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Editorial

Dear Colleagues,

It is our pleasure to present you the 302$^{\rm nd}$ issue of the AGB Newsletter, with exciting new results as well as questions raised.

If you're looking for a postdoctoral researcher position then consider the fantastic opportunity to work with Keiichi Ohnaka in Santiago de Chile.

Last month's Food for Thought (*We have gained a lot over the past century of astronomical research. What have we lost?*) generated several interesting responses:

"I will answer the question: "What are we going to lose?" We gained the understanding that the correct model and understanding is not the property of one person (Lord Kelvin was wrong about the age of the Sun and Earth). We should take many directions, like looking for planets close to their host stars even if theory told us that is impossible (and we found many planets there). The trend of giving a small number of people a large amount of money, like (but not only) the European Research Council does, will bring us back to a place where only few popular views and research directions hold."

"My strong impression is that we are losing, if we have not yet entirely lost, the ability and the willingness to communicate with the in-house community. In times past astronomers communicated with one another about observing, equipment, data, results – and anything relevant. That level of communication is now handled in a totally different vein, and very probably to the detriment of the ideas, tasks, and problems of the individual. Our research institutes are like microcosms of the world outside – people sitting next to one another and communicating energetically, but not with one another; each is talking by phone to someone quite different, and distant. In the research institute each person is in a closed environment, linked by computer to the world at large but unaware of the need of the person in the adjacent office to discuss this or that. Inevitably, ideas and the seeding of good projects suffer. As a parallel, people now attend conferences in virtual mode, which is tantamount to sitting at home and reading the papers behind each talk, whereas the irreplaceable benefit of attending a conference in person is to exchange ideas and to gain new thoughts, often serendipitously, by direct communication with people, mostly face to face. . . . When there is a power cut at the institute where I work, I can walk along the corridors and hear unfamiliar sounds – people actually talking to one another. It would be amusing, were it not for the realization that we are in grave danger of losing that most vital aspect of research – to chance to pick up new thoughts and ideas by bouncing our present ideas off other people.”

”Really I don’t think we have lost something, at least as science content. But in a century (this century) so many things changed in our societies and our everyday life that the way we look at the sky has changed. We work, not wonder. Keeping an outreach activity can help us to wonder still.”

”The answer should be nothing, since the ‘unknown’ does not belong to our knowledge. However, it is surprising to see so many crowd teams searching for ‘lost information’ on asteroids, stellar variations, galaxy clusters, etc. using the free access files from ground and space observatories. Not a bread crumb is lost! But it is true that we are losing something: from the media we are presently overwhelmed by an explosive production of research in a wide range of topics, from the study of the surface of Moon and Mars to the exoplanets, from exotic interstellar molecules to small and supermassive black holes and to the deep Universe. This prevents common persons (by also myself!) to have a comprehensive view of the new Astronomy. I need a two-lines frame for my grandchildren.”

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

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

Food for Thought

This month’s thought-provoking statement is:

When we are still researching the topic of mixing and surface elemental abundances, what is it in the Physics of the problem that we do not yet understand?
Is it convection? (If so, what aspect?) Or nucleosynthesis? (If so, which reactions and why?) Something else?

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)

The halo of M 105 and its group environment as traced by planetary nebula populations – II. Using kinematics of single stars to unveil the presence of intragroup light around the Leo I galaxies NGC 3384 and M 105

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Context: M 105 (NGC 3379) is an early-type galaxy in the nearby Leo I group, the closest galaxy group to contain all galaxy types and therefore an excellent environment to explore the low-mass end of intra-group light (IGL) assembly.
Aims: We present a new and extended kinematic survey of planetary nebulae (PNe) in M 105 and the surrounding $30' \times 30'$ in the Leo I group with the Planetary Nebula Spectrograph (PN.S) to investigate kinematically distinct populations of PNe in the halo and the surrounding IGL.
Methods: We use PNe as kinematic tracers of the diffuse stellar light in the halo and IGL, and employ photo-kinematic Gaussian mixture models to (i) separate contributions from the companion galaxy NGC 3384, and (ii) associate PNe with structurally defined halo and IGL components around M 105.
Results: We present a catalogue of 314 PNe in the surveyed area and firmly associate 93 of these with the companion galaxy NGC 3384 and 169 with M 105. The PNe in M 105 are further associated with its halo (138) and the surrounding exponential envelope (31). We also construct smooth velocity and velocity dispersion fields and calculate projected rotation, velocity dispersion, and λ_R profiles for the different components. PNe associated with the halo exhibit declining velocity dispersion and rotation profiles as a function of radius, while the velocity dispersion and rotation of the exponential envelope increase notably at large radii. The rotation axes of these different components are strongly misaligned.
Conclusions: Based on the kinematic profiles, we identify three regimes with distinct kinematics that are also linked to distinct stellar population properties: (i) the rotating core at the centre of the galaxy (within 1 $R_{\rm eff}$) formed in situ and is dominated by metal-rich ([M/H] ≈ 0) stars that also likely formed in situ, (ii) the halo from 1 to 7.5 $R_{\rm eff}$ consisting of a mixture of intermediate-metallicity and metal-rich stars ([M/H] > -1), either formed in situ or was brought in via major mergers, and (iii) the exponential envelope reaching beyond our farthest data point at 16 $R_{\rm eff}$, predominately composed of metal-poor ([M/H] < -1) stars. The high velocity dispersion and moderate rotation of the latter are consistent with those measured for the dwarf satellite galaxies in the Leo I group, indicating that this exponential envelope traces the transition to the IGL.

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Spinning up the surface: evidence for planetary engulfment or unexpected angular momentum transport?

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In this paper, we report the potential detection of a nonmonotonic radial rotation profile in a low-mass lower-luminosity giant star. For most low- and intermediate-mass stars, the rotation on the main sequence seems to be close to rigid. As these stars evolve into giants, the core contracts and the envelope expands, which should suggest a radial rotation profile with a fast core and a slower envelope and surface. KIC 9267654, however, seems to show a surface rotation rate that is faster than its bulk envelope rotation rate, in conflict with this simple angular momentum conservation argument. We improve the spectroscopic surface constraint, show that the pulsation frequencies are consistent with the previously published core and envelope rotation rates, and demonstrate that the star does not show strong chemical peculiarities. We discuss the evidence against any tidally interacting stellar companion. Finally, we discuss the possible origin of this unusual rotation profile, including the potential ingestion of a giant planet or unusual angular momentum transport by tidal inertial waves triggered by a close substellar companion, and encourage further observational and theoretical efforts.

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A census of post-AGB stars in Gaia DR3: evidence for a substantial population of Galactic post-RGB stars

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This paper presents the first census of Galactic post-asymptotic giant branch (post-AGB) stars in the Hertzsprung–Russell (HR) diagram. We combined Gaia DR3 parallax-based distances with extinction corrected integrated fluxes and derived luminosities for a sample of 185 stars that had been proposed to be post-AGB stars in the literature. The luminosities allow us to create an HR diagram containing the largest number of post-AGB candidate objects to date. A significant fraction of the objects fall outside the typical luminosity range as covered by theoretical evolutionary post-AGB tracks as well as observed for planetary nebula central stars. These include massive evolved supergiants and lower luminosity objects. Here, we highlight the fact that one-third of the post-AGB candidates are underluminous and we identify these with the recently recognized class of post-red giant branch objects thought to be the result of binary evolution.

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Is thermohaline mixing the full story? Evidence for separate mixing events near the red giant branch bump

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The abundances of mixing–sensitive elements including lithium, [C/N], and ^{12}C/^{13}C are known to change near the red giant branch bump. The explanation most often offered for these alterations is double diffusive thermohaline mixing in the stellar interior. In this analysis, we investigate the ability of thermohaline mixing to explain the observed timing of these chemical depletion events. Recent observational measurements of lithium and [C/N] show that the abundance of lithium decreases before the abundance of [C/N], whereas numerical simulations of the propagation of the thermohaline mixing region computed with MESA show that the synthetic abundances drop simultaneously. We therefore conclude that thermohaline mixing alone cannot explain the distinct events of lithium depletion and [C/N] depletion, as the simultaneity predicted by simulations is not consistent with the observation of separate drops. We thus invite more sophisticated theoretical explanations for the observed temporal separation of these chemical depletion episodes as well as more extensive observational explorations across a range of masses and metallicities.

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Do all low-mass stars undergo extra mixing processes?

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Standard stellar evolution models that only consider convection as a physical process to mix material inside of stars predict the production of significant amounts of ^{3}He in low-mass stars ($M < 2$ M$_\odot$), with peak abundances of ^{3}He/H $\sim$ few $\times 10^{-3}$ by number. Over the life-time of the Galaxy, this ought to produce ^{3}He/H abundances that diminish with increasing Galactocentric radius. Observations of ^{3}He$^+$ in H II regions throughout the Galactic disk, however, reveal very little variation in the ^{3}He abundance with values of ^{3}He/H similar to the primordial abundance, $(^3\mathrm{He/H})_\mathrm{p} \sim 10^{-5}$. This discrepancy, known as the "^{3}He Problem", can be resolved by invoking in stellar evolution models an extra-mixing mechanism due to the thermohaline instability. Here, we observe ^{3}He$^+$ in the planetary nebula J320 (PN G190.3−17.7) with the Jansky Very Large Array (JVLA) to confirm a previous ^{3}He$^+$ detection made with the VLA that supports standard stellar yields. This measurement alone indicates that not all stars undergo extra mixing. Our more sensitive observations do not detect ^{3}He$^+$ emission from J320 with an RMS noise of 58.8 μJy beam^{-1} after smoothing the data to a velocity resolution of 11.4 km s^{-1} . We estimate an abundance limit of ^{3}He/H $\leq 2.75 \times 10^{-3}$ by number using the numerical radiative transfer code NEBULA. This result nullifies the last significant detection of ^{3}He$^+$ in a PN and allows for the possibility that all stars undergo extra mixing processes.

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Evidence for past interaction with an asymmetric circumstellar shell in the young SNR Cassiopeia A

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Observations of the SNR Cassiopeia A (Cas A) show asymmetries in the reverse shock that cannot be explained by models describing a remnant expanding through a spherically symmetric wind of the progenitor star. We investigate whether a past interaction of Cas A with an asymmetric circumstellar shell can account for the observed asymmetries. We performed 3D MHD simulations that describe the remnant evolution from the SN to its interaction with a circumstellar shell. The initial conditions are provided by a 3D neutrino-driven SN model whose morphology resembles Cas A. We explored the parameter space of the shell, searching for a set of parameters able to produce reverse shock asymmetries at the age of 350 years analogous to those observed in Cas A. The interaction of the remnant with the shell can produce asymmetries resembling those observed in the reverse shock if the shell was asymmetric with the densest portion in the nearside to the northwest (NW). The reverse shock shows the following asymmetries at the age of Cas A: i) it moves inward in the observer frame in the NW region, while it moves outward in other regions; ii) the geometric center of the reverse shock is offset to the NW from the geometric center of the forward shock; iii) the reverse shock in the NW region has enhanced nonthermal emission because, there, the ejecta enter the reverse shock with a higher velocity (between 4000 and 7000 km s^{-1}) than in other regions (below 2000 km s^{-1}). The asymmetries observed in the reverse shock of Cas A can be interpreted as signatures of the interaction of the remnant with an asymmetric circumstellar shell that occurred between 180 and 240 years after the SN event. We suggest that the shell was, most likely, the result of a massive eruption from the progenitor star that occurred between 10^4 and 10^5 years prior to core-collapse. We estimate a total mass of the shell of the order 2 $M_\odot$.

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The structure of jets launched from post-AGB binary systems

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In this paper, we focus on post-asymptotic giant branch (post-AGB) binaries and study the interaction between the different components of these complex systems. These components comprise the post-AGB primary, a main sequence secondary, a circumbinary disk, as well as a fast bipolar outflow (jet) launched by the companion. We obtained well-sampled time series of high resolution optical spectra over the last decade and these spectra provide the basis of our study.
Aims: We aim to use the time-series data to quantify the velocity and density structure of the jets in nine of these post-AGB binaries. This complements our earlier work and this amounts to the analyses of 16 jet-launching systems in total.
Methods: The jet is detected in absorption, at superior conjunction, when the line of sight towards the primary goes through the bipolar cone. Our spectral time series scan the jets during orbital motion. Our spatio-kinematic model is constrained by these dynamical spectra. We complement this with a radiative-transfer model in which the Balmer series are used to derive total mass-loss rates in the jets.
Results: The jets are found to be wide ($> 30°$) and display an angle-dependent density structure with a dense and slower outer region near the jet cone and a fast inner part along the jet symmetry axes. The deprojected outflow velocities confirm that the companions are main sequence companions. The total mass-loss rates are large (10^{-8}–10^{-5} $M_\odot$ yr^{-1}), from which we can infer that the mass-accretion rates onto the companion star must be high as well. The circumbinary disk is likely the main source for the accretion disk around the companion. All systems with full disks that start near the sublimation radius show jets, whereas for systems with evolved transition disks this lowers to a detection rate of 50%. Objects without an infrared excess do not show jets.
Conclusions: We conclude that jet creation in post-AGB binaries is a mainstream process. Our geometric spatio-kinematic model is versatile enough to model the variety of spectral time series. The interaction between the circumbinary disks and the central binary provide the needed accretion flow, but the presence of a circumbinary disk does not seem to be the only prerequisite to launch a jet.

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Core-collapse supernovæ in dense environments – particle acceleration and non-thermal emission

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Supernova remnants are known to accelerate cosmic-rays from the detection of non-thermal emission in radio waves, X-rays, and γ-rays. However, the ability to accelerate cosmic-rays up to PeV energies has yet to be demonstrated. The presence of cut-offs in the gamma-ray spectra of several young SNRs led to the idea that PeV energies might only be achieved during the first years of a remnant's evolution. We use our time-dependent acceleration-code RATPaC to study the acceleration of cosmic-rays in supernovæ expanding into dense environments around massive stars. We performed spherically symmetric 1-D simulations in which we simultaneously solve the transport equations for cosmic-rays, magnetic turbulence, and the hydrodynamical flow of the thermal plasma in the test-particle limit. We investigated typical CSM parameters expected around RSG and LBV stars for freely expanding winds and accounted for the strong γ–γ absorption in the first days after explosion. The maximum achievable particle energy is limited to below 600 TeV even for largest considered values of the magnetic field and mass-loss rates. The maximum energy is not expected to surpass 200 TeV and 70 TeV for LBVs and RSGs that experience moderate mass-loss prior to the explosion. We find γ-ray peak luminosities consistent with current upper limits and evaluated that current-generation instruments are able to detect the γ-rays from Type IIP explosions at distances up to 60 kpc and Type IIn explosions up to 1.0 Mpc. We also find a good agreement between the thermal X-ray and radio synchrotron emission predicted by our models with a range of observations.

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Detailed spectroscopy of post-AGB supergiant GSC 04050−02366 in IRAS Z02229+6208 IR source system

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In the optical spectra of the cold post-AGB supergiant GSC 04050−02366, obtained with the 6-meter BTA telescope with a spectral resolution of $R \geq 60\,000$ on arbitrary dates over 2019÷2021, a radial velocity variability is found. Heliocentric $V_{\rm r}$ based on the positional measurements of numerous absorptions varies from date to date with a standard deviation of $\Delta V_{\rm r} \approx 1.4$ km s^{-1} about the average value of $V_{\rm r} = 24.75$ km s^{-1}, which may stem out of the low-amplitude pulsations in the atmosphere. The spectra of the star are purely absorption type, there are no obvious emissions. Intensity variability of most of absorptions and Swan bands of the C_2 molecule was discovered. A slight asymmetry of the Hα profile is observed at some observation dates. The position of Hα absorption core varies within 27.3÷30.6 km s^{-1}. Splitting into two components (or asymmetry) of strong low-excitation absorptions (Y II, Zr II, Ba II, La II, Ce II, Nd II) was found. The position of the long-wavelength component coincides with the position of other photospheric absorptions, which confirms its formation in the atmosphere of the star. The position of the shortwave component is close to the position of the rotational features of Swan bands, which indicates its formation in the circumstellar envelope expanding at a velocity of about $V_{\rm exp} = 16$ km s^{-1}.

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Infrared spectroscopy of the 2019 eruption of the recurrent nova V3890 Sgr: separation into equatorial and polar winds revealed

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We present infrared spectroscopy of the 2019 eruption of the recurrent nova V3890 Sgr, obtained over the period 5.10–46.3 days after the eruption. The spectrum of the red giant became more prominent as the flux declined, and by day 46.3 dominated the spectrum. Hydrogen and helium emission lines consisted of a narrow component superposed on a broad pedestal. The full width at half maximum of the narrow components declined with time t as the eruption progressed, as $t^{-0.74}$, whereas those of the broad components remained essentially constant. Conversely, the line fluxes of the narrow components of Paβ remained roughly constant, while those of the broad components declined by a factor ~ 30 over a period of $\lesssim 25$ days. The behaviour of the broad components is consistent with them arising in unencumbered fast-flowing ejecta perpendicular to the binary plane, in material that was ejected in a short ~ 3.3-day burst. The narrow components arise in material that encounters the accumulated circumstellar material. The outburst spectra were rich in coronal lines. There were two coronal line phases, one that originated in gas ionised by supersoft X-ray source, the other in shocked gas. From the relative fluxes of silicon and sulphur coronal lines on day 23.4 – when the emitting gas was shocked – we deduce that the temperature of the coronal gas was 9.3×10^5 K, and that the abundances are approximately solar.

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Searching for nascent planetary nebulæ: OHPNe candidates in the SPLASH survey

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The evolution of asymptotic giant branch stars from the spherical symmetry into the diverse shapes of planetary nebulæ (PNe) is a topic of intensive research. Young PNe provide a unique opportunity to characterize the onset of this transitional phase. In particular, OH maser-emitting PNe (OHPNe) are considered nascent PNe. In fact, only 6 OHPNe have been confirmed to date. In order to identify and characterise more OHPNe, we processed the unpublished continuum data of the interferometric follow-up of the Southern Parkes Large-Area Survey in Hydroxyl (SPLASH). We then matched the interferometric positions of OH maser and radio continuum emission, considering the latter as a possible tracer of free–free emission from photoionized gas, characteristic of PNe. We report 8 objects with a positive coincidence, 4 of which are classified as candidate OHPNe here for the first time (IRAS 16372−4808, IRAS 17494−2645, IRAS 18019−2216 and OH 341.6811+00.2634). Available evidence strongly indicates that they are evolved stars, while the comparison with confirmed OHPNe indicates that they are likely to be PNe. Their final confirmation as bona fide PNe, however, requires optical/infrared spectroscopy. The obtained spectral indices of the radio continuum emission (between $\simeq 0.4$–1.3) are consistent with partially optically thick free–free emission from photoionized gas. Also, they cluster in the same region of a WISE colour–colour diagram as that of the confirmed OHPNe ($9.5 \lesssim [3.4] - [22] \lesssim 13.5$, and $4.0 \lesssim [4.6] - [12] \lesssim 7.0$), thus this diagram could help to identify more OHPNe candidates in the future.

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Evidence of deep mixing in IRS 7, a cool massive supergiant member of the Galactic nuclear star cluster

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The center of the Milky Way contains stellar populations spanning a range in age and metallicity, with a recent star formation burst producing young and massive stars. Chemical abundances in the most luminous stellar member of the Nuclear Star Cluster (NSC), IRS 7, are presented for ^{19}F, ^{12}C, ^{13}C, ^{14}N, ^{16}O, ^{17}O, and Fe from an LTE analysis based on spherical modeling and radiative transfer with a 25-$M_\odot$ model atmosphere, whose chemistry was tailored to the derived photospheric abundances. We find IRS 7 to be depleted heavily in both ^{12}C (~ -0.8 dex) and ^{16}O (~ -0.4 dex), while exhibiting an extremely enhanced ^{14}N abundance ($\sim +1.1$ dex), which are isotopic signatures of the deep mixing of CNO-cycled material to the stellar surface. The ^{19}F abundance is also heavily depleted by ~ 1 dex relative to the baseline fluorine of the nuclear star cluster, providing evidence that fluorine along with carbon constrain the nature of the deep mixing in this very luminous supergiant. The abundances of the minor isotopes ^{13}C and ^{17}O are also derived, with ratios of ^{12}C/^{13}C ~ 5.3 and ^{16}O/^{17}O ~ 525. The derived abundances for IRS 7, in conjunction with previous abundance results for massive stars in the NSC, are compared with rotating and non-rotating models of massive stars and it is found that the IRS 7 abundances overall follow the behavior predicted by stellar models. The depleted fluorine abundance in IRS 7 illustrates, for the first time, the potential of using the ^{19}F abundance as a mixing probe in luminous red giants.

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Discovery of hot subdwarfs covered with helium-burning ash

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Helium rich subdwarf O stars (sdOs) are hot compact stars in a pre-white dwarf evolutionary state. Most of them have effective temperatures and surface gravities in the range $T_{\rm eff} = 40\,000$–$50\,000$ K and $\log g = 5.5$–6.0. Their atmospheres are helium dominated. If present at all, C, N, and O are trace elements. The abundance patterns are explained in terms of nucleosynthesis during single star evolution (late helium core flash) or a binary He-core white dwarf merger. Here we announce the discovery of two hot hydrogen-deficient sdOs (PG 1654+322 and PG 1528+025) that exhibit unusually strong carbon and oxygen lines. A non-LTE model atmosphere analysis of spectra obtained with the Large Binocular Telescope and by the LAMOST survey reveals astonishingly high abundances of C ($\approx 20\%$) and O ($\approx 20\%$) and that the two stars are located close to the helium main sequence. Both establish a new spectroscopic class of hot H-deficient subdwarfs (CO-sdO) and can be identified as the remnants of a He-core white dwarf that accreted matter of a merging low-mass CO-core white dwarf. We conclude that the CO-sdOs represent an alternative evolutionary channel creating PG 1159 stars besides the evolution of single stars that experience a late helium-shell flash.

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Interpolation of spectra from 3D model atmospheres

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The use of 3D hydrodynamical simulations of stellar surface convection for model atmospheres is computationally expensive. Although these models have been available for quite some time, their use is limited because of the lack of extensive grids of simulations and associated spectra. Our goal is to provide a method to interpolate spectra that can be applied to both 1D and 3D models, and implement it in a code available to the community. This tool will enable the routine use of 3D model atmospheres in the analysis of stellar spectra.
We have developed a code that makes use of radial basis functions to interpolate the spectra included in the CIFIST grid of 84 three-dimensional model atmospheres. Spectral synthesis on the hydrodynamical simulations was previously performed with the code ASS∈T. We make a tool for the interpolation of 3D spectra available to the community. The code provides interpolated spectra and interpolation errors for a given wavelength interval, and a combination of effective temperature, surface gravity, and metallicity. In addition, it optionally provides graphical representations of the RMS and mean ratio between 1D and 3D spectra, and maps of the errors in the interpolated spectra across the parameter space.

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SN 2020jfo: a short-plateau type II supernova from a low-mass progenitor

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We present spectroscopic and photometric observations of the Type IIP supernova, SN 2020jfo, in ultraviolet and optical wavelengths. SN 2020jfo occurred in the spiral galaxy M 61 (NGC 4303), with eight observed supernovæ in the past 100 years. SN 2020jfo exhibited a short plateau lasting < 65 d, and achieved a maximum brightness in V-band of $M_V = -17.4 \pm 0.4$ mag at about 8.0 ± 0.5 d since explosion. From the bolometric light curve, we have estimated the mass of ^{56}Ni synthesized in the explosion to be 0.033 ± 0.006 M$_\odot$. The observed spectral features are typical for a Type IIP supernova except for shallow Hα absorption throughout the evolution and the presence of stable ^{58}Ni feature at 7378 Å, in the nebular phase. Using hydrodynamical modelling in the MESA + STELLA framework, an ejecta mass of ~ 5 M$_\odot$ is estimated. Models also indicate SN 2020jfo could be the result of a red supergiant progenitor with $M_{\rm ZAMS} \sim 12$ M$_\odot$. Bolometric light curve modeling revealed the presence of a secondary radiation source for initial ~ 20 d, which has been attributed to interaction with a circumstellar material of mass ~ 0.2 M$_\odot$, which most likely was ejected due to enhanced mass loss about 20 years prior to the supernova explosion.

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Evolutionary status of selected post-AGB single and binary stars in Gaia DR3

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Gaia data are helping to further understand the evolutionary status of post-AGB and related stars. In this paper we present an analysis of Gaia DR3 data of post-AGB stars and post-AGB binaries with accurate parallaxes. Gaia DR3 data of 44 post-AGB candidates are analyzed, including 16 post-AGB binary candidates. Of these, 19 stars have RUWE values > 1.4. For several stars, the calculated absolute luminosities confirm that they are indeed in post-AGB evolutionary stage. We find that 12 stars have relatively lower luminosities; some of them may be post-RGB stars and some may be post-HB stars. We find that IRAS 01427+4633 (BD +46°442), IRAS 16230−3410, and IRAS 19199+3950 (HP Lyr) are evolved high-velocity stars.

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Three-dimensional imaging of convective cells in the photosphere of Betelgeuse

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Aims: Understanding convection in red supergiants and the mechanisms that trigger the mass loss from these evolved stars are the general goals of most observations of Betelgeuse and its inner circumstellar environment.

Methods: Linear spectropolarimetry of the atomic lines of the spectrum of Betelgeuse reveals information about the three-dimensional (3D) distribution of brightness in its atmosphere. We model the distribution of plasma and its velocities and use inversion algorithms to fit the observed linear polarization.
Results: We obtain the first 3D images of the photosphere of Betelgeuse. Within the limits of the used approximations, we recover vertical convective flows and measure the velocity of the rising plasma at different heights in the photosphere. In several cases, we find this velocity to be constant with height, indicating the presence of forces other than gravity acting on the plasma and counteracting it. In some cases, these forces are sufficient to maintain plasma rising at 60 km s^{-1} to heights where this velocity is comparable to the escape velocity.
Conclusions: Forces are present in the photosphere of Betelgeuse that allow plasma to reach velocities close to the escape velocity. These mechanisms may suffice to trigger mass loss and sustain the observed large stellar winds of these evolved stars.

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Conference Papers

Sudden dimming of the symbiotic Mira HM Sge

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The symbiotic Mira HM Sge has dimmed considerably over the last year, beyond what is expected of its pulsation-related variability. HM Sge is composed of a cool oxygen-rich AGB star accreting onto a hotter white dwarf companion. The system brightened 6 mag in the optical in 1975 as a result of a Nova-like outburst. It has since dimmed and plateaued in the visible, while gradually growing in brightness in the near-IR over the past 15 yr (0.092 mag yr^{-1}). Within the last year, however, the brightness has dropped by 1.52 mag in the I-band. While the system is expected to be near its pulsation minimum, the brightness is below the values expected of the last three pulsation cycles, and appears independent of the system's fundamental mode pulsations. We suspect this may be the result of a change in the orientation of the system or episodic mass loss.

Oral contribution, published in Research Notes of the AAS
Available from https://iopscience.iop.org/article/10.3847/2515-5172/ac8808

Route towards complete 3D hydro-chemical simulations of companion-perturbed AGB outflows

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Low- and intermediate-mass stars experience a significant mass loss during the last phases of their evolution, which obscures them in a vast, dusty envelope. Although it has long been thought this envelope is generally spherically symmetric in shape, recent high-resolution observations find that most of these stars exhibit complex and asymmetrical

morphologies, most likely resulting from binary interaction. In order to improve our understanding about these systems, theoretical studies are needed in the form of numerical simulations. Currently, a handful of simulations exist, albeit they mainly focus on the hydrodynamics of the outflow. Hence, we here present the pathway to more detailed and accurate modelling of companion-perturbed outflows with PHANTOM, by discussing the missing but crucial physical and chemical processes. With these state-of-the-art simulations we aim to make a direct comparison with observations to unveil the true identity on the embedded systems.

Oral contribution, published in IAU Symposium No. 366, 2021 "The Origin of Outflows in Evolved Stars"
Available from https://arxiv.org/abs/2206.12278

Job Advert

Two post-doctoral positions on cool evolved stars

Applications are invited for two post-doctoral positions in observations of cool evolved stars at the Universidad Andres Bello in Santiago, Chile.

The successful applicants will work with Prof. Keiichi Ohnaka on the analysis and interpretation optical/infrared observations of cool evolved stars such as AGB stars and red supergiants, in particular data obtained with high angular resolution techniques. Experience in high angular resolution observations such as adaptive optics and optical/infrared interferometry and/or research on cool evolved stars can be an asset but not mandatory. The successful applicants will have access to the 10% of the telescope time on international facilities in Chile, such as VLT, VLT-Interferometer, ALMA, Gemini-South, CTIO, and Magellan. The starting date can be flexible. The appointment will be for two years for both positions.

The Institute of Astrophysics at the Universidad Andres Bello currently has 12 faculty members working on stellar astrophysics, extragalactic astrophysics, and cosmology, four post-docs, and 22 Ph.D. students as well as several dozens of undergraduate students.

Interested applicants should submit a CV, publication list, description of research interests and arrange three letters of reference directly sent to Prof. Keiichi Ohnaka (k1.ohnaka@gmail.com). Applications submitted by September 30, 2022 will receive full consideration.

See also https://jobregister.aas.org/ad/f9aae82e