL Research University, CNRS, UMR 8112, 75014, Paris, France
[6]Sorbonne Universités, UPMC Univ. Paris 06, UMR 8112, LERMA, 75005, Paris, France
[7]Jodrell Bank Centre for Astrophysics, School of Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK

Red supergiant stars are surrounded by a gaseous and dusty circumstellar environment created by their mass loss which spreads heavy elements into the interstellar medium. The structure and the dynamics of this envelope are crucial to understand the processes driving the red supergiant mass loss and the shaping of the pre-supernova ejecta. We have observed the emission from the CO $J = 2$–1 line from the red supergiant star μ Cep with the NOEMA interferometer. In the line the synthesized beam was $0.92'' \times 0.72''$ (590×462 au^2 at 641 pc). The continuum map shows only the unresolved contribution of the free–free emission of the star chromosphere. The continuum-subtracted channel maps reveal a very inhomogeneous and clumpy circumstellar environment. In particular, we detected a bright CO clump, as bright as the central source in the line, at $1\farcs80$ South–West from the star, in the blue channel maps. After a deprojection of the radial velocity assuming two different constant wind velocities, the observations were modelled using the 3D radiative transfer code LIME to derive the characteristics of the different structures. We determine that the gaseous clumps observed around μ Cep are responsible for a mass-loss rate of $(4.9\pm1.0)\times10^{-7}$ $M_\odot$ yr^{-1}, in addition to a spatially unresolved wind component with an estimated mass-loss rate of 2.0×10^{-6} $M_\odot$ yr^{-1}. Therefore, the clumps have a significant role in μ Cep's mass loss ($\geq 25\%$). We cannot exclude that the unresolved central outflow may be made of smaller unresolved clumps.

Published in MNRAS, 485, 2417 (2019)
Available from https://arxiv.org/abs/1903.07129
and from https://doi.org/10.1093/mnras/stz397

ASAS-SN observations of the pulsation of some R Coronæ Borealis (RCB) stars

John R. Percy[1,2]

[1]Department of Astronomy & Astrophysics, University of Toronto, Canada

[2]Dunlap Institute for Astronomy & Astrophysics, University of Toronto, Canada

Photometry from the All-Sky Automated Survey for Supernovae (ASAS-SN), along with the AAVSO VSTAR time-series analysis package has been used to study the pulsational properties of 31 R Coronæ Borealis (RCB) stars. Periods have been derived for many of the stars, but the variability tends to be small and complex, occasionally multi-periodic, with noticeable variation in amplitude. As with other RCB stars, the periods are a few weeks.

Available from https://arxiv.org/abs/1903.05166

The Type II-P supernova 2017eaw: from explosion to the nebular phase

Tamás Szalai[1,2], *József Vinkó*[1,2,3], *Réka Könyves-Tóth*[2], *Andrea P. Nagy*[1,2], *K. Azalee Bostroem*[4], *Krisztián Sárneczky*[2], *Peter J. Brown*[5], *Ondrej Pejcha*[6], *Attila Bódi*[2,18], *Borbála Cseh*[2], *Géza Csörnyei*[2], *Zoltán Dencs*[2], *Ottó Hanyecz*[2], *Bernadett Ignácz*[2], *Csilla Kalup*[2,18], *Levente Kriskovics*[2], *András Ordasi*[2], *András Pál*[2], *Bálint Seli*[2], *Ádám Sódor*[2,18], *Róbert Szakáts*[2], *Krisztián Vida*[2], *Gabriella Zsidi*[2], *Iair Arcavi*[7], *Chris Ashall*[8,9], *Jamison Burke*[10,11], *Lluís Galbany*[12], *Daichi Hiramatsu*[10,11], *Griffin Hosseinzadeh*[10,11,13], *Eric Y. Hsiao*[9], *D. Andrew Howell*[10,11], *Curtis McCully*[10,11], *Shane Moran*[14], *Jeonghee Rho*[15], *David J. Sand*[16], *Melissa Shahbandeh*[9], *Stefano Valenti*[4], *Xiaofeng Wang*[17] *and J. Craig Wheeler*[3]

[1]Department of Optics and Quantum Electronics, University of Szeged, Dóm tér 9, Szeged, 6720 Hungary

[2]Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, H-1121 Budapest, Hungary

[3]Department of Astronomy, University of Texas at Austin, Austin, TX 78712, USA

[4]Department of Physics, University of California, Davis, CA 95616, USA

[5]George P. and Cynthia Woods Mitchell Institute for Fundamental Physics and Astronomy, Texas A&M University, Department of Physics and Astronomy, 4242 TAMU, College Station, TX 77843, USA

[6]Institute of Theoretical Physics, Faculty of Mathematics and Physics, Charles University in Prague, Czech Republic

[7]The School of Physics and Astronomy, Tel Aviv University, Tel Aviv 69978, Israel

[8]Astrophysics Research Institute, Liverpool John Moores University, IC2, Liverpool Science Park, 146 Brownlow Hill, Liverpool L3 5RF, UK

[9]Department of Physics, Florida State University, 77 Chieftan Way, Tallahassee, FL 32306, USA

[10]Las Cumbres Observatory, 6740 Cortona Drive, Suite 102, Goleta, CA 93117-5575, USA

[11]Department of Physics, University of California, Santa Barbara, CA 93106-9530, USA

[12]PITT PACC, Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15260, USA

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

[14]Tuorla Observatory, Department of Physics and Astronomy, University of Turku, Väisäläntie 20, FI-21500 Piikkiö, Finland

[15]SETI Institute, 189 North Bernardo Avenue, Suite 200, Mountain View, CA 94043, USA

[16]Department of Astronomy/Steward Observatory, 933 North Cherry Avenue, Room N204, Tucson, AZ 85721-0065, USA

[17]Physics Department and Tsinghua Center for Astrophysics (THCA), Tsinghua University, Beijing, 100084, People's Republic of China

[18]MTA CSFK Lendület Near-Field Cosmology Research Group

The nearby SN 2017eaw is a Type II-P ("plateau") supernova (SN) showing early-time, moderate CSM interaction. We present a comprehensive study of this SN, including the analysis of high-quality optical photometry and spectroscopy covering the very early epochs up to the nebular phase, as well as near-ultraviolet and near-infrared spectra and early-time X-ray and radio data. The combined data of SNe 2017eaw and 2004et allow us to get an improved distance to the host galaxy, NGC 6946, of $d \sim 6.85 \pm 0.63$ Mpc; this fits into recent independent results on the distance of the host and disfavors the previously derived (30% shorter) distances based on SN 2004et. From modeling the nebular spectra and the quasi-bolometric light curve, we estimate the progenitor mass and some basic physical parameters for the explosion and ejecta. Our results agree well with previous reports on a red supergiant progenitor star with a mass of $\sim$ 15–16 $M_\odot$. Our estimation of the pre-explosion mass-loss rate ($\dot{M} \sim 3 \times 10^{-7}$–$1 \times 10^{-6}$ $M_\odot$ yr^{-1}) agrees well

with previous results based on the opacity of the dust shell enshrouding the progenitor, but it is orders of magnitude lower than previous estimates based on general light-curve modeling of Type II-P SNe. Combining late-time optical and mid-infrared data, a clear excess at 4.5 μm can be seen, supporting the previous statements on the (moderate) dust formation in the vicinity of SN 2017eaw.

Published in ApJ, 876, 19 (2019)
Available from https://arxiv.org/abs/1903.09048
and from https://iopscience.iop.org/article/10.3847/1538-4357/ab12d0

Conference Paper

Recovering the star formation history of IC 1613 dwarf galaxy using evolved stars

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

[1]Sharif University of Technology, Tehran, Iran
[2]IPM, Iran
[3]Keele University, UK

Determining the star formation history (SFH) is key to understand the formation and evolution of dwarf galaxies. Recovering the SFH in resolved galaxies is mostly based on deep colour–magnitude diagrams (CMDs), which trace the signatures of multiple evolutionary stages of their stellar populations. In distant and unresolved galaxies, the integrated light of the galaxy can be decomposed, albeit made difficult by an age–metallicity degeneracy. Another solution to determine the SFH of resolved galaxies is based on evolved stars; these luminous stars are the most accessible tracers of the underlying stellar populations and can trace the entire SFH. Here we present a novel method based on long period variable (LPV) evolved asymptotic giant branch (AGB) stars and red supergiants (RSGs). We applied this method to reconstruct the SFH for IC 1613, an irregular dwarf galaxy at a distance of 750 kpc. Our results provide an independent confirmation that no major episode of star formation occurred in IC 1613 over the past 5 Gyr.

Poster contribution, published in IAUS 344 "Dwarf Galaxies: From the Deep Universe to the Present", XXX$^{\rm th}$ General Assembly of the IAU, Vienna, August 20–31, 2018
Available from https://arxiv.org/abs/1903.02767

Review Papers

High angular resolution astrophysics: resolving stellar surface features

Rachael M. Roettenbacher[1], Ryan P. Norris[2], Fabien Baron[2], Kenneth G. Carpenter[3], Michelle J. Creech-Eakman[4], Douglas Gies[2], Thomas Maccarone[5], John D. Monnier[6], Gioia Rau[3], Stephen Ridgway[7], Gail H. Schaefer[2,8] and Theo ten Brummelaar[2,8]

[1]Yale University, USA
[2]Georgia State University, USA
[3]NASA GSFC, USA
[4]New Mexico Tech, USA
[5]Texas Tech, USA
[6]University of Michigan, USA
[7]NOAO, USA
[8]The CHARA Array, USA

We are now in an era where we can image details on the surfaces of stars. When resolving stellar surfaces, we see that

every surface is uniquely complicated. Each imaged star provides insight into not only the stellar surface structures, but also the stellar interiors suggesting constraints on evolution and dynamo models. As more resources become operational in the coming years, imaging stellar surfaces should become commonplace for revealing the true nature of stars. Here, we discuss the main types of stars for which imaging surface features is currently useful and what improved observing techniques would provide for imaging stellar surface features.

Published in Astro2020 Decadal Survey White Paper
Available from https://arxiv.org/abs/1903.04660

Cool, evolved stars: results, challenges, and promises for the next decade

Gioia Rau[1], *Rodolfo Montez Jr.*[2], *Kenneth G. Carpenter*[1], *Markus Wittkowski*[3], *Sara Bladh*[4], *Margarita Karovska*[2], *Vladimir Airapetian*[1], *Tom Ayres*[5], *Martha Boyer*[6], *Andrea Chiavassa*[7], *Geoffrey Clayton*[8], *William Danchi*[1], *Orsola De Marco*[9], *Andrea K. Dupree*[2], *Tomasz Kaminski*[2], *Joel H. Kastner*[10], *Franz Kerschbaum*[11], *Jeffrey Linsky*[5], *Bruno Lopez*[7], *John Monnier*[12], *Miguel Montargès*[13], *Krister Nielsen*[14], *Keiichi Ohnaka*[15], *Sofia Ramstedt*[4], *Rachael Roettenbacher*[16], *Theo ten Brummelaar*[18], *Claudia Paladini*[17], *Arkaprabha Sarangi*[1,14], *Gerard van Belle*[19] *and Paolo Ventura*[20]

[1]NASA/Goddard Space Flight Center, USA
[2]Center for Astrophysics (CfA), Harvard–Smithsonian, USA
[3]ESO/Garching, Germany
[4]Uppsala University, Sweden
[5]University of Colorado, USA
[6]Space Telescope Science Institute (STScI), USA
[7]Observatoire de la Côte d'Azur (OCA), France
[8]Louisiana State University, USA
[9]Macquarie University, Australia
[10]Rochester Institute of Technology, USA
[11]University of Vienna – Institute for Astrophysics, Austria
[12]University of Michigan, USA
[13]K.U. Leuven, Belgium
[14]Catholic University of America, USA
[15]Universidad Católica del Norte, Chile
[16]Yale University, USA
[17]ESO/Chile, Chile
[18]CHARA/GSU, USA
[19]Lowell Observatory, USA
[20]INAF/OAR, Italy

Cool, evolved stars are the main source of chemical enrichment of the interstellar medium (ISM), and understanding their mass loss and structure offers a unique opportunity to study the cycle of matter in the Universe. Pulsation, convection, and other dynamic processes in cool evolved stars create an atmosphere where molecules and dust can form, including those necessary to the formation of life (e.g., carbon-bearing molecules). Understanding the structure and composition of these stars is thus vital to several aspects of stellar astrophysics, ranging from ISM studies to modeling young galaxies and to exoplanet research.

Recent modeling efforts and increasingly precise observations now reveal that our understanding of cool stars photospheric, chromospheric, and atmospheric structures is limited by inadequate knowledge of the dynamic and chemical processes at work. Here we outline promising scientific opportunities for the next decade that can provide essential constraints on stellar photospheres, chromospheres, and circumstellar envelopes (CSE), and tie together analyses of the spectra and interferometric and imaging observations of evolved stars.

We identify and discuss the following main opportunities:

- identify and model the physical processes that must be included in current 1D and 3D atmosphere models of cool, evolved stars;
- refine our understanding of photospheric, chromospheric, and outer atmospheric regions of cool evolved stars, their properties and parameters, through high-resolution spectroscopic observations, and interferometric observations at high angular resolution;
- include the neglected role of chromospheric activity in the mass-loss process of red giant branch (RGB) and red super giant (RSG) stars and understand the role played by their magnetic fields;
- identify the important shaping mechanisms for planetary nebulæ (PNe) and their relation with the parent Asymptotic Giant Branch (AGB) stars.

Published in National Academy of Science (ASTRO2020 White Paper)
Available from https://arxiv.org/abs/1903.04585

Astro2020 Science White Paper: The fundamentals of outflows from evolved stars

E. De Beck[1], M.L. Boyer[2], V. Bujarrabal[3], L. Decin[4], J.P. Fonfría[5], M. Groenewegen[6], S. Höfner[7], O. Jones[8], T. Kamiński[9], M. Maercker[1], P. Marigo[10], M. Matsuura[11], M. Meixner[12], G. Quintana Lacaci Martínez[5], P. Scicluna[13], R. Szczerba[14], L. Velilla Prieto[1], W. Vlemmings[1] and M. Wiedner[15]

[1]Division of Astronomy and Plasma Physics, Department of Space, Earth and Environment, Chalmers University of Technology, Sweden
[2]Space Telescope Science Institute, USA
[3]Observatorio Astronómico Nacional (OAN, IGN), Spain
[4]Instituut voor Sterrenkunde, K.U. Leuven, Belgium
[5]Instituto de Física Fundamental (IFF), Consejo Superior de Investigaciones Científicas (CSIC), Spain
[6]Royal Observatory Belgium, Belgium
[7]Department of Physics and Astronomy, University of Uppsala, Sweden
[8]UK Astronomy Technology Centre, UK
[9]Center for Astrophysics, Harvard–Smithsonian, Cambridge, USA
[10]Department of Physics and Astronomy, University of Padova, Italy
[11]School of Physics and Astronomy, Cardiff University, Queen's Buildings, UK
[12]Space Telescope Science Institute, USA
[13]Academia Sinica Institute of Astronomy and Astrophysics, Taiwan
[14]Nicolaus Copernicus Astronomical Center, Poland
[15]Sorbonne University, Observatoire de Paris, CNRS, LERMA, France

Models of the chemical evolution of the interstellar medium, galaxies, and the Universe rely on our understanding of the amounts and chemical composition of the material returned by stars and supernovae. Stellar yields are obtained from stellar-evolution models, which currently lack predictive prescriptions of stellar mass loss, although it significantly affects stellar lifetimes, nucleosynthesis, and chemical ejecta.

Galaxy properties are derived from observations of the integrated light of bright member stars. Stars in the late stages of their evolution are among the infrared-brightest objects in galaxies. An unrealistic treatment of the mass-loss process introduces significant uncertainties in galaxy properties derived from their integrated light.

We describe current efforts and future needs and opportunities to characterize AGB outflows: driving mechanisms, outflow rates, underlying fundamental physical and chemical processes such as dust grain formation, and dependency of these on metallicity.

Published in Astronomy and Astrophysics decadal survey – science white paper
Available from https://arxiv.org/abs/1903.12025

Announcements

High-Resolution Spectroscopy in the Era of ALMA, JWST and ELT

Registration is open for the High Resolution Spectroscopy in the Era of ALMA, JWST and ELT workshop, July 22–26, at the Sexten Centre for Astrophysics.

Workshop Aims:

The aim of the workshop is to bring together researchers working with one of the leading facilities available today (ALMA) in order to plan for the next generation (JWST, ELT). Key to the motivation for this workshop is that astronomers must harness the high spatial resolution spectroscopic capabilities of each of these facilities, in a multi-wavelength approach, in order to reach their scientific goals.

The meeting is focussed around this technique, rather than a specific science area, in order to capture the combined scientific power of all facilities. This meeting will bring together researchers from different astrophysical areas, and with expertise in each of these telescopes, to plan the programmes we need to answer the most important outstanding astronomical questions debated today.

The number of participants in the workshop will be limited to enable discussions and interaction with all participants. The participation of early stage researchers is strongly encouraged.

To ensure as much lively discussion as possible in a pan-chromatic workshop, we are limiting science topics to the following broad categories:

- Star and Planet Formation
- Evolved stars
- Resolved Stellar populations
- Galaxy Evolution

The abstract submission deadline is 17$^{\text{th}}$ May 2019, and registration deadline is 31$^{\text{st}}$ May. However abstract submission and registration may close earlier if all available spaces have been filled.
Conference website: https://hsrs2019.freemyip.com/ Registration page: http://www.sexten-cfa.eu/event/high-spatial-resolution-spectroscopy-in-the-era-of-alma-jwst-and-elt/
Conference email address: hsrs2019 at gmail.com.

Confirmed Invited Speakers:

- Alessio Caratti-o-Garatti (DIAS)
- Pierre Ferruit (ESA)
- Macarena Garcia-Marin (ESA)
- Oscar Gonzalez (UK ATC)
- Wouter Vlemmings (Chalmers)

Scientific Organising Committee:

- Giuseppina Battaglia (Instituto de Astrofísica de Canarias)
- Liz Humphreys (ESO)

- Pamela Klaassen (Chair, UK ATC)
- Livia Origlia (INAF)
- Suzie Ramsay (ESO)
- Gillian Wright (UK ATC)

See also https://hsrs2019.freemyip.com/

Refereed proceedings of the Asymmetric Planetary Nebulæ VII meeting

Dear all,

we are pleased to announce that the refereed proceedings of the APNVII meeting held in Hong Kong (China) from 4–8th December 2017 is available for free download: https://www.mdpi.com/books/pdfview/book/1176

Below is a brief summary of the focus, scope and purpose of this special issue.

This Special Issue was broadly based around the current major themes and questions regarding late-stage stellar evolution, and especially planetary nebulæ, via the invited and submitted talks. The scope of the meeting and thus the contents of this Special Issue include:

- Shaping Mechanisms – role of binarity, magnetic fields and other factors
- What can we learn from the major increase in known PNe?
- How are post-AGB, pre-PNe and PNe phase shapes related?
- What role do the properties of the central stars play?
- What can we learn from jets and accretion disks in related/unrelated objects?
- What do advances in evolutionary models and timescales tell us?
- How do we maximally extract science from the available/planned facilities?
- What are the most important current issues to resolve?

See also https://www.mdpi.com/books/pdfview/book/1176

A star has evolved. A conference in the honour of Hans Olofsson

For nearly four decades Hans has been a pioneer and driving actor in the field of evolved stars research. He has significantly contributed to our knowledge of the mass loss from AGB stars, the mechanism behind the mass loss, the chemical composition of the stellar winds, the nature behind episodic mass-loss, the maser emission from the envelopes around AGB stars, and the evolution of stars past the AGB stage. In addition, he has been one of the leading scientists to develop the observational methods using molecular line emission at millimetre and submillimetre wavelengths from both single-dish telescopes and interferometers. To celebrate his efforts but also to discuss the advances and prospects of our field we will hold a dedicated conference this year in August.

See also https://sites.google.com/view/astarhasevolved/