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Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

Editorial

Dear Colleagues,

It is a pleasure to present you the 272$^{\text{nd}}$ issue of the AGB Newsletter. There is a lot to read – especially about white dwarfs and asteroseismology, but much else too! If you are pressed for time, do skim the titles but make sure you read the first couple of pages of this newsletter in full. This month's "What am I thinking?" by another rising star, Gioia Rau is especially timely given the new facilities to study the Sun – *Parker* Solar Probe, *Inouye* Solar Telescope, Solar Orbiter... learning more about how Alfvén waves, acoustic waves and magnetic reconnection drives a wind like the Sun's may also help us understand how relatively-warm red giants and red supergiants lose mass.

Don't miss the announcement for a special session at the European Astronomical Society's meeting in Leiden. Also, while the European Southern Observatory's studentship programme may be familiar to you, you may not have realised there is a real – and recently heightened – potential for a student to work with ESO astronomers on AGB-related topics.

We are getting a healthy response to the discussion items – feel free to comment on anything else in the newsletter or field of red giants and supergiants! Costantino Sigismondi shared his personal story and pledge in relation to the anticipated explosion of Betelgeuse:
"The question originates itself from the recent dimming of the star, which has been larger than a whole magnitude, since september 2019. Many media presented simulations of the aspect of the sky in the case Betelgeuse would become the new Galactic supernova, and more have attributed to this forthcoming event the unusual behaviour of this star.
I had the privilege to follow on a daily basis the evolution of the light curve of Betelgeuse since december 2011, as part of my observational project within the AAVSO, American Association of Variable Stars Observers, and I would like to spend some words in describing and motivating it.
Betelgeuse is a first magnitude variable star. Semi-regular. The secular AAVSO database (1911-on) allows to see at first sight two main periods, 1.2 and 5.9 years modulation, but identifying its regularities is only one way to try to understand the complexity with a simple model.
I have chosen to follow Betelgeuse and Antares after starting to observe δ Scorpii from my window when I was working at Rio de Janeiro Observatory. This star was near the zenith, I noticed its brightness and after identification, I read about its variability discovered only in 2000 by Sebastian Otero, an AAVSO member who provided visual observations with 0.01 magnitudes of accuracy. Until 2011 my variable star targets were preferably novæ, for their relevance in the History of Astronomy, that I taught at Sapienza University of Rome. Betelgeuse and Antares were chosen in order to have always the instrument for measuring them: the naked eye, and to maintain the eye contact with observational

astronomy in an historical epoch of strong mediation between the astrophysical objects and us, made primarily by automated (electronic) detectors. The addition I made to my observing pipeline was including the airmass correction since the reference stars were usually very far from the target star, at different altitudes above the horizon. This procedure was followed in each of my naked eye observations, which are more than 1000 for both stars, with also a didactic objective in mind: to spread the spirit and the technique of accurate measurements, also with the unaided eye. In AAVSO database you can find these observations under the observer's acronym SGQ assigned to me in 1999. After so many years, this occasion of Betelgeuse great minimum, is giving an additional value to my effort: the possibility to give an effective contribution to the science community and to the amateurs one. Dr. Paolo Ochner, a colleague of Asiago Observatory (Italy), has commented the present situation with the following statement: if a Galactic supernova explodes only amateur astronomers can classify it! Yes because the 1.22-m Galileo telescope of Asiago cannot take spectra of Betelgeuse at 1.5 magnitude, or photometry without diaphragming the instrument to an unusual level, let's imagine the star would shone at −9 magnitude or −14. . . all detectors would saturate or burn!
The occasion of such deep minimum of Betelgeuse is a great opportunity to present a variable star to the great public. A variable star behaves exactly like that! Mira, that I studied in depth on the historical data 2 decades ago, does not have a maximum equal to another. . . its period is on average constant but its magnitude is unpredictable. Our Sun also has a constant period for the solar spots, the 11 years cycle, but its maximum value is still unpredictable, and we don't know whether the Sun will enter a new Maunder minimum (no spots for several decades as in 1645–1715) or not. . .
Betelgeuse is behaving according to its statistical behaviour. . . and a delay of a few days on the 1.2 years period is normal. The depth of this minimum is the first time we see it after 100 years, but there is nothing extraordinary if compared with other long period variable stars. Needless to say it is worth to be studied.
Finally this event is another occasion to speak about stellar evolution to the great public. A 3 months long dimming of a star which undergoes periodically such events can be an annoucement of an imminent explosion?
The Supernova event for a star with more than 10 $M_\odot$ like Betelgeuse is the result of the gravitational instability after the inner nuclear engine becomes endo-thermical and cannot sustain any more the wheight of the outer mass shells. This instability sets in the free fall time, about some tens of minutes for a stellar nucleus, nothing to do with months. The Betelgeuse great dimming of 2019/2020 is then the occasion, for professional astronomers, through interviews, conferences, papers, lectures, to make acquainted many people with stellar variability achievable also with the naked eye from urban sites (with light pollution), and to free-fall supernova dynamics at the end of stellar evolution for high mass stars.
A much stronger goal than predicting its explosion!"
The new *Food for Thought* is inspired by more recent work on Betelgeuse's dimming.

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

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

Food for Thought

This month's thought-provoking statement is:

Spectral type does not directly yield effective temperature (and thus radius).

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?

Gioia Rau

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On the role of Chromospheres in cool, evolved stars

Over the last few years, in collaboration with Dr. Kenneth G. Carpenter and his group at NASA/GSFC, I have worked on understanding the role of the chromosphere in cool, evolved K and M giant and supergiant stars, following the longstanding research of Carpenter, Linsky, Ayres, Robinson, and collaborators. In order to pursue this research and cover the broadest possible range of atmospheric layers, we are combining space-based high-resolution HST spectra with ground-based interferometric data from facilities such as the CHARA array and the ESOs VLTI.

Even though progress has been made, much work still needs to be done in this area of research (e.g., Rau et al. 2019, BAAS, 51, 241) to more fully address some very basic questions. For example, in cool K and M giant stars, is there a clear boundary where the chromosphere ends and the wind begins or do these regions overlap, and what are the terminal velocities of the winds in these stars? Is there a direct relationship between chromospheric activity and the presence of dust in RGB and RSG stars, and is the strength of the chromosphere effectively reduced by the presence of dust? Do chromospheres exist, and what is their role, in AGB stars?

To answer these questions, we must improve our empirical understanding of the photospheric and chromospheric layers and outer circumstellar envelopes through systematic surveys of a large number of objects, enabled by multiwavelength high-resolution spectroscopic and interferometric observations.

And why do I want to think about evolved stars and chromospheres? Could this be another layer affecting the dust production, and the magnetic fields, even in AGB stars? How can we understand more about those and which instruments/models are the best to be used?

I would be extremely interested in having input from our community on this matter. Especially now, just prior to the launch/turn-on of the most powerful telescopes and facilities in the world, such as JWST and MROI, I invite our community to submit your thoughts about this.

Refereed Journal Papers

Distance mapping applied to four well-known planetary nebulæ and a nova shell

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Accurate distance estimates of astrophysical objects as planetary nebulæ (PNe), nova and supernova remnants, among others, allow us to constrain their physical characteristics, such as size, mass, luminosity and age. An innovative technique based on the expansion parallax method, the so-called distance mapping technique (DMT), provides distance maps of expanding nebulæ as well as an estimation of their distances. The DMT combines the tangential velocity vectors obtained from 3D morpho-kinematic models and the observed proper motion vectors to estimate the distance. We applied the DMT to four PNe (NGC 6702, NGC 6543, NGC 6302 and BD +30°3639) and one nova remnant (GK Persei) and derived new distances in good agreement with previous studies. New simple morpho-kinematic SHAPE models were generated for NGC 6543, NGC 6302 and NGC 6702, whereas for BD +30°3639 and GK Per published models were used. We demonstrate that the DMT is a useful tool to obtain distance values of PNe, in addition to revealing kinematically peculiar regions within the nebulae. Distances are also derived from the trigonometric Gaia parallaxes. The effect of the non-negligible parallax offset in the Gaia DR2 is also discussed.

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Available from https://arxiv.org/abs/2001.12009

A new mass-loss rate prescription for red supergiants

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Evolutionary models have shown the substantial effect that strong mass-loss rates ($\dot{M}$s) can have on the fate of massive stars. Red supergiant (RSG) mass-loss is poorly understood theoretically, and so stellar models rely on purely empirical $\dot{M}$–luminosity relations to calculate evolution. Empirical prescriptions usually scale with luminosity and effective temperature, but $\dot{M}$ should also depend on the current mass and hence the surface gravity of the star, yielding more than one possible $\dot{M}$ for the same position on the Hertzsprung–Russell diagram. One can solve this degeneracy by measuring $\dot{M}$ for RSGs that reside in clusters, where age and initial mass ($M_{\rm ini}$) are known. In this paper we derive $\dot{M}$ values and luminosities for RSGs in two clusters, NGC 2004 and RSG C1. Using newly derived $M_{\rm ini}$ measurements, we combine the results with those of clusters with a range of ages and derive an $M_{\rm ini}$-dependent $\dot{M}$-prescription. When comparing this new prescription to the treatment of mass-loss currently implemented in evolutionary models, we find models drastically over-predict the total mass-loss, by up to a factor of 20. Importantly, the most massive RSGs experience the largest downward revision in their mass-loss rates, drastically changing the impact of wind mass-loss on their evolution. Our results suggest that for most initial masses of RSG progenitors, quiescent mass-loss during the RSG phase is not effective at removing a significant fraction of the H-envelope prior to core-collapse, and we discuss the implications of this for stellar evolution and observations of SNe and SN progenitors.

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Modelling stochastic signatures in classical pulsators

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We consider the impact of stochastic perturbations on otherwise coherent oscillations of classical pulsators. The resulting dynamics are modelled by a driven damped harmonic oscillator subject to either an external or an internal forcing and white noise velocity fluctuations. We characterize the phase and relative amplitude variations using analytical and numerical tools. When the forcing is internal the phase variation displays a random walk behaviour and a red noise power spectrum with a ragged erratic appearance. We determine the dependence of the root mean square phase and relative amplitude variations ($\sigma_{\Delta\phi}$ and $\sigma_{\Delta A/A}$, respectively) on the amplitude of the stochastic perturbations, the damping constant η, and the total observation time $t_{\rm obs}$ for this case, under the assumption that the relative amplitude variations remain small, showing that $\sigma_{\Delta\phi}$ increases with $t_{\rm obs}^{1/2}$ becoming much larger than $\sigma_{\Delta A/A}$ for $t_{\rm obs} \gg \eta^{-1}$. In the case of an external forcing the phase and relative amplitude variations remain of the same order, independently of the observing time. In the case of an internal forcing, we find that $\sigma_{\Delta\phi}$ does not depend on η. Hence, the damping time cannot be inferred from fitting the power of the signal, as done for solar-like pulsators, but the amplitude of the stochastic perturbations may be constrained from the observations. Our results imply that, given sufficient time, the variation of the phase associated to the stochastic perturbations in internally driven classical pulsators will become sufficiently large to be probed observationally.

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Discovery of technetium- and niobium-rich S stars: the case for bitrinsic stars

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Context: S stars are late-type giants with overabundances of s-process elements. They come in two flavors depending on the presence or lack of presence of technetium (Tc), an element without stable isotopes. Intrinsic S stars are Tc-rich and genuine asymptotic giant branch (AGB) stars, while extrinsic S stars owe their s-process overabundances to the pollution from a former AGB companion, which is now a white dwarf (WD). In addition to Tc, another distinctive feature between intrinsic and extrinsic S stars is the overabundance of niobium (Nb) in the latter class. Indeed, since the mass transfer occurred long ago, ^{93}Zr had time to decay into the only stable isotope of Nb, ^{93}Nb, causing its overabundance.
Aims: We discuss the case of the S stars BD +79°156 and o^1 Ori, whose specificity lies in sharing the distinctive features of both intrinsic and extrinsic S stars, namely the presence of Tc along with a Nb overabundance.
Methods: We used high-resolution HERMES optical spectra, MARCS model atmospheres of S stars, Gaia DR2 parallaxes, and STAREVOL evolutionary tracks to determine the stellar parameters and chemical abundances of the two S stars, and to locate them in the Hertzsprung–Russell (HR) diagram.
Results: BD +79°156 is the first clear case of a bitrinsic star, that is, a doubly s-process-enriched object, first through mass transfer in a binary system and then through internal nucleosynthesis that is responsible for the Tc-enrichment in BD +79°156, which must,therefore, have reached the AGB phase of its evolution. This hybrid nature of the s-process pattern in BD +79°156 is supported by its binary nature and its location in the HR diagram that is just beyond

the onset of the third dredge-up on the AGB. The Tc-rich, binary S-star o^1 Ori with a WD companion was another long-standing candidate for a similar hybrid s-process enrichment. However,the marginal overabundance of Nb derived in o^1 Ori does not allow one to trace evidence of large amounts of pollution coming from the AGB progenitor of its current WD companion unambiguously. As a side product, the current study offers a new way of detecting binary AGB stars with WD companions by identifying their Tc-rich nature along with a Nb overabundance.

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Wind morphology around cool evolved stars in binaries – The case of slowly accelerating oxygen-rich outflows

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In this paper, we carry out an investigation of the non-spherical imprints left in the wind from a cool evolved star by the presence of an orbiting stellar-mass companion. We identified the main parameters susceptible to influence the morphology of the circumbinary envelope: the dust chemical content, the terminal wind speed relative to the orbital speed, the extension of the dust condensation region around the donor star and the mass ratio. We ran an extensive grid of 70 3D numerical simulations to cover the whole parameter space. The highly adaptive mesh we rely on enables us to capture the wind dynamics from the bow shock formed around the companion up to 40 orbital separations. Thanks to a parametrization of the wind launching, we could reproduce the slow acceleration phase of dust-driven winds emitted by oxygen-rich asymptotic giant branch stars and evaluate the differences with carbon-rich outflows. In order to quantify how overestimated mass-loss rates are when the wind is wrongly assumed to be isotropic, we compute the density enhancement in the orbital plane in each configuration. Finally, we measure the mass transfer rate between the two bodies and discuss the long-term consequences on the shrinking or widening of the orbital separation.
An animation of the flow morphology in the orbital plane can be found at:
https://homes.esat.kuleuven.be/∼ileyk/resources/GIF/dust_wind.gif

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Thirty years of radio observations of type Ia SN 1972E and SN 1895B: constraints on circumstellar shells

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We have imaged over 35 years of archival Very Large Array (VLA) observations of the nearby (d_L = 3.15 Mpc) type Ia supernovæ SN 1972E and SN 1895B between 9 and 121 years post-explosion. No radio emission is detected, constraining the 8.5 GHz luminosities of SN 1972E and SN 1895B to be $L_{\nu,8.5\,\mathrm{GHz}} < 6.0 \times 10^{23}$ erg s^{-1} Hz^{-1} 45 years post-explosion and $L_{\nu,8.5\,\mathrm{GHz}} < 8.9 \times 10^{23}$ erg s^{-1} Hz^{-1} 121 years post-explosion, respectively. These limits imply a clean circumstellar medium (CSM), with $n < 0.9$ cm^{-3} out to radii of a few $\times 10^{18}$ cm, if the SN blastwave is expanding into uniform density material. Due to the extensive time coverage of our observations, we also constrain the presence of CSM shells surrounding the progenitor of SN 1972E. We rule out essentially all medium and thick shells with masses of 0.05–0.3 M$_\odot$ at radii between $\sim 10^{17}$ and 10^{18} cm, and thin shells at specific radii with masses down to $\lesssim 0.01$ M$_\odot$.

These constraints rule out swaths of parameter space for a range of single and double degenerate progenitor scenarios, including recurrent nova, core-degenerate objects, ultra-prompt explosions and white dwarf (WD) mergers with delays of a few hundred years between the onset of merger and explosion. Allowed progenitors include WD–WD systems with a significant ($> 10^4$ years) delay from the last episode of common envelope evolution and single degenerate systems undergoing recurrent nova, provided that the recurrence timescale i short and the system has been in the nova phase for $\gtrsim 10^4$ yr, such that a large ($> 10^{18}$ cm) cavity has been evacuated. Future multi-epoch observations of additional intermediate-aged Type Ia SNe will provide a comprehensive view of the large-scale CSM environments around these explosions.

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Variability in the massive open cluster NGC 1817 from K2: a rich population of asteroseismic red clump, eclipsing binary, and main sequence pulsating stars

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We present a survey of variable stars detected in K2 Campaign 13 within the massive intermediate age ($\sim$ 1 Gyr) open cluster NGC 1817. We identify a complete sample of 44 red clump stars in the cluster, and have measured asteroseismic quantities ($\nu_{\rm max}$ and/or $\Delta\nu$) for 29 of them. Five stars showed suppressed dipole modes, and the occurrence rates indicate that mode suppression is unaffected by evolution through core helium burning. A subset of the giants in NGC 1817 (and in the similarly aged cluster NGC 6811) have $\nu_{\rm max}$ and $\Delta\nu$ values at or near the maximum observed for core helium burning stars, indicating they have core masses near the minimum for fully non-degenerate helium ignition. Further asteroseismic study of these stars can constrain the minimum helium core mass in red clump stars and the physics that determines this limit.
Two giant stars show photometric variations on timescales similar to previously measured spectroscopic orbits. Thirteen systems in the field show eclipses, but only five are probable cluster members.
We identify 32 δ Sct pulsators, 27 γ Dor candidates, and 7 hybrids that are probable cluster members, with most new detections. We used the ensemble properties of the δ Sct stars to identify stars with possible radial pulsation modes. Among the oddities we have uncovered are: an eccentric orbit for a short-period binary containing a δ Sct pulsating star; a rare subgiant within the Hertzsprung gap showing δ Sct pulsations; and two hot γ Dor pulsating star candidates.

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The infrared view of dust and molecules around V4334 Sgr (Sakurai's Object): a 20-year retrospective

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We present an analysis of the evolution of circumstellar dust and molecules in the environment of the very late thermal pulse object V4334 Sgr (Sakurai's Object) over a $\sim$ 20-year period, drawing on ground-, airborne- and space-based infrared photometry and spectroscopy. The dust emission, which started in 1997, resembles a blackbody that cooled from $\sim 1,200$ K in 1998 August to ~ 180 K in 2016 July. The dust mass, assuming amorphous carbon, was $\sim 5\times10^{-10}$ $M_\odot$ in 1998 August, and we estimate that the total dust mass was $\sim 2\times10^{-5}$ $M_\odot$ by $\sim$ 2016. The appearance of a near infrared excess in 2008 suggests a new episode of (or renewed) mass loss began then. We infer lower limits on the bolometric luminosity of the embedded star from that of the dust shell, which rose to $\sim 16,000$ $L_\odot$ before declining to $\sim 3,000$ $L_\odot$. There is evidence for weak 6–7-μm absorption, which we attribute to hydrogenated amorphous carbon formed in material ejected by Sakurai's Object during a mass ejection phase that preceded the 1997 event. We detect small hydrocarbon and other molecules in the spectra, and trace the column densities in hydrogen cyanide (HCN) and acetylene (C_2H_2). We use the former to determine the $^{12}C/^{13}C$ ratio to be 6.4 ± 0.7, 14 times smaller than the Solar System value.

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AGB winds in interacting binary stars

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We perform numerical simulations to investigate the stellar wind from interacting binary stars. Our aim is to find analytical formulæ describing the outflow structure. In each binary system the more massive star is in the asymptotic giant branch and its wind is driven by a combination of pulsations in the stellar surface layers and radiation pressure on dust, while the less massive star is in the main sequence. Time averages of density and outflow velocity of the stellar wind are calculated and plotted as profiles against distance from the centre of mass and co-latitude angle. We find that mass is lost mainly through the outer Lagrangian point L2. The resultant outflow develops into a spiral at low distances from the binary. The outflowing spiral is quickly smoothed out by shocks and becomes an excretion disk at larger distances. This leads to the formation of an outflow structure with an equatorial density excess, which is greater in binaries with smaller orbital separation. The pole-to-equator density ratio reaches a maximum value of $\sim 10^5$ at Roche-Lobe Overflow state. We also find that the gas stream leaving L2 does not form a circumbinary ring for stellar mass ratios above 0.78, when radiation pressure on dust is taken into account. Analytical formulæ are obtained by curve fitting the 2-dimensional, azimuthally averaged density and outflow velocity profiles. The formulæ can be used in future studies to setup the initial outflow structure in hydrodynamic simulations of common-envelope evolution and formation of planetary nebulæ.

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Rapid grain growth in post-AGB disc systems from far-infrared and sub-millimetre photometry

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The timescales on which astronomical dust grows remain poorly understood, with important consequences for our understanding of processes like circumstellar disk evolution and planet formation.A number of post-asymptotic giant branch stars are found to host optically thick, dust- and gas-rich circumstellar discs in Keplerian orbits. These discs exhibit evidence of dust evolution, similar to protoplanetary discs; however since post-AGB discs have substantially shorter lifetimes than protoplanetary discs they may provide new insights on the grain-growth process. We examine a sample of post-AGB stars with discs to determine the FIR and sub-mm spectral index by homogeneously fitting a sample of data from *Herschel*, the SMA and the literature. We find that grain growth to at least hundreds of micrometres is ubiquitous in these systems, and that the distribution of spectral indices is more similar to that of protoplanetary discs than debris discs. No correlation is found with the mid-infrared colours of the discs, implying that grain growth occurs independently of the disc structure in post-AGB discs. We infer that grain growth to $\sim$mm sizes must occur on timescales $\ll 10^5$ yr, perhaps by orders of magnitude, as the lifetimes of these discs are expected to be $\lesssim 10^5$ yr and all objects have converged to the same state. This growth timescale is short compared to the results of models for protoplanetary discs including fragmentation, and may provide new constraints on the physics of grain growth.

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Planetary nebulæ seen by TESS: results and discovery of new binary central star candidates from Cycle 1

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Context: It is now clear that binarity plays a crucial role in many aspects of planetary nebulæ (PNe), particularly the striking morphologies that they show. To date, there are ~ 60 bCSPNe known. However, both theory and observation

indicates that this represents only the tip of the iceberg, with the Galactic PN population hosting orders of magnitude more.
Aims: We are involved in a search for new bCSPNe to enhance the statistical validation of the key role of binarity in the formation and shaping of PNe. New discoveries of bCSPNe and their characterization have important implications not only in understanding PN evolution but also in understanding binary evolution and the poorly-understood common-envelope phase.
Methods: We used data from the TESS satellite to search for variability in the eight CSPNe that belong to the two-minute cadence preselected targets in Cycle 1, which have available pipeline-extracted light curves. We identified strong periodicities and analysed them in the context of the binary scenario.
Results: All the CSPNe but one (Abell 15) show clear signs of periodic variability in TESS. The cause of this variability can be attributed to different effects, some of them requiring the presence of a companion star. We find simple sinusoidal modulations in several of the systems, compatible to irradiation effects. In addition, two of the central stars (PG 1034+001 and NGC 5189) also show photometric variations due to ellipsoidal variations and other signs of variability probably caused by star spots and/or relativistic Doppler-beaming. Especially interesting is the case of the well-studied Helix Nebula, in which we constructed a series of binary models to explain the modulations we see in the light curve. We find that the variability constrains the possible companion to be very low-mass main-sequence star or sub-stellar object. We also identify with a great detail the individual pulsation frequencies of NGC 246.

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On carbon nanotubes in the interstellar medium

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Since their discovery in 1991, carbon nanotubes (CNTs) – a novel one-dimensional carbon allotrope – have attracted considerable interest worldwide because of their potential technological applications such as electric and optical devices. In the astrophysical context, CNTs may be present in the interstellar space since many of the other allotropes of carbon (e.g., amorphous carbon, fullerenes, nanodiamonds, graphite, polycyclic aromatic hydrocarbons, and possibly graphene as well) are known to be widespread in the Universe, as revealed by presolar grains in carbonaceous primitive meteorites and/or by their fingerprint spectral features in astronomical spectra. In addition, there are also experimental and theoretical pathways to the formation of CNTs in the interstellar medium (ISM). In this work, we examine their possible presence in the ISM by comparing the observed interstellar extinction curve with the ultraviolet/optical absorption spectra experimentally obtained for single-walled CNTs of a wide range of diameters and chiralities. Based on the absence in the interstellar extinction curve of the ~ 4.5 and 5.25 eV π-plasmon absorption bands which are pronounced in the experimental spectra of CNTs, we place an upper limit of ~ 10 ppm of C/H (i.e. $\sim 4\%$ of the total interstellar C) on the interstellar CNT abundance.

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Shaping the envelope of the asymptotic giant branch star W43A with a collimated fast jet

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One of the major puzzles in the study of stellar evolution is the formation process of bipolar and multipolar planetary nebulæ. There is growing consensus that collimated jets create cavities with dense walls in the slowly expanding (10–20 km s^{-1}) envelope ejected in previous evolutionary phases, leading to the observed morphologies. However, the launching of the jet and the way it interacts with the circumstellar material to create such asymmetric morphologies have remained poorly known. Here we present for the first time CO emission from the asymptotic giant branch star W43A that traces the whole stream of a jet, from the vicinity of its driving stellar system out to the regions where it shapes the circumstellar envelope. We found that the jet has a launch velocity of 175 km s^{-1} and decelerates to a velocity of 130 km s^{-1} as it interacts with circumstellar material. The continuum emission reveals a bipolar shell with a compact bright dot in the center that pinpoints the location of the driving source of the jet. The kinematical ages of the jet and the bipolar shell are equal, $\tau \sim 60$ yr, indicating that they were created simultaneously, probably by a common underlying mechanism, and in an extremely short time. These results provide key initial conditions for the theoretical models that aim to explain the formation of bipolar morphologies in the circumstellar envelopes of low- and intermediate-mass stars.

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Angular expansion of nova shells

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Nova shells can provide us with important information on their distance, their interactions with the circumstellar and interstellar media, and the evolution in morphology of the ejecta. We have obtained narrow-band images of a sample of five nova shells, namely DQ Her, FH Ser, T Aur, V476 Cyg, and V533 Her, with ages in the range from 50 to 130 years. These images have been compared with suitable available archival images to derive their angular expansion rates. We find that all the nova shells in our sample are still in the free expansion phase, which can be expected, as the mass of the ejecta is 7–45 times larger than the mass of the swept-up circumstellar medium. The nova shells will keep expanding freely for time periods up to a few hundred years, reducing their time dispersal into the interstellar medium.

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From hydrogen to helium: the spectral evolution of white dwarfs as evidence for convective mixing

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We present a study of the hypothesis that white dwarfs undergo a spectral change from hydrogen- to helium-dominated atmospheres using a volume-limited photometric sample drawn from the Gaia DR2 catalogue, the Sloan Digital Sky Survey (SDSS) and the Galaxy Evolution Explorer (GALEX). We exploit the strength of the Balmer jump in hydrogen-atmosphere DA white dwarfs to separate them from helium-dominated objects in SDSS colour space. Across the effective temperature range from 20 000 K to 9000 K we find that 22% of white dwarfs will undergo a spectral change, with no spectral evolution being ruled out at 5σ. The most likely explanation is that the increase in He-rich objects is caused by the convective mixing of DA stars with thin hydrogen layers, in which helium is dredged up from deeper layers by a surface hydrogen convection zone. The rate of change in the fraction of He-rich objects as a function of temperature, coupled with a recent grid of 3D radiation–hydrodynamic simulations of convective DA white dwarfs – which include the full overshoot region – lead to a discussion on the distribution of total hydrogen mass in white dwarfs. We find that 60% of white dwarfs must have a hydrogen mass larger than $M_{\rm H}/M_{\rm WD} = 10^{-10}$, another 25% have masses in the range $M_{\rm H}/M_{\rm WD} = 10^{-14}$–$10^{-10}$, and 15% have less hydrogen than $M_{\rm H}/M_{\rm WD} = 10^{-14}$. These results have implications for white dwarf asteroseismology, stellar evolution through the asymptotic giant branch (AGB) and accretion of planetesimals onto white dwarfs.

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HD 54361: evidence for the status of a low mass TP-AGB star

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The mass of the cool carbon star HD 54361 was suspected to be high, assuming the membership in the stellar association CMa OB1, in conflict with the theory of stellar evolution. The Gaia parallax and a high-resolution spectrum in the wavelength region from about 4800 to 6900 Å was employed in order to update the distance, atmospheric parameters and abundances using the method of spectral synthesis and new model atmospheres. Absorption lines are broad in the spectrum presumably because of a large macroturbulence, $\xi_{\rm RT} = 10 \pm 1$ km s^{-1}. Radial-velocity monitoring revealed a scatter of about 4 km s^{-1} which reflects probably a large scale convection in the atmosphere. The effective temperature was found to be about 3200 K by modelling the wings of Na I D doublet, a somewhat higher than that estimated from the angular diameter. The difference in the temperature could be due to the light/colour variation. The abundances of iron peak elements calculated from less blended lines blueward of 5000 Å are near solar, [M/H] $= 0.0 \pm 0.2$ dex. The neutron-capture elements are enhanced up to 1 dex. The parallax leads to the distance of 554^{+49}_{-41} pc, the absolute magnitude, $M_K = -7.7 \pm 0.2$ mag, and the bolometric magnitude, $M_{\rm bol}(K) = -4.6 \pm 0.2$ mag. The observed stellar parameters and abundances are typical values for the low mass ~ 1.8 M$_\odot$ star on the TP-AGB branch according to the isochrone calculated for log Age(yr) = 9.20 with solar initial metallicity. HD 54361 possibly belongs to the spike in the TP-AGB star numbers associated with the AGB-boosting effect.

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Surprising variability of the planetary nebula IC 4997 = QV Sge

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We present the results of a new epoch (2009–2019) of a long-term (50 years) photometric monitoring of the variable planetary nebula IC 4997 (QV Sge). The integral (star + nebula) UBV light curves display a continuing brightening of $0\overset{\mathrm{m}}{.}15$ in V, a slight rise ($< 0\overset{\mathrm{m}}{.}1$) in B, and constancy in U. The $B-V$ color has got redder from $0\overset{\mathrm{m}}{.}4$ in 2000 to $0\overset{\mathrm{m}}{.}7$ in 2019, whereas the $U-B$ color has not changed significantly at that time. We carried out near infrared (IR) $JHKL$ photometry in 2019, and comparing it to the data obtained in 1999–2006 we found the source to be fainter by $0\overset{\mathrm{m}}{.}4$ in L and bluer by $0\overset{\mathrm{m}}{.}2$ in the $K-L$ color. The long-term brightness variations in the optical and IR regions are shown to be due mostly to the changing input of emission lines to the integral light. Low-dispersion spectroscopic observations carried out in 2010–2019 revealed a continuing decrease in the [O III] λ4363 to Hγ intensity ratio: it decreased by a factor of ~ 3 in 30 years and reached the level of 1960–1970. We discovered that the absolute intensities of [O III] $\lambda\lambda$49595007 nebular lines had increased by a factor of > 2 from 1990 to 2019, whereas the [O III] λ4363 auroral line had weakened by a factor of 2 comparing to the maximum value observed in 2000. The variation of Hβ absolute intensity in 1960–2019 was shown to be similar to that of [O III] λ4959 (and λ5007), but of smaller amplitude. The electron density in the outer part of the nebula was estimated from the [S II] and [Cl III] lines. Basing on the data on absolute intensities for the Hβ, [O III] $\lambda\lambda$4363,4959 lines and their ratios we propose a possible scenario describing the change of physical conditions ($N_{\mathrm{e}}, T_{\mathrm{e}}$) in IC 4997 in 1970–2019. The main features of spectral variability of IC 4997 could be explained by a variation of electron temperature in the nebula caused by not so much the change in ionizing flux from the central star as the variable stellar wind and related processes. The photometric and spectral changes observed for IC 4997 in 1960–2019 may be interpreted as an observable consequence of a single episode of enhanced mass loss from the variable central star.

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Magneto-gravity wave packet dynamics in strongly magnetised cores of evolved stars

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Magnetic fields are believed to be generated in the cores of massive main sequence stars, and these may survive on to later stages of evolution. Observations of depressed dipole modes in red giant stars have been touted as evidence for these fields, but the predictions of existing magnetic theories have difficulty accommodating several aspects, including the need to return a fraction of wave energy from the core to the envelope, and the persistent gravity-like character of affected modes. In this work we perform a Hamiltonian ray tracing study investigating the dynamics of magneto-gravity waves in full spherical geometry, using realistic stellar models and magnetic field configurations. This technique applies in the limit where wavelengths are much shorter than scales of background variation. We conduct a comprehensive exploration of parameter space, examining the roles of wave frequency, spherical harmonic degree, wavevector polarisation, incoming latitude, field strength, field radius, and evolutionary state. We demonstrate that even in the presence of a strong field, there exist trajectories where waves remain predominantly gravity-like in character, and these are able to undergo reflection out of the core much like pure gravity waves. The remaining trajectories are ones where waves acquire significant Alfvén character, becoming trapped and eventually dissipated. Orientation effects, i.e. wavevector polarisation and incoming latitude, are found to be crucial factors in determining the outcome (trapped versus reflected) of individual wave packets. The allowance for partial energy return from the core offers a solution to the conundrum faced by the magnetic hypothesis.

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Asteroseismology of luminous red giants with *Kepler* – I: long-period variables with radial and non-radial modes

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While long-period variables (LPVs) have been extensively investigated, especially with MACHO and OGLE data for the Magellanic Clouds, there still exist open questions in their pulsations regarding the excitation mechanisms, radial order, and angular degree assignment. Here, we perform asteroseismic analyses on LPVs observed by the 4-year *Kepler* mission. Using a cross-correlation method, we detect unambiguous pulsation ridges associated with radial fundamental modes ($n = 1$) and overtones ($n \geq 2$), where the radial order assignment is made using theoretical frequencies and observed frequencies. Our results confirm that the amplitude variability seen in semiregulars is consistent with oscillations being solar-like. We identify that the dipole modes, $l = 1$, are dominant in the radial orders of $3 \leq n \leq 6$, and that quadrupole modes, $l = 2$, are dominant in the first overtone $n = 2$. A test of seismic scaling relations using Gaia DR2 parallaxes reveals the possibility that the relations break down when $\nu_{\rm max} \lesssim 3$ μHz ($R \gtrsim 40$ $R_\odot$, or $\log L/L_\odot \gtrsim 2.6$). Our homogeneous measurements of pulsation amplitude and period for 3213 LPVs will be valuable for probing effects of pulsation on mass-loss, in particular in those stars with periods around 60 d, which has been argued as a threshold of substantial pulsation-triggered mass-loss.

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A catalog of Galactic multiple systems with a red supergiant and a B star

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Binary systems composed of a red supergiant and a B star are useful probes of stellar evolution. We have searched the literature to create a catalog of 108 Galactic systems of such type, which is presented here.

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Optical and near-infrared observations of the Fried Egg Nebula; Multiple shell ejections on a 100 yr timescale from a massive yellow hypergiant

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Context: The fate of a massive star during the latest stages of its evolution is highly dependent on its mass-loss rate and geometry and therefore knowing the geometry of the circumstellar material close to the star and its surroundings is crucial.
Aims: We aim to provide insight into the nature (i.e. geometry, rates) of mass-loss episodes, and in particular, the connection between the observed asymmetries due to the mass lost in a fast wind or during a previous, prodigious mass-losing phase. In this context, yellow hypergiants offer a good opportunity to study mass-loss events.
Methods: We analysed a large set of optical and near-infrared data in spectroscopic and photometric, spectropolarimetric, and interferometric (GRAVITY/VLTI) modes, towards the yellow hypergiant IRAS 17163−3907. We used X-shooter optical observations to determine the spectral type of this yellow hypergiant and we present the first model-independent, reconstructed images of IRAS 17163−3907 at these wavelengths tracing milli-arcsecond scales. Lastly, we applied a 2D radiative transfer model to fit the dereddened photometry and the radial profiles of published diffraction-limited VISIR images at 8.59 μm, 11.85 μm, and 12.81 μm simultaneously, adopting a revised distance determination using Gaia Data Release 2 measurements.
Results: We constrain the spectral type of IRAS 17163−3907 to be slightly earlier than A6 Ia ($T_{\rm eff} \sim 8500$ K). The interferometric observables around the 2-μm window towards IRAS 17163−3907 show that the Brγ emission appears to be more extended and asymmetric than the Na I and the continuum emission. Interestingly, the spectrum of IRAS 17163−3907 around 2 μm shows Mg II emission that is not previously seen in other objects of its class. In addition, Brγ shows variability in a time interval of four months that is not seen towards Na I. Lastly, in addition to the two known shells surrounding IRAS 17163−3907, we report on the existence of a third hot inner shell with a maximum dynamical age of only 30 yr.
Conclusions: The 2-μm continuum originates directly from the star and not from hot dust surrounding the stellar object. The observed spectroscopic variability of Brγ could be a result of variability in the mass-loss rate. The interpretation of the presence of Na I emission at closer distances to the star compared to Brγ has been a challenge in various studies. To address this, we examine several scenarios. We argue that the presence of a pseudo-photosphere, which was traditionally considered to be the prominent explanation, is not needed and that it is rather an optical depth effect. The three observed distinct mass-loss episodes are characterised by different mass-loss rates and can inform theories of mass-loss mechanisms, which is a topic still under debate both in theory and observations. We discuss these in the context of photospheric pulsations and wind bi-stability mechanisms.

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Spectroscopic orbits of three dwarf barium stars

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Barium stars are thought to result from binary evolution in systems wide enough to allow the more massive component to reach the asymptotic giant branch and eventually become a CO white dwarf. While Ba stars were initially known only among giant or subgiant stars, some were subsequently discovered also on the main sequence (and known as dwarf Ba stars). We provide here the orbital parameters of three dwarf Ba stars, completing the sample of 27 orbits published recently by Escorza et al. with these three southern targets. We show that these new orbital parameters are consistent with those of other dwarf Ba stars.

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Shaping planetary nebulæ with jets and the grazing envelope evolution

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I argue that the high percentage of PNe that are shaped by jets show that main sequence stars in binary systems can accrete mass at a high rate from an accretion disk and launch jets. Not only this allows jets to shape PNe, but this also points to the importance of jets in other types of binary systems and in other processes. These processes include the grazing envelope evolution (GEE), the common envelope evolution (CEE), and the efficient conversion of kinetic energy to radiation in outflows. As well, the jets point to the possibility that many systems launch jets as they enter the CEE, possibly through a GEE phase. The other binary systems where jets might play significant roles include intermediate-luminosity optical transients (ILOTs), supernova impostors (including pre-explosion outbursts), post-CEE binary systems, post-GEE binary systems, and progenitors of neutron star binary systems and black hole binary systems. One of the immediate consequences is that the outflow of these systems is highly-non-spherical, including bipolar lobes, jets, and rings.

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Calibration of the tip of the red giant branch (TRGB)

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The Tip of the Red Giant Branch (TRGB) method provides one of the most accurate and precise means of measuring the distances to nearby galaxies. Here we present a $VIJHK$ absolute calibration of the TRGB based on observations

of TRGB stars in the Large Magellanic Cloud (LMC), grounded on detached eclipsing binaries (DEBs). This paper presents a more detailed description of the method first presented in Freedman et al. (2019) for measuring corrections for the total line-of-sight extinction and reddening to the LMC. In this method, we use a differential comparison of the red giant population in the LMC, first with red giants in the Local Group galaxy, IC 1613, and then with those in the Small Magellanic Cloud. As a consistency check, we derive an independent calibration of the TRGB sequence using the SMC alone, invoking its geometric distance also calibrated by DEBs. An additional consistency check comes from near-infrared observations of Galactic globular clusters covering a wide range of metallicities. In all cases we find excellent agreement in the zero-point calibration. We then examine the recent claims by Yuan et al. (2019), demonstrating that, in the case of the SMC, they corrected for extinction alone while neglecting the essential correction for reddening as well. In the case of IC 1613, we show that their analysis contains an incorrect treatment of (over-correction for) metallicity. Using our revised (and direct) measurement of the LMC TRGB extinction, we find a value of $H_0 = 69.6 \pm 0.8$ ($\pm 1.1\%$ stat) ± 1.7 ($\pm 2.4\%$ sys) km s^{-1} Mpc^{-1}.

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PRECISION: A fast python pipeline for high-contrast imaging – application to SPHERE observations of the red supergiant VX Sagitariæ

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The search for extrasolar planets has driven rapid advances in instrumentation, resulting in cameras such as SPHERE at the VLT, GPI at Gemini South and SCExAO at Subaru, capable of achieving very high contrast ($\sim 10^6$) around bright stars with small inner working angles ($\sim 0.''1$). The optimal exploitation of data from these instruments depends on the availability of easy-to-use software to process and analyse their data products. We present a pure-python pipeline, PRECISION, which provides fast, memory-efficient reduction of data from the SPHERE/IRDIS near-infrared imager, and can be readily extended to other instruments. We apply PRECISION to observations of the extreme red supergiant VX Sgr, the inner outflow of which is revealed to host complex, asymmetric structure in the near-IR. In addition, optical polarimetric imaging reveals clear extended polarised emission on $\sim 0.''5$ scales which varies significantly with azimuth, confirming the asymmetry. While not conclusive, this could suggest that the ejecta are confined to a disc or torus, which we are viewing nearly face on, although other non-spherical or clumpy configurations remain possible. VX Sgr has no known companions, making such a geometry difficult to explain, as there is no obvious source of angular momentum in the system.

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Asteroid belt survival through stellar evolution: dependence on the stellar mass

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Polluted white dwarfs are generally accreting terrestrial-like material that may originate from a debris belt like the asteroid belt in the solar system. The fraction of white dwarfs that are polluted drops off significantly for white dwarfs with masses $M_{\rm WD} \gtrsim 0.8$ M$_\odot$. This implies that asteroid belts and planetary systems around main-sequence stars with mass $M_{\rm MS} \gtrsim 3$ M$_\odot$ may not form because of the intense radiation from the star. This is in agreement with current

debris disc and exoplanet observations. The fraction of white dwarfs that show pollution also drops off significantly for low mass white dwarfs ($M_{\rm WD} \lesssim 0.55$ M$_\odot$). However, the low-mass white dwarfs that do show pollution are not currently accreting but have accreted in the past. We suggest that asteroid belts around main sequence stars with masses $M_{\rm MS} \lesssim 2$ M$_\odot$ are not likely to survive the stellar evolution process. The destruction likely occurs during the AGB phase and could be the result of interactions of the asteroids with the stellar wind, the high radiation or, for the lowest mass stars that have an unusually close-in asteroid belt, scattering during the tidal orbital decay of the inner planetary system.

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Available from https://arxiv.org/abs/2002.04751
and from https://ui.adsabs.harvard.edu/abs/2020MNRAS.tmpL..26M/abstract

Conference Papers

New fully evolutionary models for asteroseismology of ultra-massive white dwarf stars

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Ultra-massive hydrogen-rich (DA spectral type) white dwarf (WD) stars ($M_\star > 1$ M$_\odot$) coming from single-star evolution are expected to harbor cores made of ^{16}O and ^{20}Ne, resulting from semi-degenerate carbon burning when the progenitor star evolves through the super asymptotic giant branch (S-AGB) phase. These stars are expected to be crystallized by the time they reach the ZZ Ceti instability strip ($T_{\rm eff} \sim 12\,500$ K). Theoretical models predict that crystallization leads to a separation of ^{16}O and ^{20}Ne in the core of ultra-massive WDs, which impacts their pulsational properties. This property offers a unique opportunity to study the processes of crystallization. Here, we present the first results of a detailed asteroseismic analysis of the best-studied ultra-massive ZZ Ceti star BPM 37093. As a second step, we plan to repeat this analysis using ultra-massive DA WD models with C/O cores in order to study the possibility of elucidating the core chemical composition of BPM 37093 and shed some light on its possible evolutionary origin. We also plan to extend this kind of analyses to other stars observed from the ground and also from space missions like *Kepler* and TESS.

Poster contribution, published in "Stars and their variability observed from space – Celebrating the 5$^{\rm th}$ anniversary of BRITE–Constellation", Vienna, Austria, August 19–23, 2019. Eds. C. Neiner, W. Weiß, D. Baade, E. Griffin, C. Lovekin & A. Moffat
Available from https://arxiv.org/abs/2001.00671

White-dwarf asteroseismology: an update

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The vast majority of stars that populate the Universe will end their evolution as white-dwarf stars. Applications of white dwarfs include cosmochronology, evolution of planetary systems, and also as laboratories to study non-standard physics and crystallization. In addition to the knowledge of their surface properties from spectroscopy combined with model atmospheres, the global pulsations that they exhibit during several phases of their evolution allow spying on the deep interior of these stars. Indeed, by means of asteroseismology, an approach based on the comparison between the

observed pulsation periods of variable white dwarfs and the periods predicted by representative theoretical models, we can infer details of the internal chemical stratification, the total mass, and even the stellar rotation profile and strength of magnetic fields. In this article, we review the current state of the area, emphasizing the latest findings provided by space-mission data.

Oral contribution, published in IAU Symposium No. 357, "White Dwarfs as Probes of Fundamental Physics and Tracers of Planetary, Stellar, and Galactic Evolution", held in Hilo, Hawai'i, 21–25 October 2019
Available from https://arxiv.org/abs/1912.06738

Current and future development of CLOUDY

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The gas and dust that is present in the interstellar medium is usually very far removed from (local) thermodynamic equilibrium, and a sophisticated numerical code is needed to model it. For this purpose the open-source photoionization code CLOUDY was created. It models the physical state of the gas and predicts the spectrum that it emits. CLOUDY is continually being developed to improve the treatment of the microphysical processes and the database of fundamental data that it uses. In this paper we will discuss how we are developing the code to improve our high-density predictions by implementing better collisional–radiative models for all ions. We will also briefly discuss the experimental mode in CLOUDY to model gas that is not in steady-state equilibrium and present a preliminary model of recombining gas in a planetary nebula that is on the cooling track. We finish with a short discussion of how we are speeding up the code by using parallelization.

Oral contribution, published in "12$^{\text{th}}$ Serbian Conference on Spectral Line Shapes in Astrophysics"
Available from https://arxiv.org/abs/2002.05821
and from https://www.ta3.sk/caosp/Eedition/Abstracts/2020/Vol_50/No_1/pp32-43_abstract.html

Review Papers

Accrete, accrete, accrete... bang! (and repeat): the remarkable recurrent novæ

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All novæ recur, but only a handful have been observed in eruption more than once. These systems, the recurrent novæ (RNe), are among the most extreme examples of novæ. RNe have long been thought of as potential type Ia supernova progenitors, and their claim to this 'accolade' has recently been strengthened. In this short review RNe will be presented within the framework of the maximum magnitude-rate of decline (MMRD) phase-space. Recent work integrating He-flashes into nova models, and the subsequent growth of the white dwarf, will be explored. This review also presents an overview of the Galactic and extragalactic populations of RNe, including the newly identified 'rapid recurrent nova' subset – those with recurrence periods of ten years, or less. The most exciting nova system yet discovered – M31N 2008-12a, with its annual eruptions and vast nova super-remnant, is introduced. Throughout, open questions regarding RNe, and some of the expected challenges and opportunities that the near future will bring are addressed.

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Available from https://arxiv.org/abs/1912.13209

Magnetic field studies in the next decade

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Magnetic fields are ubiquitous in our Universe, but remain poorly understood in many branches of astrophysics. A key tool for inferring astrophysical magnetic field properties is dust emission polarimetry. The James Clerk Maxwell Telescope (JCMT) is planning a new 850-μm camera consisting of an array of 7272 paired Microwave Kinetic Inductance Detectors (MKIDs), which will inherently acquire linear polarization information. The camera will allow wide-area polarization mapping of dust emission at $14''$-resolution, allowing magnetic field properties to be studied in a wide range of environments, including all stages of the star formation process, Asymptotic Giant Branch stellar envelopes and planetary nebula, external galaxies including starburst galaxies and analogues for the Milky Way, and the environments of active galactic nuclei (AGN). Time domain studies of AGN and protostellar polarization variability will also become practicable. Studies of the polarization properties of the interstellar medium will also allow detailed investigation of dust grain properties and physics. These investigations would benefit from a potential future upgrade adding 450-μm capability to the camera, which would allow inference of spectral indices for polarized dust emission in a range of environments. The enhanced mapping speed and polarization capabilities of the new camera will transform the JCMT into a true submillimetre polarization survey instrument, offering the potential to revolutionize our understanding of magnetic fields in the cold Universe.

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Available from https://arxiv.org/abs/2001.05753

Studies of evolved stars in the next decade

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This white paper discusses recent progress in the field of evolved stars, primarily highlighting the contributions of the *James Clerk Maxwell* Telescope. It discusses the ongoing project, the Nearby Evolved Stars Survey (NESS), and the potential to build upon NESS in the next decade. It then outlines a number of science cases which may become feasible with the proposed 850-μm camera which is due to become available at the JCMT in late 2022. These

include mapping the extended envelopes of evolved stars, including in polarisation, and time-domain monitoring of their variations. The improved sensitivity of the proposed instrument will facilitate statistical studies that put the morphology, polarisation properties and sub-mm variability in perspective with a relatively modest commitment of time that would be impossible with current instrumentation. We also consider the role that could be played by other continuum wavelengths, heterodyne instruments or other facilities in contributing towards these objectives.

Published in the 2019 EAO Submillimetre Futures Paper Series
Available from https://arxiv.org/abs/2002.04762
and from https://www.eaobservatory.org//jcmt/wp-content/uploads/sites/2/2019/11/EAOSubmmFuturesWPs.pdf

Announcements

EAS Special Session 11
"The molecular journey: from stars to disk (and exoplanets)"

The Special Session "The molecular journey: from stars to disk (and exoplanets)" will take place on June 29, 2020 at the EAS2020 in Leiden.

Aim & Scope
In this special session we will focus on the study of molecules and their isotopologues and what they can teach us about the journey of molecules in our Galaxy. The scope is to bring the community together to showcase molecular insights in the evolution of matter from old stars to the ISM and into newly formed planets, to highlight recent advances in molecular astrophysics, to design strategies to best exploit the new astronomical facilities, and to provide fertile ground for future, interdisciplinary collaborations.

Invited Speakers

- Leen Decin (K.U. Leuven, Belgium)
- Paola Caselli (MPIE, Germany)
- Catherine Walsh (University of Leeds, UK)

More information and registration through the EAS 2020 website: https://eas.unige.ch/EAS_meeting/session.jsp?id=SS11

Deadline for abstract submissions (talk and poster) is March 2. 2020.

Limited financial support may be available for early career researchers (Ph.D. students and postdocs). For information and/or question: a.candian@uva.nl

On behalf of the SOC
Alessandra Candian, Annemieke Petrignani, Marie Van de Sande, Serena Viti, Tom Millar, Francesco Fontani

See also https://eas.unige.ch//EAS_meeting/session.jsp?id=SS11

ESO studentship program

Dear colleagues,

we would like to advertise the ESO studentship (Santiago-Chile and Garching-Germany) programs. The programs fund students already enrolled in a University Ph.D. program in astronomy or a related field. The students have the possibility to spend part of their Ph.D. project under the formal supervision of their home institute, in one of the ESO premises under co-supervision of an ESO staff member for a period up to two years, with funding provided.

The calls are issued twice a year (May and November), and the application deadline of the first semester is typically May 31st.

At the following link
http://www.eso.org/sci/activities/FeSt-overview/ESOstudentship/PhDThesisTopics.html
you will be able to find available topics covering the aspects of the field of evolved stars (watch out for updates from time to time!). Of course additional topics can be discussed, just remember: for a successful application, you and your supervisor need to contact in advance a co-supervisor from ESO to define the project.

Looking forward to increasing the ESO/AGB team!

Claudia Paladini, Liz Humphreys, Markus Wittkowski, Peter Scicluna,
on behalf of the ESO/AGB team

See also http://www.eso.org/studentship