THE AGB NEWSLETTER

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Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

Figure 1: Planetary nebula Longmore 11 imaged by Steve Crouch. Sakib Rasool thinks it looks like it belongs to the same category as NGC 1501 and NGC 7094, and wonders therefore whether it would also have a PG 1159-type central star? For more details see http://members.pcug.org.au/~stevec/Longmore11_STXL6303_RC14.htm.

Editorial

Dear Colleagues,

It is a pleasure to present you the 264$^{\rm th}$ issue of the AGB Newsletter. Don't miss the announcement, at the end of the newsletter, by Thomas Kallinger from the Institute for Astrophysics at the University of Vienna, Austria, of the release of asteroseismic products on a large sample of red giant stars observed with the *Kepler* satellite.

There's an exciting job as a postdoctoral researcher to work in Melbourne with Simon Campbell, so do consider applying.

No-one responded to last month's Food for Thought – "What is the most critical element for AGB evolution after hydrogen and helium?" Is it not obvious? Is it unimportant to know? What does this say about the use of scaled-solar metallicities, or considering the α elements (CNO) as the only additional variance? Would the elemental abundances in the interstellar gas from which they formed not present a much richer variety, especially in very metal-poor systems?

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

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

Food for Thought

This month's thought-provoking statement is:

Do all stars start with the same carbon-to-oxygen ratio and should we care?

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

Refereed Journal Papers

The most metal-poor stars. V. The CEMP-no stars in 3D and non-LTE

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We explore the nature of carbon-rich ($[C/Fe]_{1D,LTE} > +0.7$), metal-poor ($[Fe/H]_{1D,LTE} < -2.0$) stars in the light of post 1D,LTE literature analyses, which provide 3D–1D and NLTE–LTE corrections for iron, and 3D–1D corrections for carbon (from the CH G-band, the only indicator at lowest [Fe/H]). High-excitation C I lines are used to constrain 3D,NLTE corrections of G-band analyses. Corrections to the 1D,LTE compilations of Yoon et al. and Yong et al. yield 3D,LTE and 3D,NLTE Fe and C abundances. The number of CEMP-no stars in the Yoon et al. compilation (plus eight others) decreases from 130 (1D,LTE) to 68 (3D,LTE) and 35 (3D,NLTE). For stars with $-4.5 <$ [Fe/H] < -3.0 in the compilation of Yong et al., the corresponding CEMP-no fractions change from 0.30 to 0.15 and 0.12, respectively. We present a toy model of the coalescence of pre-stellar clouds of the two populations that followed chemical enrichment by the first zero-heavy-element stars: the C-rich, hyper-metal-poor and the C-normal, very-metal-poor populations. The model provides a reasonable first-order explanation of the distribution of the 1D,LTE abundances of CEMP-no stars in the A(C) and [C/Fe] vs. [Fe/H] planes, in the range $-4.0 <$ [Fe/H] < -2.0. The Yoon et al. CEMP Group I contains a subset of 19 CEMP-no stars (14% of the group), 4/9 of which are binary, and which have large $[Sr/Ba]_{1D,LTE}$ values. The data support the conjectures of Hansen et al. (2016b, 2019) and Arentsen et al. (2018) that these stars may have experienced enrichment from AGB stars and/or "spinstars".

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Formation of transition alumina dust around asymptotic giant branch stars: condensation experiments using induction thermal plasma systems

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Mid-infrared spectroscopic observations of oxygen-rich asymptotic giant branch (AGB) stars show the common presence of dust species that have a broad feature at $\sim$ 11–12 μm. Chemically synthesized amorphous alumina (Al_2O_3) is widely accepted as the source of this emission, although it is not obvious that amorphous alumina can condense in circumstellar conditions. We performed condensation experiments of Al–Si–Mg–O and Mg–Al–O gases using induction thermal plasma systems, in which small particles condense from vapors with a steep temperature gradient. The

condensates were analyzed using X-ray diffraction and Fourier transform infrared spectroscopy, and observed with a transmission electron microscope. The condensed nanoparticles from the Al and O gases were transition aluminas based on face-centered cubic (fcc) packed oxygen (δ- and λ-alumina, and an unknown phase). The fcc oxygen frameworks were maintained in the condensed alumina containing small amounts of Mg and Si. Condensates from the gases of Al:Mg = 99:1 and 95:5 had δ- and γ-alumina structures. Particles with λ- and γ-alumina structures formed from starting materials of Al:Si = 9:1 and Al:Si:Mg = 8:1:1, respectively. Amorphous silica-rich particles condensed from gases of Al/(Si+Al) < 0.75. The condensed transition alumina containing $\sim 10\%$ Si showed similar spectral shapes to the observed dust emission from the alumina-rich AGB star T Cep. Based on the present results, it is reasonable that the source of 11–12 μm broad emission of alumina-rich stars is not amorphous alumina, but is transition alumina containing $\sim 10\%$ Si.

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SPIRITS catalog of infrared variables: identification of extremely luminous long period variables

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We present a catalog of 417 luminous infrared variable stars with periods exceeding 250 days. These were identified in 20 nearby galaxies by the ongoing SPIRITS survey with the *Spitzer* Space Telescope. Of these, 359 variables have $M_{[4.5]}$ (phase-weighted mean magnitudes) fainter than -12 and periods and luminosities consistent with previously reported variables in the Large Magellanic Cloud. However, 58 variables are more luminous than $M_{[4.5]} = -12$ mag, including 11 that are brighter than $M_{[4.5]} = -13$ mag with the brightest having $M_{[4.5]} = -15.51$ mag. Most of these bright variable sources have quasi-periods longer than 1000 days, including four over 2000 days. We suggest that the fundamental period–luminosity relationship, previously measured for the Large Magellanic Cloud, extends to much higher luminosities and longer periods in this large galaxy sample. We posit that these variables include massive AGB stars (possibly super-AGB stars), red supergiants experiencing exceptionally high mass-loss rates, and interacting binaries. We also present 3.6, 4.5, 5.8 and 8.0 μm photometric catalogs for all sources in these 20 galaxies.

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Stellar evolution in real time: models consistent with direct observation of thermal pulse in T Ursæ Minoris

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Most aspects of stellar evolution proceed far too slowly to be directly observable in a single star on human timescales. The thermally pulsing asymptotic giant branch is one exception. The combination of state-of-the-art modelling techniques with data assimilated from observations collected by amateur astronomers over many decades provide, for the first time, the opportunity to identify a star occupying precisely this evolutionary stage. In this study, we show that the rapid pulsation period change and associated reduction in radius in the bright, northern variable star T Ursæ Minoris are caused by the recent onset of a thermal pulse. We demonstrate that T UMi transitioned into a double-mode pulsation state, and we exploit its astero-seismic features to constrain its fundamental stellar parameters. We use evolutionary models from MESA and linear pulsation models from GYRE to track simultaneously the structural and oscillatory evolution of models with varying mass. We apply a sophisticated iterative sampling scheme to achieve time resolution ≤ 10 years at the onset of the relevant thermal pulses. We report initial mass of 2.0 ± 0.15 $M_\odot$ and an age of 1.17 ± 0.21 Gyr for T UMi. This is the most precise mass and age determination for a single asymptotic giant branch star ever obtained. The ultimate test of our models will be the continued observation of its evolution in real time: we predict that the pulsation periods in T UMi will continue shortening for a few decades before they rebound and begin to lengthen again, as the star expands in radius.

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Templates of binary-induced spiral-shell patterns around mass-losing post -main sequence stars

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The morphological properties of the outflowing circumstellar envelopes surrounding mass-losing stars in eccentric binary systems are presented from a set of three-dimensional hydrodynamical model simulations. Based on four template models of the envelope viewed for a range of inclination angles of the systems, we implement interpretative tools for observations at high spectral/angular resolutions (as illustrated via velocity channel maps as well as position–velocity, radius–velocity, and angle–radius diagrams). Within this framework, the image and kinematical structures can be used to place constraints on the orbital parameters of the system. Specifically, three unique characteristic patterns in the envelopes are found that distinguish these systems from those in binary systems in circular orbits. Bifurcation of the spiral pattern, asymmetry in the interarm density depression, and a concurrent spiral/ring appearance all point to a binary system with an eccentric orbit. The methodology presented in this paper is illustrated in an analysis of recent radio observations of several asymptotic giant branch stars.

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The envelope of the semiregular variable V CVn

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V CVn is a semiregular variable star with a V-band amplitude of 2 mag. This star has an unusually high amplitude of polarimetric variability: up to 6 per cent. It also exhibits a prominent inverse correlation between the flux and the fraction of polarization and a substantial constancy of the angle of polarization. To figure out the nature of these features, we observed the object using the Differential Speckle Polarimetry at three bands centered on 550, 625 and 880 nm using the 2.5-m telescope of Sternberg Astronomical Institute MSU. The observations were conducted on 20 dates distributed over three cycles of pulsation. We detected an asymmetric reflection nebula consisting of three regions and surrounding the star at the typical distance of 35 mas. The components of the nebula change their brightness with the same period as the star, but with significant and different phase shifts. We discuss several hypotheses that could explain this behavior.

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The star formation history in the solar neighborhood as told by massive white dwarfs

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White dwarfs are the remnants of low and intermediate mass stars. Because of electron degeneracy, their evolution is just a simple gravothermal process of cooling. Recently, thanks to Gaia data, it has been possible to construct the luminosity function of massive ($0.9 \leq M/\mathrm{M}_{\odot} \leq 1.1$) white dwarfs in the solar neighborhood ($d < 100$ pc). Since the lifetime of their progenitors is very short, the birth times of both, parents and daughters, are very close and allow to reconstruct the (effective) star formation rate. This rate started growing from zero during the early Galaxy and reached a maximum 6–7 Gyr ago. It declined and ~ 5 Gyr ago started to climb once more reaching a maximum 2–3 Gyr in the past and decreased since then. There are some traces of a recent star formation burst, but the method used here is not appropriate for recently born white dwarfs.

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Spatio-kinematical model of the collimated molecular outflow in the water-fountain nebula IRAS 16342−3814

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Water fountain nebulae are AGB and post-AGB objects that exhibit high-velocity outflows traced by water maser emission. Their study is important to understand the interaction between collimated jets and the circumstellar material that leads to the formation of bipolar/multi-polar morphologies in evolved stars. The goal of the present work is to describe the three-dimensional morphology and kinematics of the molecular gas of the water-fountain nebula IRAS 16342−3814. We retrieved data from the ALMA archive to analyse it using a simple spatio-kinematical model. We used the software SHAPE to construct a three-dimensional spatio-kinematical model of the molecular gas in IRAS 16342−3814. We succeeded at reproducing the intensity distribution and position–velocity diagram of the CO emission from the ALMA observations to derive the morphology and velocity field of the gas. In addition, we used CO ($J = 1 \rightarrow 0$) data to support the physical interpretation of the model. A spatio-kinematical model that includes a high-velocity collimated outflow embedded within material expanding at relatively lower velocity reproduces the images and position–velocity diagrams from the observations. The derived morphology is in good agreement with previous results from IR and H_2O maser emission observations. The high-velocity collimated outflow exhibits deceleration across its length, while the velocity of the surrounding component increases with distance. The morphology of the emitting region; the velocity field and the mass of the gas as function of velocity are in excellent agreement with the properties predicted for a molecular outflow driven by a jet. The timescale of the molecular outflow is estimated to be ∼ 70–100 years. The scalar momentum carried by the outflow is much larger than it can be provided by the radiation of the central star. An oscillating pattern was found associated to the high-velocity collimated outflow. The oscillation period of the pattern is $T \approx 60$–90 years and its opening angle is $\theta_{\rm op} \approx 2^{\circ}$. The CO ($J = 3 \rightarrow 2$) emission in IRAS 16342−3814 is interpreted in terms of a jet-driven molecular outflow expanding along an elongated region. The position–velocity diagram and the mass spectrum reveal a feature due to entrained material that is associated to the driving jet. This feature is not seen in other more evolved objects that exhibit more developed bipolar morphologies. It is likely that the jet in those objects has already disappeared since it is expected to last only for a couple of hundred years. This strengthens the idea that water fountain nebulæ are undergoing a very short transition during which they develop the collimated outflows that shape the circumstellar envelope. The oscillating pattern seen in the CO high-velocity outflow is interpreted as due to precession with a relatively small opening angle. The precession period is compatible with the period of the corkscrew pattern seen at IR wavelengths. We propose that the high-velocity molecular outflow traces the underlying primary jet that produces such pattern.

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Galactic chemical evolution of radioactive isotopes

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The presence of short-lived (∼Myr) radioactive isotopes in meteoritic inclusions at the time of their formation represents a unique opportunity to study the circumstances that led to the formation of the Solar System. To interpret these observations we need to calculate the evolution of radioactive-to-stable isotopic ratios in the Galaxy. We present an extension of the open-source galactic chemical evolution codes NuPyCEE and JINAPyCEE that enables to track the decay of radioactive isotopes in the interstellar medium. We show how the evolution of isotopic ratio depends on the star formation history and efficiency, star-to-gas mass ratio, and galactic outflows. Given the uncertainties in the observations used to calibrate our model, our predictions for isotopic ratios at the time of formation of the Sun are uncertain by a factor of 3.6. At that time, to recover the actual radioactive-to-stable isotopic ratios predicted by our model, one can multiply the steady-state solution (see Equation 1) by $2.3^{+3.4}_{-0.7}$. However, in the cases where the radioactive isotope has a half-life longer than ∼ 200 Myr, or the target radioactive or stable isotopes have mass- and/or metallicity-dependent production rates, or they originate from different sources with different delay-time distributions, or the reference isotope is radioactive, our codes should be used for more accurate solutions. Our

preliminary calculations confirm the dichotomy between radioactive nuclei in the early Solar System with r- and s-process origin, and that ^{55}Mn and ^{60}Fe can be explained by galactic chemical evolution, while ^{26}Al cannot.

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Common envelope to explosion delay time of type Ia supernovæ

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I study the rate of type Ia supernovæ (SNe Ia) within about a million years after the assumed common envelope evolution (CEE) that forms the progenitors of these SNe Ia, and find that the population of SNe Ia with short CEE to explosion delay (CEED) time is few times 0.1 of all SNe Ia. I also claim for an expression for the rate of these SNe Ia that occur at short times after the CEE, $t < 10^6$ yr, that is different from that of the delay time distribution (DTD) billions of years after star formation. This tentatively hints that the physical processes that determine the short CEED times are different (at least to some extend) from those that determine the DTD at billions of years. To reach these conclusions I examine SNe Ia that interact with a circumstellar matter (CSM) within months after explosion, so called SNe Ia–CSM, and the rate of SNe Ia that on a time scale of tens to hundreds of years interact with a CSM that might have been a planetary nebula, so called SNe Ia inside a planetary nebula (SNIPs). I assume that the CSM in these populations results from a CEE, and hence this study is relevant mainly to the core degenerate (CD) scenario, to the double degenerate (DD) scenario, to the double detonation (DDet) scenario with white dwarf companions, and to the CEE-wind channel of the single degenerate (SD) scenario.

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Detection of 4765-MHz OH emission in a pre-planetary nebula – CRL 618

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Jets and outflows are ubiquitous phenomena in astrophysics, found in our Galaxy in diverse environments, from the formation of stars to late-type stellar objects. We present observations conducted with the 305m Arecibo Telescope of the pre-planetary nebula CRL 618 (Westbrook Nebula) – a well studied late-type star that has developed bipolar jets. The observations resulted in the first detection of 4765-MHz OH in a late-type stellar object. The line was narrow (FWHM ~ 0.6 km s^{-1}) and ~ 40 km s^{-1} blueshifted with respect to the systemic velocity, which suggests association with the expanding jets/bullets in CRL 618. We also report non-detection at Arecibo of any other OH transition between 1 and 9 GHz. The non-detections were obtained during the observations in 2008, when the 4765-MHz OH line was first discovered, and also in 2015 when the 4765-MHz OH line was not detected. Our data indicate that the 4765-MHz OH line was a variable maser. Modeling of the 4765-MHz OH detection and non-detection of the other transitions is consistent with the physical conditions expected in CRL 618. The 4765-MHz OH maser could originate from dissociation of H_2O by shocks after sublimation of icy objects in this dying carbon-rich stellar system, although other alternatives such as OH in an oxygen-rich circumstellar region associated with a binary companion are also possible.

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Formation of second generation stars in globular clusters

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By means of grid-based, 3D hydrodynamical simulations we study the formation of second generation (SG) stars in a young globular cluster (GC) of mass 10^7 $M_\odot$, the possible progenitor of an old GC with a present mass $\sim$ (1–5) $\times$ 10^6 $M_\odot$. The cluster accretes external gas as its first generation (FG) asymptotic giant branch (AGB) stars release their ejecta and SG stars form. We consider two models characterised by different densities of the external gas. In both cases, we find that a very compact SG subsystem with central density $> 10^5$ $M_\odot$ pc^{-3} forms in the innermost regions of the cluster. The low-density model forms a population of extreme SG stars with high helium enhancement, followed by the formation of another SG group out of a mix of pristine gas and AGB ejecta and characterised by a modest helium enhancement. On the other hand, the high-density model forms in prevalence SG stars with modest helium enhancement. Our simulations illustrate the dynamical processes governing the formation of SG populations in GCs and shed light on the structural properties emerging at the end of this phase. The newly born SG groups have different concentrations, with more extreme SG stars more centrally concentrated than those with less extreme chemical abundances. The very high density of the SG subsystems implies that SG massive stars, if formed, might suffer frequent close encounters, collisions and gas stripping, thus possibly contributing further gas to the SG formation.

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The spectroscopic binaries RV Tauri and DF Cygni

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Aims: The focus of this paper is on two famous but still poorly understood RV Tauri stars: RV Tau and DF Cyg. We aim at confirming their suspected binary nature and deriving their orbital elements to investigate the impact of their orbits on the evolution of these systems. This research is embedded into a wider endeavour to study binary evolution

of low- and intermediate-mass stars.
Methods: The high amplitude pulsations were cleaned from the radial-velocity data to better constrain the orbital motion. We used Gaia DR2 parallaxes in combination with the spectral energy distributions (SEDs) to compute their luminosities which were complemented with the ones computed using a period–luminosity–colour relation. The ratio of the circumstellar infrared flux to the photospheric flux obtained from the SEDs was used to estimate the orbital inclination of each system.
Results: DF Cyg and RV Tau are binaries with spectroscopic orbital periods of 784 ± 16 days and 1198 ± 17 days, respectively. These orbital periods are found to be similar to the long-term periodic variability in the photometric time series, indicating that binarity indeed explains the long-term photometric variability. Both systems are surrounded by a circumbinary disc which is grazed by our line-of-sight. As a result, the stellar photometric flux is extinct periodically with the orbital period. Our derived orbital inclinations enabled us to obtain accurate companion masses for DF Cyg and RV Tau. Analysis of the *Kepler* photometry of DF Cyg revealed a power spectrum with side lobes around the fundamental pulsation frequency. This modulation corresponds to the spectroscopic orbital period and hence to the long-term photometric period. Finally we report on the evidence of high velocity absorption features related to the Hα profile in both objects, indicating outflows launched from around the companion.

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Second outburst of the yellow symbiotic star LT Delphini

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We present the results of our photoelectric UBV observations of the yellow symbiotic star LT Del over 2010–2018. The binary system LT Del, which consists of a bright K giant and a compact hot star with a temperature of $\sim 100\,000$ K, has an orbital period of 476 days. In 2017 the variable experienced a second low-amplitude ($\Delta V \sim 0\overset{m}{.}7$) outburst in the history of its studies whose maximum occurred at an orbital phase of 0.15 ± 0.05. The outburst duration was ~ 60 days. The $B - V$ and $U - B$ colors in the outburst became noticeably bluer. A difference in the photometric behavior of the star in the 1994 and 2017 outburst has been detected. In the orbital cycle preceding the 2017 outburst a secondary minimum with a depth of $0\overset{m}{.}15$ and $0\overset{m}{.}20$ appeared in the B and V light curves, respectively, whose cause is discussed. The phase light and color curves are presented and explained; the position of the star on the color–color diagram is interpreted. We have estimated the parameters of the cool and hot components of the system based on the distance determination from Gaia DR2.

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A high-mass planetary nebula in a Galactic open cluster

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Planetary Nebulæ are the ionised ejected envelopes surrounding the remnant cores of dying stars. Theory predicts that main-sequence stars with one to about eight times the mass of our sun may eventually form planetary nebulae. Until now no example has been confirmed at the higher mass range. Here we report that planetary nebula BMP J1613−5406 is associated with Galactic star cluster NGC 6067. Stars evolving off the main sequence of this cluster have a mass

around five solar masses. Confidence in the planetary nebula–cluster association comes from their tightly consistent radial velocities in a sightline with a steep velocity–distance gradient, common distances, reddening and location of the planetary nebula within the cluster boundary. This is an unprecedented example of a planetary nebular whose progenitor star mass is getting close to the theoretical lower limit of core-collapse supernova formation. It provides evidence supporting theoretical predictions that 5+ solar mass stars can form planetary nebulæ. Further study should provide fresh insights into stellar and Galactic chemical evolution.

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Observation of a pair of gas streams in the nascent wind of R Doradus

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AGB star R Dor is very similar to AGB star EP Aqr for which evidence for narrow high velocity polar streams of gas in its nascent wind has been recently obtained. We study the morpho-kinematics of the circumstellar envelope of R Dor at distances between ~ 10 and ~ 100 au from the star using archival ALMA observations of five different molecular lines. High Doppler velocity enhancements of the line emission are observed in the vicinity of the line of sight crossing the star, similar to those interpreted as gas streams in EP Aqr. We consider whether they might in fact be artefacts of an improper data reduction, in particular by looking at data obtained without continuum subtraction, but fail to find a plausible interpretation in such terms. The implications for the detection of high Doppler velocities at short distances from an AGB star are discussed.

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Discovery of the first Ca-bearing molecule in space: CaNC

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We report on the detection of calcium isocyanide, CaNC, in the carbon-rich evolved star IRC +10°216. We derived a column density for this species of $(2.0 \pm 0.5) \times 10^{11}$ cm^{-2}. Based on the observed line profiles and the modelling of its emission through the envelope, the molecule has to be produced in the intermediate and outer layers of the circumstellar envelope where other metal-isocyanides have previously been found in this source. The abundance ratio of CaNC relative to MgNC and FeCN is $\simeq 1/60$ and $\simeq 1$, respectively. We searched for the species CaF, CaCl, CaC, CaCCH, and $CaCH_3$ for which accurate frequency predictions are available. Only upper limits have been obtained for these molecules.

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Origin of α-rich young stars: clues from C, N and O

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A small set of chemically old stars that appear young by their independently derived masses has been detected. These are so-called α-rich young stars. For a sample of 51 red-giant stars, for which spectra are available from SDSS/APOGEE and masses are available from asteroseismic measures based on *Kepler* lightcurves, we derive the C, N and O abundances through an independent analysis. These stars span a wide range of N/C surface number density ratios. We interpret the high-mass stars with low N/C as being products of mergers or mass transfer during or after first dredge up, because the dredge-up features are the same as for low-mass stars. The α-rich young stars with high N/C follow the expected trend of N/C for their mass, and could be either genuine young stars (leaving their high [α/Fe] unexplained) or the results of mergers on the main sequence.

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and from https://academic.oup.com/mnras/article/487/3/4343/5512150

Hot UV-bright stars of galactic globular clusters

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Context: We have performed a census of the UV-bright population in 78 globular clusters using wide-field UV telescopes. This population includes a variety of phases of post-horizontal branch (HB) evolution, including hot post-asymptotic giant branch (AGB) stars, and post-early AGB stars. There are indications that old stellar systems like globular clusters produce fewer post-(early) AGB stars than currently predicted by evolutionary models, but observations are still scarce.
Aims: We wish to derive effective temperatures, surface gravities, and helium abundances of the luminous hot UV-bright stars in these clusters to determine their evolutionary status and compare the observed numbers to predictions from evolutionary theory.
Methods: We obtained FORS2 spectroscopy of eleven of these UV-selected objects (covering a range of $-2.3 <$ [Fe/H] < -1.0), which we (re-)analysed together with previously observed data. We used model atmospheres of different metallicities, including super-solar ones. Where possible, we verified our atmospheric parameters using UV spectrophotometry and searched for metal lines in the optical spectra. We calculated evolutionary sequences for four metallicity regimes and used them together with information about the HB morphology of the globular clusters to estimate the expected numbers of post-AGB stars.
Results: We find that metal-rich model spectra are required to analyse stars hotter than 40 000 K. Seven of the eleven new luminous UV-bright stars are post-AGB or post-early AGB stars, while two are evolving away from the HB, one is a foreground white dwarf, and another is a white dwarf merger. Taking into account published information on other hot UV-bright stars in globular clusters, we find that the number of observed hot post-AGB stars generally agrees with the predicted values, although the numbers are still low.
Conclusions: Spectroscopy is clearly required to identify the evolutionary status of hot UV-bright stars. For hotter stars, metal-rich model spectra are required to reproduce their optical and UV spectra, which may affect the flux contribution of hot post-AGB stars to the UV spectra of evolved populations. While the observed numbers of post-AGB and post-early AGB stars roughly agree with the predictions, our current comparison is affected by low number statistics.

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Available from https://arxiv.org/abs/1905.06718

and from https://www.aanda.org/articles/aa/full_html/2019/07/aa35694-19/aa35694-19.html

Conference Papers

Resolving discrepancy in the pPN OH 231.8+4.2

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OH 231.8+4.2 is an archetypal pre-planetary nebula (pPN). It is a binary system surrounded by bipolar nebula. Some years ago the authors extensively studied it and performed several VLBI observations from which they obtained mas-resolution maps of the SiO (7 mm) and H_2O (1.3 cm) maser emissions. H_2O masers were found to be distributed in two areas along the symmetry axis of the nebula oriented nearly North–South delineating a bipolar outflow and their astrometric positions were accurately measured. SiO masers, indicating the position of the Mira component of the binary system, form a structure perpendicular to the axis of the nebula. The general picture of the source looked satisfactory, except for the relative position of the two masers. Surprisingly, SiO masers, were tentatively placed 250 mas away (370 au) from the apparent center of the outflow. Using the ALMA we observed the SiO maser emission at 86 GHz and accurately derived the position of the Mira component. Combining our previous VLBA data and our new ALMA observations we are now able to give a more complete and detailed description of the inner part of this amazing pPN.

Oral contribution, published in the "14$^{\mathrm{th}}$ European VLBI Network Symposium & Users Meeting" (EVN 2018) 8–11 October 2018, Granada, Spain
Available from https://arxiv.org/abs/1905.07219
and from https://pos.sissa.it/344/074/

Galactic radial abundance gradients: Cepheids and photo-ionized nebulæ

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Radial abundance gradients are observed in the Galaxy and other galaxies as well, and include several chemical elements in different stellar systems. Possibly the most accurate gradients in the Galaxy are those determined from Cepheid variable stars. These objects have very accurate abundances for many elements and are generally considered as standard candles, so that their galactocentric distances are very well determined. These stars are relatively young, with ages between the main types of photo-ionized nebulæ, namely the younger H II regions and the older planetary nebulæ. In this paper we consider the O/H and Fe/H gradients based on a large sample of galactic Cepheids, and compare the results with recent determinations from photo-ionized nebulæ.

Oral contribution, published in the "II Workshop on Chemical Abundances in Gaseous Nebulæ", 11–14 March 2019, São José dos Campos, SP, Brazil, Boletín de la Asociación Argentina de Astronómía, eds. M. Cardaci, G. Hagele & E. Perez-Montero (invited talk)
Available from https://arxiv.org/abs/1906.01686
and from http://www.astro.iag.usp.br/~maciel/research/articles/art172.pdf

Surface imaging of cool evolved stars in the era of the ELT

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Cool evolved stars are the main source of chemical enrichment of the interstellar medium. Understanding their mass loss offers a unique opportunity to study the cycle of matter. We discuss interferometric studies and their comparison to latest state-of-the-art dynamic model atmospheres. They show broad agreement for asymptotic giant branch stars. For red supergiants, however, current models cannot explain observed extensions by far, pointing to missing physical processes in their models, and uncertainties in our general understanding of mass loss. We present ongoing imaging and time-series observations that may provide the strongest constraint and may help to identify missing dynamic processes. VLTI studies will remain the highest spatial resolution observations at ESO into the ELT era, complemented by ALMA observations. We discuss crucial improvements in both instrumental and operational areas for surface imaging of cool evolved stars in the era of the ELT.

Poster contribution, published in "The Very Large Telescope in 2030", held at ESO Garching bei München, June 17–20, 2019
Available from https://arxiv.org/abs/1906.07940
and from https://www.eso.org/sci/meetings/2019/VLT2030.html

Review Papers

Spectroscopy of supergiants with infrared excess: results of 1998–2018

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The results of our second stage (1998–2018) of the detailed spectroscopy of peculiar supergiants identified with galactic infrared sources, performed at the 6-meter BTA telescope are summarized. The main aspect of the program is a search for the evolutionary variations in the chemical composition of stars, past the AGB stage and the third dredge-up (TDU), as well as an analysis of spectral manifestations of kinematic processes in their extended, often unstable, atmospheres and in the envelopes. The most significant result is detection of the s-process element excesses in seven single post-AGB stars, which empirically confirms the theory of evolution of this type of stars. In three of these stars we for the first time discovered the ejection of the *s*-process heavy metals to the circumstellar envelopes. A lithium excess was found in the atmospheres of peculiar supergiants V2324 Cyg and V4334 Sgr. The results of investigation of the kinematics of atmospheres and shells will clarify the equilibrium of matter produced by stars in the AGB and post-AGB stages and delivered to the interstellar medium.

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Pulsating white dwarfs: new insights

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Stars are extremely important astronomical objects that constitute the pillars on which the Universe is built, and as such, their study has gained increasing interest over the years. White dwarf stars are not the exception. Indeed, these stars constitute the final evolutionary stage for more than 95 per cent of all stars. The Galactic population of white dwarfs conveys a wealth of information about several fundamental issues and are of vital importance to study the structure, evolution and chemical enrichment of our Galaxy and its components – including the star formation history of the Milky Way. Several important studies have emphasized the advantage of using white dwarfs as reliable clocks to date a variety of stellar populations in the solar neighbourhood and in the nearest stellar clusters, including the thin and thick disks, the Galactic spheroid and the system of globular and open clusters. In addition, white dwarfs are tracers of the evolution of planetary systems along several phases of stellar evolution. Not less relevant than these applications, the study of matter at high densities has benefited from our detailed knowledge about evolutionary and observational properties of white dwarfs. In this sense, white dwarfs are used as laboratories for astro-particle physics, being their interest focused on physics beyond the standard model, that is, neutrino physics, axion physics and also radiation from "extra dimensions", and even crystallization. The last decade has witnessed a great progress in the study of white dwarfs. In particular, a wealth of information of these stars from different surveys has allowed us to make meaningful comparison of evolutionary models with observations. While some information like surface chemical composition, temperature and gravity of isolated white dwarfs can be inferred from spectroscopy, and the total mass and radius can be derived as well when they are in binaries, the internal structure of these compact stars can be unveiled only by means of asteroseismology, an approach based on the comparison between the observed pulsation periods of variable stars and the periods predicted by appropriate theoretical models. The asteroseismological techniques allow us to infer details of the internal chemical stratification, the total mass, and even the stellar rotation profile. In this review, we first revise the evolutionary channels currently accepted that lead to the formation of white-dwarf stars, and then, we give a detailed account of the different sub-types of pulsating white dwarfs known so far, emphasizing the recent observational and theoretical advancements in the study of these fascinating variable stars.

Published in Astronomy and Astrophysics Review
Available from https://arxiv.org/abs/1907.00115

Job Advert

Postdoctoral Position in Stellar Astrophysics

The School of Physics & Astronomy at Monash University in Australia is seeking a Postdoctoral Research Fellow in the field of Stellar Astrophysics. The duration of the position is 2.5 years.

The application deadline is the 5$^{\text{th}}$ of July.

The primary role of this position is to work with Dr. Simon Campbell and collaborators on 3D hydrodynamic simulations of convective-reactive events in stars. This is an Australian Research Council funded research project that combines heavy-element nucleosynthesis, 1D simulations, and 3D hydrodynamics. For this role expertise in 3D stellar hydrodynamics, including code development, is the primary criterion. Expertise in neutron-capture nucleosynthesis and 1D stellar modelling would also be beneficial.

Instructions on how to apply are available via the URL below.

See also https://jobregister.aas.org/ad/09df8547

Announcement

Release note: Massive peak bagging of red giants in the *Kepler* field

The NASA satellite *Kepler* has gathered about 1420 days-long photometric time series for more than 20 000 red giant stars. For about 6600 of them also APOGEE spectroscopic parameters are available, making the sample of high interest for various astrophysical investigations. To optimally exploit the full wealth of the seismic information, extraction of mode parameters of all significant individual frequencies is necessary. However, the complex structure of the mixed mode pattern makes it challenging to automate the peak bagging (i.e. the extraction of the individual mode parameters from the stars power density spectra). Even though several approaches have been successfully implemented, the available results are still limited to a handful of stars. Here I present frequencies, amplitudes, and lifetimes of more than a quarter of a million oscillation modes of the spherical degree $l = 0$ to 3, which have been observed in 6179 *Kepler* red giants. The sample covers evolutionary stages from the lower red-giant branch to high up the asymptotic giant branch. The modes were extracted with the Automated Bayesian Peak-Bagging Algorithm (ABBA) and are publicly available at https://github.com/tkallinger/KeplerRGpeakbagging

See also https://github.com/tkallinger/KeplerRGpeakbagging