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Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 287th issue of the AGB Newsletter. There are fascinating new results about the interiors of red (super)giants, the behaviour of their envelopes, and more.

Please alert your best students looking for a Ph.D. to the advert for a project to work with Ambra Nanni.

Also note the announcements with updates on the IAU Symposium on stellar outflows and the Marcel Grossmann meeting session on Betelgeuse.

We look forward to the discussions at the IAU-sponsored meeting on unsolved problems in red giants and supergiants, GAPS 2021: https://gaps2021.wixsite.com/conference – note also the call for works of art by the public and feel welcome to distribute it widely.

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

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

Food for Thought

This month's thought-provoking statement is:

How does the s process in AGB stars depend on the precise initial elemental abundances?

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

Lithium abundances and asteroseismology of red giants: understanding the evolution of lithium in giants based on asteroseismic parameters

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In this study, we explore the evolution of lithium in giant stars based on data assembled from the literature on asteroseismology and Li abundances for giants. Our final sample of 187 giants consists of 44 red giant branch (RGB), 140 core He-burning (CHeB) and three giants with an unclassified evolutionary phase. For all 187 stars, the seismic parameters $\nu_{\rm max}$ (frequency of maximum oscillation power) and $\Delta\nu$ (large frequency spacing) are available, while $\Delta\Pi_1$ (the asymptotic gravity-mode period spacing) is available for a subset of 64. For some of the CHeB giants, mass estimates from the asteroseismic scaling relations are found to be underestimated when compared with mass estimates from isochrones based on seismic data. Whilst most of the Li-rich giants in the sample have masses less than 1.5 $M_\odot$, they are also present up to and beyond the maximum mass expected to have suffered a core He-flash, i.e. $M \leq 2.25$ $M_\odot$: this suggests contributions from other processes towards Li enrichment. To understand the evolution of giants in the $\Delta\Pi_1$–$\Delta\nu$ plane, we use the *Modules for Experiments in Stellar Astrophysics* models which show the presence of mini He-flashes following the initial strong core He-flash. From the distribution of A(Li) as a function of $\Delta\nu$, which is similar to the distribution of A(Li) as a function of luminosity, we find no indication of Li enrichment near the luminosity bump. Also, A(Li) trends to ~ -1.5 dex near the RGB tip. The data also suggest a decrease in A(Li) with an increase in $\Delta\Pi_1$ for CHeB giants.

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Panchromatic calibration of Ca II triplet luminosity dependence

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Context: The line strength of the near-infrared Ca II triplet (CaT) lines are a proxy for measuring metallicity from integrated and individual stellar spectra of bright red giant stars. In the latter case it is a mandatory step to remove the magnitude (proxy for gravity, temperature, and luminosity) dependence from the equivalent width (EW) of the lines before converting them into metallicities. For decades the working empirical procedure has been to use the relative magnitude with respect to the horizontal branch level or red clump, with the advantage that it is independent from distance and extinction.
Aims: The V filter is broadly adopted as the reference magnitude, although a few works have used different filters (I and $K_{\rm s}$, for example). In this work we investigate the dependence of the CaT calibration using the $griz$ filters from the Dark Energy Camera (DECam) and the Gemini Multi-Object Spectrograph (GMOS), the G filter from Gaia, the BVI filters from the Magellanic Clouds photometric survey (MCPS), and the $YJK_{\rm s}$ filters from the Visible and Infrared Survey Telescope for Astronomy (VISTA) InfraRed CAMera (VIRCAM). We use as a reference the FOcal Reducer and low dispersion Spectrograph 2 (FORS2) V filter used in the original analysis of the sample.
Methods: Red giant stars from clusters with known metallicity and available CaT EWs were used as reference. Public photometric catalogues were taken from the Survey of the MAgellanic Stellar History (SMASH) second data release,

VISTA survey of the Magellanic Clouds system (VMC), Gaia, MCPS surveys, plus VIsible Soar photometry of star Clusters in tApi'i and Coxi HuguA (VISCACHA) GMOS data, for a selection of Small Magellanic Cloud clusters. The slopes were fitted using two and three lines to be applicable to most of the metallicity scales.
Results: The magnitude dependence of the CaT EWs is well described by a linear relation using any filter analysed in this work. The slope increases with wavelength of the filters. The zero point (i.e. reduced EW), which is the metallicity indicator, remains the same.
Conclusions: If the same line profile function is used with the same bandpasses and continuum regions, and the total EW comes from the same number of lines (2 or 3), then the reduced EW is the same regardless the filter used. Therefore, any filter can be used to convert the CaT equivalent widths into metallicity for a given CaT calibration.

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S stars and s-process in the Gaia era – II. Constraining the luminosity of the third dredge-up with Tc-rich S stars

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Context: S stars are late-type giants that are transition objects between M-type stars and carbon stars on the asymptotic giant branch (AGB). They are classified into two types: intrinsic or extrinsic, based on the presence or absence of technetium (Tc). The Tc-rich or intrinsic S stars are thermally-pulsing (TP-)AGB stars internally producing s-process elements (including Tc) which are brought to their surface via the third dredge-up (TDU). Tc-poor or extrinsic S stars gained their s-process overabundances via accretion of s-process-rich material from an AGB companion which has since turned into a dim white dwarf.
Aims: Our goal is to investigate the evolutionary status of Tc-rich S stars by locating them in a Hertzsprung–Russell (HR) diagram using the results of Gaia early Data Release 3 (EDR3). We combine the current sample of 13 Tc-rich stars with our previous studies of 10 Tc-rich stars to determine the observational onset of the TDU in the metallicity range [−0.7; 0]. We also compare our abundance determinations with dedicated AGB nucleosynthesis predictions.
Methods: The stellar parameters are derived using an iterative tool which combines HERMES high-resolution spectra, accurate Gaia EDR3 parallaxes, stellar evolution models and tailored MARCS model atmospheres for S-type stars. Using these stellar parameters we determine the heavy-element abundances by line synthesis.
Results: In the HR diagram, the intrinsic S stars are located at higher luminosities than the predicted onset of the TDU. These findings are consistent with Tc-rich S stars being genuinely TP-AGB stars. The comparison of the derived s-process abundance profiles of our intrinsic S stars with the nucleosynthesis predictions provide an overall good agreement. Stars with highest [s/Fe] tend to have the highest C/O ratios.

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Heavy-element Rydberg transition line emission from the post-giant-evolution star HD 101584

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We report the detection of two lines at millimetre wavelengths towards the immediate surroundings of the post-giant and most likely post-common-envelope star HD 101584 using high-angular-resolution ALMA observations. The circumstellar environment of this object is rich in different molecular species, but we find no viable identifications in terms of molecular lines.
We aim to determine whether or not these lines can be attributed to the Rydberg transitions – X30α and X26α – of neutral atoms of elements heavier than carbon.
A simple model in strict local thermodynamic equilibrium for a warm-gas environment of the moderate-temperature star ($T_{\rm eff} \approx 8500$ K) was constructed to corroborate our findings. A geometrically thin, disc-like geometry seen face-on was chosen and a distance of 1 kpc.
The observed flux densities of the lines and the continuum at 232 and 354 GHz can be reproduced using $\approx 10^{-3}$ $M_\odot$ of gas at a temperature of ≈ 2800 K and a hydrogen density of $\approx 10^{12}$ cm^{-3}, assuming solar abundances for the elements. The gas lies within a distance of about 5 au from the star (assuming a distance of 1 kpc). The ionisation fraction is low, $\approx 3 \times 10^{-5}$. The origin of such a region is not clear, but it may be related to a common-envelope-evolution phase. With these conditions, the line emissions are dominated by Rydberg transitions within the stable isotopes of Mg. A turbulent velocity field in the range 5.5–7.5 km s^{-1} is required to fit the Gaussian line shapes. An upper limit to the average magnetic field in the line-emitting region of 1 G is set using the Zeeman effect in these lines.
We speculate that Rydberg transitions of heavy elements may be an interesting probe for the close-in environments of other moderate-temperature objects like AGB stars, red supergiants, yellow hypergiants, and binaries of various types.

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Detection of young (≤ 20 Myr) stellar populations in apparently quenched low-mass galaxies using red spectral line indices

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We report on the detection of a small contribution (around and below 1 per cent in mass) from young stellar components with ages ≤ 20 Myr in low-mass galaxies purposely selected from the MaNGA survey to be already-quenched systems. Among the sample of 28 galaxies, 8 of them show signatures of having suffered a very recent burst of star formation. The detection has been done through the analysis of line-strength indices in the red spectral range [5700,8800] Å. The increasing contribution of red supergiants to this red regime is responsible for a deviation of the index measurements with respect to their position within the model grids in the standard spectral range [3600,5700] Å. We demonstrate that a combination of red indices, as well as a qualitative assessment of the mean luminosity-weighted underlying stellar population, is required in order to distinguish between a true superyoung population and other possible causes of this deviation, such as abundance ratio variations. Our result implies that many presumably quenched low-mass galaxies actually contain gas that is triggering some level of star formation. They have, therefore, either accreted external gas, internally recycled enough gas from stellar evolution to trigger new star formation, or they kept a gas reservoir after the harassment or stripping process that quenched them in the first place. Internal processes are favoured since we find no particular trends between our non-quenched galaxies and their environment, although more work is needed to

fully discard an external influence.

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Multi-frequency high spectral resolution observations of HCN toward the circumstellar envelope of Y CVn

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High spectral resolution observations toward the low mass-loss rate C-rich, J-type AGB star Y CVn have been carried out at 7.5, 13.1 and 14.0 μm with SOFIA/EXES and IRTF/TEXES. Around 130 HCN and $H^{13}CN$ lines of bands v_2, $2v_2$, $2v_2$–v_2, $3v_2$–$2v_2$, $3v_2$–v_2, and $4v_2$–$2v_2$ have been identified involving lower levels with energies up to $\sim$ 3900 K. These lines have been complemented with the pure rotational lines $J = 1$–0 and 3–2 of the vibrational states up to $2v_2$ acquired with the IRAM 30 m telescope, and with the continuum taken with ISO. We have analyzed the data with a ro-vibrational diagram and a code which models the absorption and emission of the circumstellar envelope of an AGB star. The continuum is produced by the star with a small contribution from dust grains comprising warm to hot SiC and cold amorphous carbon. The HCN abundance distribution seems to be anisotropic. The ejected gas is accelerated up to the terminal velocity ($\sim$ 8 km s^{-1}) from the photosphere to $\sim 3\ R_\star$ but there is evidence of higher velocities ($>$ 9–10 km s^{-1}) beyond this region. In the vicinity of Y CVn, the line widths are as high as $\sim$ 10 km s^{-1}, which implies a maximum turbulent velocity of 6 km s^{-1} or the existence of other physical mechanisms probably related to matter ejection that involve higher gas expansion velocities than expected. HCN is rotationally and vibrationally out of LTE throughout the whole envelope. A difference of about 1500 K in the rotational temperature at the photosphere is needed to explain the observations at 7.5 and 13–14 μm. Our analysis finds a total HCN column density that ranges from $\sim 2.1\times10^{18}$ to 3.5×10^{18} cm^{-2}, an abundance with respect to H_2 of 3.5×10^{-5} to 1.3×10^{-5}, and a $^{12}C/^{13}C$ isotopic ratio of $\sim$ 2.5 throughout the whole envelope.

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Dust changes in Sakurai's Object: new PAHs and SiC with coagulation of submicron-sized silicate dust into 10 μm-sized melilite grains

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6–14 μm *Spitzer* spectra obtained at 6 epochs between April 2005 and October 2008 are used to determine temporal changes in dust features associated with Sakurai's Object (V4334 Sgr), a low mass post-AGB star that has been forming dust in an eruptive event since 1996. The obscured carbon-rich photosphere is surrounded by a 40-milliarcsec torus and 32 arcsec PN. An initially rapid mid-infrared flux decrease stalled after 21 April 2008. Optically-thin emission due to nanometre-sized SiC grains reached a minimum in October 2007, increased rapidly between 21–30 April 2008 and more slowly to October 2008. 6.3-μm absorption due to PAHs increased throughout. 20 μm-sized SiC grains might have contributed to the 6–7 μm absorption after May 2007. Mass estimates based on the optically-thick emission agree with those in the absorption features if the large SiC grains formed before May 1999 and PAHs formed in April–June 1999. Estimated masses of PAH and large-SiC grains in October 2008, were 3×10^{-9} $M_{\odot}$ and 10^{-8} $M_{\odot}$, respectively. Some of the submicron-sized silicates responsible for a weak 10-μm absorption feature are probably located within the PN because the optical depth decreased between October 2007 and October 2008. 6.9-μm absorption assigned to ~ 10 μm-sized crystalline melilite silicates increased between April 2005 and October 2008. Abundance and spectroscopic constraints are satisfied if $\sim$ 2.8 per cent of the submicron-sized silicates coagulated to form melilites. This figure is similar to the abundance of melilite-bearing calcium–aluminium-rich inclusions in chondritic meteorites.

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The Betelgeuse project – III. Merger characteristics

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We previously proposed that Betelgeuse might have been spun up by accreting a companion of about 1 solar mass. Here we explore in more detail the possible systematics of such a merger and a larger range of accreted masses. We use the stellar evolutionary code MESA to add angular momentum to a primary star in core helium burning, core carbon burning, or shell carbon burning. Our models provide a reasonable "natural" explanation for why Betelgeuse has a large, but sub-Keplerian equatorial velocity. They eject sufficient mass and angular momentum in rotationally induced mass loss to reproduce the observed ratio of the equatorial velocity to escape velocity of Betelgeuse, ~ 0.23, within a factor of 3 nearly independent of the primary mass, the secondary mass, and the epoch at which merger occurs. Our models suggest that merger of a primary of somewhat less than 15 solar masses with secondaries from 1 to 10 solar masses during core helium burning or core carbon burning could yield the equatorial rotational velocity of ~ 15 km s^{-1} attributed to Betelgeuse. For accreting models, a wave of angular momentum is halted at the composition boundary at the edge of the helium core. The inner core is thus not affected by the accretion of the companion in these simulations. Accretion has relatively little effect on the production of magnetic fields in the inner core. Our results do not prove, but do not negate, that Betelgeuse might have ingested a companion of several solar masses.

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X-ray AGB stars in the 4XMM-DR9 catalog: further evidence for companions

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Single AGB stars are not normally expected to be X-ray emitters due to the lack of a corona capable of powering a hot plasma. Therefore, the detection of X-ray emission in AGB stars by the ROSAT, *Chandra*, and XMM–*Newton* observatories has been interpreted as evidence for binarity. The number of X-ray-emitting AGB stars is, however,very small, and statistically sound conclusions shall be considered tentative. In this paper we aim at increasing the number of X-ray-emitting AGB stars and at providing a consistent analysis of their X-ray emission to be compared to their UV and optical properties. The XMM–*Newton* 4XMM-DR9 catalog has been searched for X-ray counterparts of various types of AGB stars: nearby (i.e. listed in *Hipparcos*), mass-losing, and S- and C-types. Seventeen X-ray counterparts of AGB stars have been found in the 4XMM-DR9. Nine of them have pointed XMM–*Newton* observations, whereas eight are genuine serendipitous discoveries. Together with the AGB stars detected by ROSAT, this increases the number of X-ray AGB stars to 26. Most of their X-ray spectra can be fit by the emission from an optically thin single-temperature thermal plasma with temperatures typically larger than 10^7 K. There is no obvious correlation between the X-ray and bolometric luminosity of these stars, but the X-ray luminosity generally increases with the amount of far-UV excess. The high temperature of some X-ray-emitting plasma in AGB stars and the correlation of their X-ray luminosity with the far-UV emission supports the origin of this X-ray emission from accretion disks around unseen companions.

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The Pristine Inner Galaxy Survey (PIGS) – III: carbon-enhanced metal-poor stars in the bulge

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The most metal-deficient stars hold important clues about the early build-up and chemical evolution of the Milky Way, and carbon-enhanced metal-poor (CEMP) stars are of special interest. However, little is known about CEMP stars in the Galactic bulge. In this paper, we use the large spectroscopic sample of metal-poor stars from the Pristine Inner Galaxy Survey (PIGS) to identify CEMP stars ([C/Fe] $\geq +0.7$) in the bulge region and to derive a CEMP fraction. We identify 96 new CEMP stars in the inner Galaxy, of which 62 are very metal-poor ([Fe/H] < -2.0); this is more than a ten-fold increase compared to the seven previously known bulge CEMP stars. The cumulative fraction of CEMP stars in PIGS is 42^{+14}_{-13}% for stars with [Fe/H] < -3.0, and decreases to 16^{+3}_{-3}% for Fe/H] < -2.5 and $5.7^{+0.6}_{-0.5}$% for [Fe/H] < -2.0. The PIGS inner Galaxy CEMP fraction for [Fe/H < -3.0 is consistent with the halo fraction found in the literature, but at higher metallicities the PIGS fraction is substantially lower. While this can partly be attributed to a photometric selection bias, such bias is unlikely to fully explain the low CEMP fraction at higher metallicities. Considering the typical carbon excesses and metallicity ranges for halo CEMP-s and CEMP-no stars, our results point to a possible deficiency of both CEMP-s and CEMP-no stars (especially the more metal-rich) in the inner Galaxy. The former is potentially related to a difference in the binary fraction, whereas the latter may be the result of a fast chemical enrichment in the early building blocks of the inner Galaxy.

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An infrared study of Galactic OH/IR stars – III. Variability properties of the Arecibo sample

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We present the results of a near-infrared (NIR) monitoring program carried out between 1999 and 2005 to determine the variability properties of the 'Arecibo sample of OH/IR stars'. The sample consists of 385 IRAS-selected Asymptotic Giant Branch (AGB) candidates, for which their O-rich chemistry has been proven by the detection of 1612 MHz OH maser emission. The monitoring data was complemented by data collected from public optical and NIR surveys. We fitted the light curves obtained in the optical and NIR bands with a model using an asymmetric cosine function, and derived a period for 345 sources ($\sim 90\%$ of the sample). Based on their variability properties, most of the Arecibo sources are classified as long-period large-amplitude variable stars (LPLAV), 4% as (candidate) post-AGB stars, and 3% remain unclassified although they are likely post-AGB stars or highly obscured AGB stars. The period distribution of the LPLAVs peaks at ~ 400 days, with periods between 300 and 800 days for most of the sources, and has a long tail up to ~ 2100 days. Typically, the amplitudes are between 1 and 3 mag in the NIR and between 2 and 6 mag in the optical. We find correlations between periods and amplitudes, with larger amplitudes associated to longer periods, as well as between the period and the infrared colours, with the longer periods linked to the redder sources. Among the post-AGB stars, the light curve of IRAS 19566+3423 was exceptional, showing a large systematic increase (> 0.4 mag yr^{-1}) in K-band brightness over 7 years.

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Multi-epoch optical images of IRC +10°216 tell about the central star and the adjacent environment

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Six images of IRC +10°216 taken by the *Hubble* Space Telescope at three epochs in 2001, 2011, and 2016 are compared in the rest frame of the central carbon star. An accurate astrometry has been achieved with the help of Gaia Data Release 2. The positions of the carbon star in the individual epochs are determined using its known proper motion, defining the rest frame of the star. In 2016, a local brightness peak with compact and red nature is detected at the stellar position. A comparison of the color maps between 2016 and 2011 epochs reveals that the reddest spot moved along with the star, suggesting a possibility of its being the dusty material surrounding the carbon star. Relatively red, ambient region is distributed in an Ω shape and well corresponds to the dusty disk previously suggested based on near-infrared polarization observations. In a larger scale, differential proper motion of multiple ring-like pattern in the rest frame of the star is used to derive the average expansion velocity of transverse wind components, resulting in ~ 12.5 km s^{-1} (d/123 pc), where d is the distance to IRC +10°216. Three dimensional geometry is implied from its comparison with the line-of-sight wind velocity determined from half-widths of submillimeter emission line profiles of abundant molecules. Uneven temporal variations in brightness for different searchlight beams and anisotropic

distribution of extended halo are revisited in the context of the stellar light illumination through a porous envelope with postulated longer-term variations for a period of $\lesssim 10$ years.

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Internal mixing of rotating stars inferred from dipole gravity modes

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During most of their life, stars fuse hydrogen into helium in their cores. The mixing of chemical elements in the radiative envelope of stars with a convective core is able to replenish the core with extra fuel. If effective, such deep mixing allows stars to live longer and change their evolutionary path. Yet localized observations to constrain internal mixing are absent so far. Gravity modes probe the deep stellar interior near the convective core and allow us to calibrate internal mixing processes. Here we provide core-to-surface mixing profiles inferred from observed dipole gravity modes in 26 rotating stars with masses between 3 and 10 solar masses. We find a wide range of internal mixing levels across the sample. Stellar models with stratified mixing profiles in the envelope reveal the best asteroseismic performance. Our results provide observational guidance for three-dimensional hydrodynamical simulations of transport processes in the deep interiors of stars.

Published in Nature Astronomy
Available from https://arxiv.org/abs/2105.04533
and from https://rdcu.be/ckjRm

The vertical and adiabatic ionization energies of silicon carbide clusters, $(SiC)_n$, with $n = 1$–12

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Silicon carbide (SiC) is one of the major cosmic dust components in carbon-rich environments. However, the formation of SiC dust is not well understood. In particular, the initial stages of the SiC condensation (i.e. the SiC nucleation) remain unclear, as the basic building blocks (i.e. molecular clusters) exhibit atomic segregation at the (sub-)nanoscale. We report vertical and adiabatic ionization energies of small silicon carbide clusters, $(SiC)_n$, $n = 2$–12, ranging from 6.6–10.0 eV, which are lower than for the SiC molecule (~ 10.6 eV). The most favorable structures of the singly ionized $(SiC)_n^+$, $n = 5$–12, cations resemble their neutral counterparts. However, for sizes $n = 2$–4, these structural analogues are metastable and different cation geometries are favored. Moreover, we find that the $(SiC)_5^+$ cation is likely to be a transition state. Therefore, we place constraints on the stability limit for small, neutral $(SiC)_n$ clusters to persist ionization through (inter)-stellar radiation fields or high temperatures.

Published in Frontiers in Astronomy and Space Science, Astrochemistry, Research topic: Refractory Astrochemistry
Available from https://arxiv.org/abs/2105.01482
and from https://www.frontiersin.org/articles/10.3389/fspas.2021.662545/full

Search for period changes in Mira stars

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We reobserved in the R_{C} and i'_{Sloan} bands, during the years 2020–2021, seven Mira variables in Cassiopeia, for which historical i'_{Sloan} light curves were available from Asiago Observatory plates taken in the years 1967–84. The aim was to check if any of them had undergone a substantial change in the period or in the light curve shape. Very recent public data form ZTF-DR5 were also used to expand our time base window. A marked color change was detected for all the stars along their variability cycle. The star V890 Cas showed a significant period decrease of 12% from 483 to 428 days, one of the largest known to date. All the stars, save AV Cas, showed a smaller variation amplitude in the recent CCD data, possibly due to a photometric accuracy higher than that of the photographic plates.

Accepted for publication in OEJV (Open European Journal on Variable Stars)
Available from https://arxiv.org/abs/2105.09018

The survey of planetary nebulæ in Andromeda (M 31) – III. Constraints from deep planetary nebula luminosity functions on the origin of the inner halo substructures in M 31

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Context: The Andromeda (M 31) galaxy displays several substructures in its inner halo. Different simulations associate their origin with either a single relatively massive merger, or with a larger number of distinct, less massive accretions.
Aims: The origin of these substructures as remnants of accreted satellites or perturbations of the pre-existing disc would be encoded in the properties of their stellar populations (SPs). The metallicity and star formation history of these distinct populations leave traces on their deep [O III] 5007Å planetary nebula luminosity function (PNLF). By characterizing the morphology of the PNLFs, we constrain their origin.
Methods: From our 54 sq. deg. deep narrow-band [O III] survey of M 31, we identify planetary nebulæ in six major inner-halo substructures: the Giant Stream, North East Shelf, G1 Clump, Northern Clump, Western Shelf, and Stream D. We obtain their PNLFs and those in two disc annuli, with galactocentric radii of $R_{\mathrm{GC}} = 10$–20 kpc and $R_{\mathrm{GC}} = 20$–30 kpc. We measure PNLF parameters from cumulative fits and statistically compare the PNLFs in each substructure and disc annulus. We link these deep PNLF parameters and those for the Large Magellanic Cloud (LMC) to published metallicities and resolved stellar population-age measurements for their parent SPs.
Results: The absolute magnitudes (M^*) of the PNLF bright cut-off for these sub-populations span a significant magnitude range, despite being located at the same distance and having a similar line-of-sight extinction. The M^* values of the Giant Stream, W Shelf, and Stream D PNLFs are fainter than those predicted by PN evolution models by 0.6, 0.8, and 1.5 mag, respectively, assuming the measured metallicity of the parent stellar populations. The faint-end slope of the PNLF increases linearly with decreasing fraction of stellar mass younger than 5 Gyr across the M 31 regions and the LMC. From their PNLFs, the Giant Stream and NE Shelf are consistent with being stellar debris from an infalling satellite, while the G1 Clump appears to be linked with the pre-merger disc with an additional contribution from younger stars.

Conclusions: The SPs of the substructures are consistent with those predicted by simulations of a single fairly massive merger event that took place 2–3 Gyr ago in M 31. Stream D has an unrelated, distinct origin. Furthermore, this study provides independent evidence that the faint-end of the PNLF is preferentially populated by planetary nebulæ evolved from older stars.

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Available from https://arxiv.org/abs/2101.11860

TEM analyses of unusual presolar silicon carbide: insights into the range of circumstellar dust condensation conditions

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Presolar silicon carbide (SiC) grains in meteoritic samples can help constrain circumstellar condensation processes and conditions in C-rich stars and core-collapse supernovæ (CCSNe). This study presents our findings on eight presolar SiC grains from asymptotic giant branch (AGB) stars (four mainstream and one Y grain) and CCSNe (three X grains), chosen on the basis of μ-Raman spectral features that were indicative of their having unusual non-3C polytypes and/or high degrees of crystal disorder. Analytical transmission electron microscopy (TEM), which provides elemental compositional and structural information, shows evidence for complex histories for the grains. Our TEM results confirm the presence of non-3C,2H crystal domains. Minor-element heterogeneities and/or subgrains were observed in all grains analyzed for their compositions. The C/O ratios inferred for the parent stars varied from 0.98 to ≥ 1.03. Our data show that SiC condensation can occur under a wide range of conditions, in which environmental factors other than temperature (e.g., pressure, gas composition, heterogeneous nucleation on precondensed phases) play a significant role. Based on previous μ-Raman studies, $\sim 10\%$ of SiC grains may have infrared (IR) spectral features that are influenced by crystal defects, porosity, and/or subgrains. Future subdiffraction-limited IR measurements of complex SiC grains might shed further light on the relative contributions of each of these features to the shape and position of the characteristic IR 11 μm SiC feature and thus improve the interpretation of IR spectra of AGB stars like those that produced the presolar SiC grains.

Published in The Astrophysical Journal
Available from https://doi.org/10.3847/1538-4357/abece2

Job Advert

Ph.D. scholarship

The Astrophysics Division at the National Centre for Nuclear Research, Warsaw, invites applications for one Ph.D. scholarship (4 years) starting in October 2021 in the project SONATA BIS 2020/38/E/ST9/00077 (founded by National Science Centre): "DINGLE: Dust IN Galaxies: Looking through its Emission" (P.I. Ambra Nanni).

The Ph.D. thesis is in the framework of DINGLE project, and it will aim to model the observed mid-infrared emission and features of spatially resolved evolved stars as a function of the stellar parameters. The results will be included in stellar population synthesis models and in the code CIGALE in order to model the spectral energy distribution of spatially unresolved galaxies. The student will be collaborating with an international team of astrophysicists and statisticians. He/she is going to participate in the local and international conferences as well as in the dedicated schools.

Requirements:

- M.Sc. college degree in physics/astronomy or a similar specialization;
- very good command of written/spoken English;
- very good knowledge of at least one programming language using for data analysis (as Python or similar) and the UNIX/LINUX environment;
- involvement in scientific research, analytical skills, thinking independence, good communication/team-work skills;
- good ability in Fortran and Python programming will be an asset.

For details about the application procedure and documents please go to:
https://www.ncbj.gov.pl/en/praktyki/phd-student-scholarship-astrophysics
For details about the project, please visit: https://www.ncbj.gov.pl/bp4/dingle
E-mail your application before June 13th 2021 to ambra.nanni@ncbj.gov.pl specifying "DINGLE" in the mail Subject field.

See also https://www.ncbj.gov.pl/bp4

Announcements

Update: IAU Symposium 366: The Origin of Outflows in Evolved Stars

Update: Due to the ongoing COVID-19 pandemic, we are currently planning to hold the IAUS366 "The Origin of Outflows in Evolved Stars" conference, which will take place November 1–6 2021 in Leuven (Belgium), in a hybride online/live format. This means we will welcome participants to Leuven but will also provide full online access and participation for people not travelling to Leuven. Practical details will be communicated at a later stage. The COVID-19 situation will be further monitored to see if changes in the format are needed at a later stage.

Rationale

A proper understanding of stellar evolution and of the chemical make-up of the building blocks in the Universe near and far cannot be achieved without a detailed understanding of the wind physics during the late stages of stellar evolution as a function of the cosmic environment and hence metallicity. The goal of this IAU Symposium 366 is to propel our understanding of stellar wind physics across stellar mass by bringing together the scientific communities which often focus on either the low-mass or the massive stars. This cross-disciplinary approach will fuel new scientific ideas and insights and will facilitate for new collaborations to grow across communities.

Key topics of the conference include: Theory of stellar outflows: low mass & massive stars, Observing stellar outflows: low mass & massive stars, Numerical models for stellar outflows: low mass & massive stars, Binarity, Enrichment of the interstellar medium by stellar winds, Astrochemistry, Current and new observing facilities, Hot topics, Education, Outreach, Arts and STEAM

Deadlines and important dates:

Registration opens: 1 June 2021
Deadline IAU Travel Grant application: 1 August 2021
Deadline contributed talk abstracts: 15 August 2021
Deadline poster abstracts: 25 August 2021
Announcement selected contributed talks: 5 September 2021
Announcement selected posters: 15 September 2021

In-person registration closes: 15 October 2021
Conference starts: 1 November 2021

See also https://iaus366.be

Special Session on Betelgeuse at the Marcel Grossmann virtual Meeting XVI: last call

Betelgeuse, the red supergiant of Orion has completed another cycle of primary oscillation of 425 days after the deep minimum of February 11, 2020. Now, 31 May 2021, its visibility from Earth is ending for its conjunction with the Sun, and its visual magnitude is still at 0.8, about 0.7 mag brighter than the past deep minimum.

The last visual observations are possibile until about June 10–12 from the Southern hemisphere, and some techniques in daylight with appropriate filters are in program to be used during this period, to measure the luminosity of the star.

What happened in 2020 to this star? The opportunity of this meeting is to focus on

1) observations and their criticities in the AAVSO 130 years database on Betelgeuse
2) time series analyses of Betelgeuse's light curve
3) spectral data on Betelgeuse during the deep minimum and in other phases
4) high resolution imaging of Betelgeuse
5) models of Betelgeuse

The session dedicated to Betelgeuse will be held online on July 8^{th} at 16:30-19:30 CEST

The MG16 website is http://www.icra.it/mg/mg16
Abstracts are welcome until June 15^{th}.
Direct contacts to the session's chairman Costantino Sigismondi: sigismondi@icra.it

See also http://www.icra.it/mg/mg16