THE AGB NEWSLETTER

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Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

Editorial

Dear Colleagues,

It is a pleasure to present you the 266$^{\rm th}$ issue of the AGB Newsletter, featuring no fewer than two papers on triple central stars of planetary nebulæ, two papers on R Doradus, and three on IRC +10°216!

Unfortunately we must bring you the sad news that Alfred Glassgold has died. Many of us will know his work, if not him personally. Please read the inspirational obituary overleaf, kindly written by Joan Najita.

On a positive note, there's a Ph.D. position open to work with Elvire De Beck, at Chalmers in Sweden.

Also have a look at the announcements asking for your input – one in preparation for meetings on planetary nebulæ and another on the new IAU ombud.

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

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

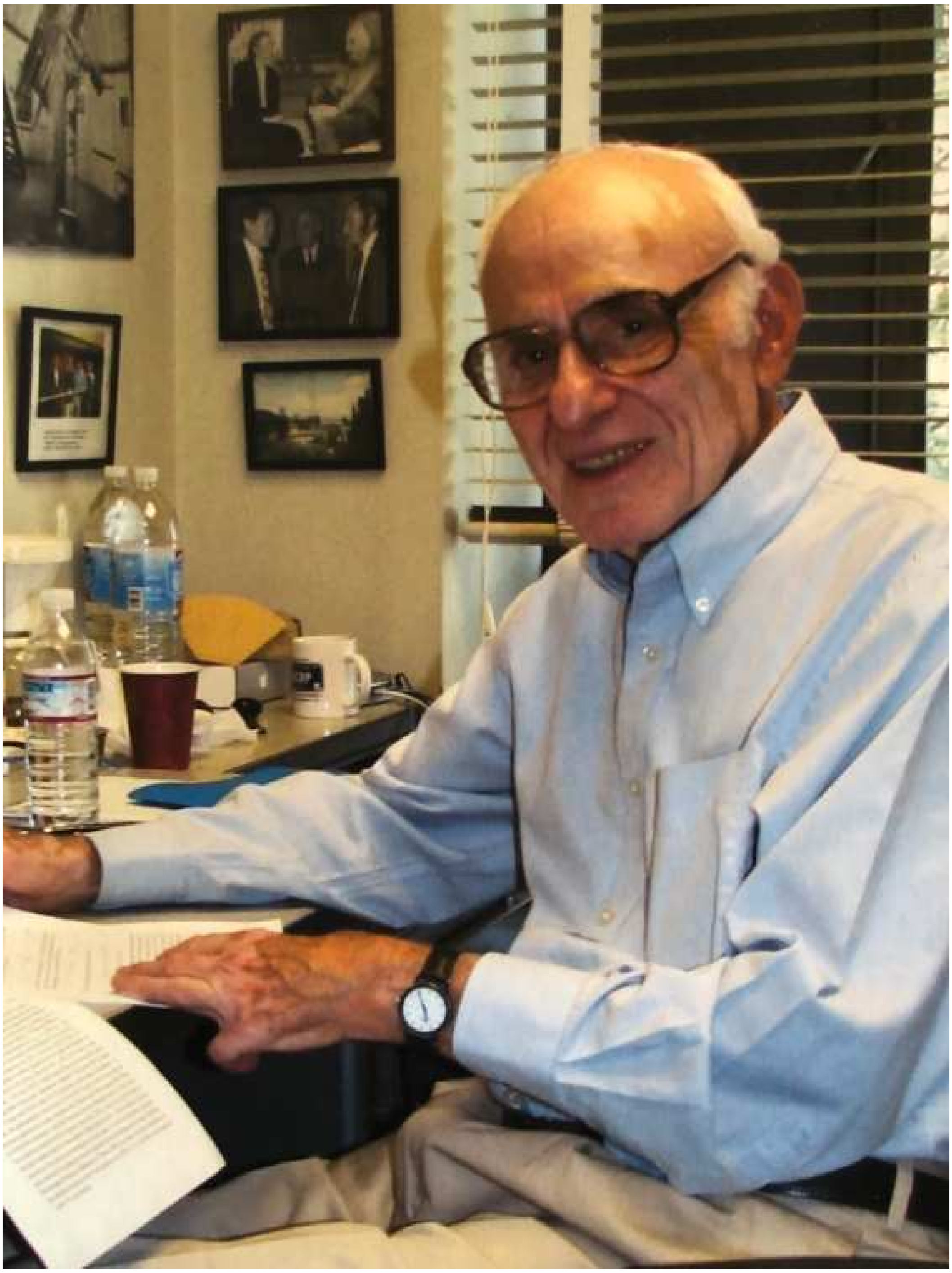
Food for Thought

This month's thought-provoking statement is:

Besides intrinsic reaction rates, what uncertainties affect the nucleosynthesis inside red giants and supergiants most?

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)

Alfred E. Glassgold
20 July 1929 – 4 January 2019



Alfred Glassgold, an atomic and nuclear physicist who became an astrophysicist and astrochemist, died in San Francisco on 4 January 2019. His work progressed from atomic nuclei and superfluidity, to interstellar clouds and circumstellar envelopes, to winds from young stars and the birthplaces of planets, illuminating our understanding of these regions of the cosmos. A versatile physicist who was active in teaching and research well into his 80s, he was also a treasured colleague and mentor.

Born 20 July 1929 and raised in Philadelphia, Al was an accomplished clarinetist, who initially considered a career in music but ultimately chose physics as his lifelong pursuit. As an undergraduate, he majored in Physics at the University of Pennsylvania. He later studied theoretical nuclear physics with Victor Weisskopfs group, obtaining his Ph.D. from MIT in 1954. For his postdoctoral studies, Al moved to UC Berkeley, where he worked on problems in statistical mechanics with applications to atomic physics, superfluidity, and nuclear physics. For a few years, he taught with Edward Teller, physics courses to UC students.

In 1963, Al moved with his wife and two children to New York, where he joined the physics faculty at NYU. He was an integral member of the University for 36 years, serving as head of the academic senate as well as chair of the Physics Department during an important period when the department was growing rapidly and its new building was planned and constructed.

Although his initial background was in atomic and nuclear physics, Als research interests turned to astrophysics in the early 1970s, as a result of the detection of interstellar molecules made by the Charles Townes group using microwave techniques as well as UV observations of interstellar molecules made from space. Simple interstellar molecules had been detected in absorption as early as 1937. However, the detection of molecular emission and the discovery of polyatomic molecules (e.g., ammonia, water) opened up many new avenues of study.

Inspired to use his knowledge of atomic physics to understand the physical conditions in the interstellar medium, Al went to UC Berkeley for a summer to work with Townes, who shared his interest in this topic. It was the beginning of his career as an astrophysicist and an astrochemist. Throughout the 1970s and 1980s, Al and his collaborators, students, and postdocs studied the thermal, chemical, and ionization structure of interstellar clouds and the circumstellar envelopes of late-type stars.

In 1990, Al spent a sabbatical year at UC Berkeley, and his research interests changed direction once again. At the time, Berkeley was a lively focal point for studies on the origins of stars and planets. Als astrochemistry expertise complemented the theoretical and observational interests of the star and planet formation group, and he began long-term collaborations with Frank Shu and others. His insights contributed to our understanding of the important role atomic winds play in driving molecular outflows and solving a stars angular momentum problem, i.e. understanding how stars remove enough angular momentum to allow their assembly to proceed.

Als work on winds also led to studies of protoplanetary disks, the rotationally supported structures around young stars that are the birthplaces of planets. Over the past two decades, he led fundamental work on the ionization structure of disks as well as the molecular and atomic diagnostics that are used to understand their chemical and dynamical nature. These studies demonstrated that stellar X-rays, not cosmic rays, are primarily responsible for disk ionization. The ionization structure of disks governs how they interact with magnetic fields and how they evolve dynamically. Further studies on disk chemistry illustrated how water and other simple molecules can be synthesized in disk atmospheres, and how atmospheres can be heated enough to produce observable emission features, i.e. the signposts that provide clues to their nature.

Much of this later work was carried out after 2000, when Al retired from NYU and joined the UC Berkeley Astronomy faculty. He continued to teach and advise students and postdocs until just a few years ago. Throughout his life, Al read widely on all subjects and enjoyed music, art, and food. Since moving to San Francisco, he had also been closely involved in the political life of the city.

Al is remembered not only for his research accomplishments but also as a treasured mentor and colleague. Unfailingly polite and with a playful sense of humor, he welcomed and encouraged colleagues of diverse backgrounds, including many women astronomers. He is survived by his wife Irene and children, Judith and Eric Glassgold. He is much missed.

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Refereed Journal Papers

ALMA monitoring of mm line variation in IRC +10°216: I. Overview of millimeter variability

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Temporal variation of millimeter lines is a new direction of research for evolved stars. It has the potential to probe the dynamical wind launching processes from time dimension. We report here the first ALMA (Atacama Large Millimeter Array) results that cover 817 days of an on-going monitoring of 1.1 mm lines in the archetypal carbon star IRC +10°216. The monitoring is done with the compact 7-m array (ACA) and in infrared with a 1.25-m telescope in Crimea. A high sensitivity of the cumulative spectra covering a total of $\sim$ 7.2 GHz between 250–270 GHz range has allowed us to detect about 148 known transitions of 20 molecules, together with more of their isotopologues, and 81 unidentified lines. An overview of the variabilities of all detected line features are presented in spectral plots. Although a handful of lines are found to be very possibly stable in time, most other lines are varying either roughly in phase or in anti-correlation with the near-infrared light. Several lines have their variations in the ALMA data coincident with existing single dish monitoring results, while several others do not, which requires an yet unknown mechanism in the circumstellar envelop to explain.

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Available from https://arxiv.org/abs/1904.07114

Inclined jets inside a common envelope of a triple stellar system

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We conduct a three-dimensional hydrodynamical simulation to study the interaction of two opposite inclined jets inside the envelope of a giant star, and find that the jets induce many vortices inside the envelope and that they efficiently remove mass from the envelope and form a very clumpy outflow. We assume that this very rare type of interaction occurs when a tight binary system enters the envelope of a giant star, and that the orbital plane of the tight binary system and that of the triple stellar system are inclined to each other. We further assume that one of the stars of the tight binary system accretes mass and launches two opposite jets and that the jets' axis is inclined to the angular momentum axis of the triple stellar system. The many vortices that the jets induce along the orbit of the tight binary system inside the giant envelope might play an important role in the common envelope evolution (CEE) by distributing energy in the envelope. The density fluctuations that accompany the vortices lead to an outflow with many clumps that might facilitate the formation of dust. This outflow lacks any clear symmetry, and it might account for very rare types of 'messy' planetary nebulæ and 'messy' nebulæ around massive stars. On a broader scope, our study adds to the notion that jets can play important roles in the CEE, and that they can form a rich variety of shapes of nebulæ around evolved stars.

Submitted to a journal
Available from https://arxiv.org/abs/1907.13175

Modelling depletion by re-accretion of gas from a dusty disc in post-AGB stars

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Many disc-type post-asymptotic giant branch (post-AGB) stars are chemically peculiar, showing underabundances of refractory elements in their photospheres that correlate with condensation temperature. The aim of this paper is to investigate how accretion from a circumbinary disc can cause this phenomenon of depletion and how this impacts the evolution of post-AGB stars. We used the MESA code to evolve stars in the post-AGB phase, while including accretion of metal-poor gas. We compared the models to a sample of 58 observed disc-type post-AGB stars with chemical abundance data. For each of these stars, we estimated the luminosity and the mass using the Gaia distance. We modelled the accretion rate onto the binary from a viscously evolving disc for a range of initial accretion rates and disc masses. We find that large initial accretion rates ($\gtrsim 3 \times 10^{-7}$ M$_\odot$ yr^{-1}) and large initial disc masses ($\sim 10^{-2}$ $M_\odot$) are needed to reproduce the observed depleted post-AGB stars. Based on these high accretion rates, the evolution timescale of post-AGB stars can be significantly extended by a factor between two and five. We distinguish depletion patterns that are unsaturated (plateau profile) from those that are saturated, and we expect that post-red giant branch (post-RGB) stars are much more likely to show an unsaturated abundance pattern compared to post-AGB stars. Finally, because of the slower evolution of the low-mass post-RGB stars, we find that these systems can become depleted at lower effective temperatures (< 5000 K). We conclude that accretion from a circumbinary disc successfully accounts for the chemical peculiarity of post-AGB stars.

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Available from https://arxiv.org/abs/1908.01788

The nascent wind of AGB star R Doradus: evidence for a recent episode of enhanced mass loss

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We analyse ALMA observations of the SO($J_K = 6_5$–5_4) emission of the circumstellar envelope of oxygen-rich AGB star R Dor, probing distances between 20 and 100 au from the star where the nascent wind is building up. We give evidence for the slow wind to host, in addition to a previously observed rotating disc, a radial outflow covering very large solid angles and displaying strong inhomogeneity both in direction and radially: the former takes the form of multiple cores and the latter displays a radial dependence suggesting an episode of enhanced mass loss having occurred a century or so ago.

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Available from https://arxiv.org/abs/1908.03311

Systematic search for stellar pulsators in the eclipsing binaries observed by *Kepler*

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Eclipsing binaries (EBs) are unique targets for measuring precise stellar properties and constrain stellar evolution models. In particular, it is possible to measure at the percent level masses and radii of both components of a double-lined spectroscopic EB. Since the advent of high-precision photometric space missions (MOST, CoRoT, *Kepler*, BRITE, TESS), the use of stellar pulsation properties to infer stellar interiors and dynamics constitutes a revolution for low-mass star studies. The *Kepler* mission has led to the discovery of thousands of classical pulsators such as δ Scuti and solar-like oscillators (main sequence and evolved), but also almost 3000 EBs with orbital periods shorter than 1100 days. We report the first systematic search for stellar pulsators in the entire *Kepler* eclipsing binary catalog. The focus is mainly aimed at discovering δ Scuti, γ Doradus, red giant, and tidally excited pulsators. We developed a data inspection tool (DIT) that automatically produces a series of plots from the *Kepler* light-curves that allows us to visually identify whether stellar oscillations are present in a given time series. We applied the DIT to the whole *Kepler* eclipsing binary database and identified 303 systems whose light curves display oscillations, including 163 new discoveries. A total of 149 stars are flagged as δ Scuti (100 from this paper), 115 stars as γ Doradus (69 new), 85 stars as red giants (27 new), 59 as tidally excited oscillators (29 new). There is some overlap among these groups, as some display several types of oscillations. Despite many of these systems are likely to be false positives, i.e. when an EB light curve is blended with a pulsator, this catalog gathers a vast sample of systems that are valuable for a better understanding of stellar evolution.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1908.06773

On the triple-star origin of the planetary nebula Sh 2-71

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Recent studies have indicated that triple star systems may play a role in the formation of an appreciable number of planetary nebulæ, however only one triple central star is known to date (and that system is likely too wide to have had much influence on the evolution of its component stars). Here, we consider the possibility that Sh 2-71 was formed by a triple system which has since broken apart. We present the discovery of two regions of emission, seemingly aligned with the proposed tertiary orbit (i.e. in line with the axis formed by the two candidate central star systems previously considered in the literature). We also perform a few simple tests of the plausibility of the triple hypothesis based on the observed properties (coordinates, radial velocities, distances and proper motions) of the stars observed close to the projected centre of the nebula, adding further support through numerical integrations of binary orbits responding to mass loss. Although a number of open questions remain, we conclude that Sh 2-71 is currently one of the best candidates for planetary nebula formation influenced by triple-star interactions.

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Influence of inelastic collisions with hydrogen atoms on the non-LTE line formation for Fe I and Fe II in the 1D model atmospheres of late-type stars

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Iron plays a crucial role in studies of late-type stars. In their atmospheres, Fe I is the minority species and its lines are subject to the departures from LTE. In contrast, one believes that LTE is a realistic approximation for Fe II lines. The main source of the uncertainties in the non-LTE (NLTE) calculations for cool atmospheres is a treatment of inelastic collisions with hydrogen atoms. We investigate the effect of Fe I + H I and Fe II + H I collisions and their different treatment on the Fe I/Fe II ionisation equilibrium and Fe abundance determinations for Galactic halo benchmark stars HD 84937, HD 122563, and HD 140283 and a sample of 38 very metal-poor giants in the dwarf galaxies with well known

distances. We perform the NLTE calculations for Fe I–II with using quantum-mechanical (QM) rate coefficients for collisions with H I from Barklem (2018, B18), Yakovleva, Belyaev & Kraemer (2018, YBK18), and Yakovleva, Belyaev & Kraemer (2019). We find that collisions with H I serve as efficient thermalisation processes for Fe II and the NLTE abundance corrections for Fe II lines do not exceed 0.02 dex at [Fe/H] > -3 and reach $+0.06$ dex at [Fe/H] ~ -4. For given star, the B18 and YBK18 treatments of Fe I + H I collisions lead to similar average NLTE abundances from Fe I lines, although there exist discrepancies in the NLTE corrections for individual lines. With using QM collisional data and the Gaia based surface gravity, we obtain consistent abundances from Fe I and Fe II for a red giant HD 122563. For HD 84937 and HD 140283, we study the Fe lines in the visible and the UV (1968–2990 Å) range. For both Fe I and Fe II, abundances from the visible and UV lines are consistent. The abundances from Fe I and Fe II agree within 0.10 and 0.13 dex in the YBK18 and B18 cases. The Fe I/Fe II ionisation equilibrium is achieved for each [Fe/H] > -3.5 star of our dwarf galaxy sample.

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Infrared interferometric three-dimensional diagnosis of the atmospheric dynamics of the AGB star R Dor with VLTI/AMBER

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The mechanism of mass loss in late evolutionary stages of low- and intermediate-mass stars is not yet well understood. Therefore, it is crucial to study the dynamics of the region within a few $R_\star$, where the wind acceleration is considered to take place. We present three-dimensional diagnosis of the atmospheric dynamics of the closest asymptotic giant branch (AGB) star R Dor from the low photospheric layers to the extended outer atmosphere – for the first time for a star other than the Sun. The images reconstructed with a spatial resolution of 6.8 mas – seven times finer than the star's angular diameter of 51.2 mas in the continuum – using the AMBER instrument at the Very Large Telescope Interferometer show a large, bright region over the surface of the star and an extended atmosphere. The velocity-field maps over the star's surface and atmosphere obtained from the Mg and H_2O lines near 2.3 μm forming at atmospheric heights below $\sim 1.5\ R_\star$ show little systematic motion beyond the measurement uncertainty of 1.7 km s^{-1}. In marked contrast, the velocity-field map obtained from the CO first overtone lines reveals systematic outward motion at 7–15 km s^{-1} in the extended outer atmosphere at a height of $\sim 1.8\ R_\star$. Given the detection of dust formation at $\sim 1.5\ R_\star$, the strong acceleration of material between ~ 1.5 and 1.8 $R_\star$ may be caused by the radiation pressure on dust grains. However, we cannot yet exclude the possibility that the outward motion may be intermittent, caused by ballistic motion due to convection and/or pulsation.

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XMM–*Newton* observations of the symbiotic recurrent nova T CrB: evolution of X-ray emission during the active phase

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We present an analysis of the XMM–*Newton* observations of the symbiotic recurrent nova T CrB, obtained during its active phase that started in 2015. The XMM–*Newton* spectra of T CrB have two prominent components: a soft one (0.2–0.6 keV), well represented by black-body emission, and a heavily absorbed hard component (2–10 keV), well

matched by optically-thin plasma emission with high temperature ($kT \sim 8$ keV). The XMM–*Newton* observations reveal evolution of the X-ray emission from T CrB in its active phase. Namely, the soft component in its spectrum is decreasing with time while the opposite is true for the hard component. Comparison with data obtained in the quiescent phase shows that the soft component is typical only for the active phase, while the hard component is present in both phases but it is considerably stronger in the quiescent phase. Presence of stochastic variability (flickering) on time-scales of minutes and hours is confirmed both in X-rays and UV (UVM2 filter of the XMM–*Newton* optical monitor). On the other hand, periodic variability of 6000–6500 s is found for the first time in the soft X-ray emission (0.2–0.6 keV) from T CrB. We associate this periodic variability with the rotational period of the white dwarf in this symbiotic binary.

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Optical spectrum of distant OH/IR star V1648 Aql (IRAS 19386+0155)

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An optical spectrum of the star V1648 Aql (= IRAS 19386+0155) was obtained at the 6-meter telescope with a spectral resolution of $R \geq 60\,000$. Heliocentric radial velocity measured from numerous metallic absorptions is equal to $v_{\rm r} = 10.18 \pm 0.05$ km s^{-1} ($v_{\rm LSR} = 18.1$ km s^{-1}). We determined the atmospheric, circumstellar, and interstellar components in the profile of the Na I D lines at $v_{\rm r} = 9.2$, -3.4, and -12.8 km s^{-1} respectively. The averaged over twenty identified DIBs velocity $v_{\rm r}$(DIBs) $= -12.5 \pm 0.2$ km s^{-1} coincides with the interstellar Na I component. Weak emissions with an intensity of about 10% of the local continuum level were detected in the spectrum; they are identified as low-excitation metal lines. Their averaged position, $v_{\rm r} = 8.44 \pm 0.28$ km s^{-1}, may point to the presence of a weak velocity gradient in the upper layers of the stellar atmosphere. Based on the spectroscopic data and taking into account the interstellar and circumstellar reddening, we estimated the star's luminosity $M_V \approx -5$ mag and also obtained the lower estimate of distance $d > 1.8$ kpc. Using the model atmosphere method, we determined the fundamental parameters and chemical abundances in the atmosphere approving the status of a post-AGB star for V1648 Aql.

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Photospheric nitrogen abundances and carbon ^{12}C/^{13}C ratios of red giant stars

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Nitrogen abundances and carbon isotope ratios (^{12}C/^{13}C) in the atmospheres of red giants are known to be influenced by dredge-up of H-burning products and serve as useful probes to study the nature of evolution-induced envelope mixing. We determined the [N/Fe] and ^{12}C/^{13}C ratios for 239 late-G/early-K giant stars by applying the spectrum-fitting technique to the ^{12}CN and ^{13}CN lines in the $\sim$ 8002–8005 Å region, with an aim to investigate how these quantities are related to other similar mixing-affected indicators which were already reported in our previous work. It was confirmed that [N/Fe] values are generally supersolar (typically by several tenths dex though widely differ from star to star), anti-correlated with [C/Fe], and correlated with [Na/Fe], as expected from theory. As seen from their

dependence upon stellar parameters, it appears that mixing tends to be enhanced with an increase of stellar luminosity (or mass) and rotational velocity, which is also reasonable from the theoretical viewpoint. In contrast, the resulting ^{12}C/^{13}C ratios turned out to be considerably diversified in the range of $\sim$ 5–50 (with a peak around $\sim$ 20), without showing any systematic dependence upon C or N abundance anomalies caused by the mixing of CN-cycled material. It thus appears that our understanding on the photospheric ^{12}C/^{13}C ratios in red giants is still incomplete, for which more observational studies would be required.

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Available from https://arxiv.org/abs/1908.07670

The case of NGC 6302: The impact of shocks in the derivation of Nitrogen abundances

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High nitrogen abundance is characteristic of Type I planetary nebulæ as well as their highly filamentary structure. In the present work we test the hypothesis of shocks as a relevant excitation mechanism for a Type-I nebula, NGC 6302, using recently released diagnostic diagrams to distinguish shocks from photo-excitation. The construction of diagrams depends on emission line ratios and kinematical information. NGC 6302 shows the relevance of shocks in peripheral regions and the importance to the whole nebula. Using shocks, we question the usual assumption of ICF calculation, justifying a warning to broadly used abundance derivation methods. From a kinematical analysis, we derive a new distance for NGC 6302 of 805 $\pm$ 143 pc.

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The sub-mm variability of IRC +10°216 and *o* Ceti

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We present the sub-mm variability of two of the most well studied AGB stars, IRC +10°216 and *o* Ceti. The data are obtained at 450 μm and 850 μm as part of pointing calibration observations for the *James Clerk Maxwell* Telescope's SCUBA-2 instrument over a span of 7 years. The periods are derived using non-parametric methods, Gatspy Supersmoother and P4J in order not to assume an underlying shape to the periodicity. These were compared to two Lomb–Scargle parametric methods. We find that for both sources and wavelengths the periods derived from all methods are consistent within 1σ. The 850-μm phase folded light curves of IRC +10°216 show a time lag of $\sim$ 540 days compared to its optical counterpart. We explore the origins of the sub-mm variability and the phase lag using radiative transfer models. Combining the modelling with findings in the literature, we find that the sub-mm emission and phase lag can be partially attributed to the dust formation/destruction cycle. A second, unknown mechanism must be invoked; we defer an investigation of the origin and nature of this mechanism to a future work.

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The Nearby Evolved Stars Survey: I. JCMT/SCUBA-2 sub-millimetre detection of the detached shell of U Antliæ

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We present the highest resolution single-dish submillimetre observations of the detached shell source U Antliæ to date. The observations were obtained at 450 μm and 850 μm with SCUBA-2 instrument on the *James Clerk Maxwell* Telescope as part of the Nearby Evolved Stars Survey. The emission at 850 μm peaks at 40″ with hints of a second peak seen at $\sim 20''$. The emission can be traced out to a radius of 56″ at a 3σ level. The outer peak observed at 850 μm aligns well with the peak observed at *Herschel*/PACS wavelengths. With the help of spectral energy distribution fitting and radiative transfer calculations of multiple-shell models for the circumstellar envelope, we explore the various shell structures and the variation of grain sizes along the in the circumstellar envelope. We determine a total shell dust mass of $(2.0 \pm 0.3) \times 10^{-5}$ M$_\odot$ and established that the thermal pulse which gave rise to the detached shell occurred 3500 ± 500 years ago.

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Two's company, three's a crowd: SALT reveals the likely triple nature of the nucleus of the extreme abundance discrepancy factor planetary nebula Sp 3

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The substantial number of binary central stars of planetary nebulæ (CSPNe) now known (~ 50) has revealed a strong connection between binarity and some morphological features including jets and low-ionisation structures. However, some morphological features and asymmetries might be too complex or subtle to ascribe to binary interactions alone. In these cases a tertiary component, i.e. a triple nucleus, could be the missing ingredient required to produce these features. The only proven triple, NGC 246, is alone insufficient to investigate the shaping role of triple nuclei, but one straight-forward way to identify more triples is to search for binaries in nuclei with known visual companions. Here we demonstrate this approach with the SALT HRS discovery of a 4.81 d orbital period in the CSPN of Sp 3 which has a visual companion $0.''31$ away. The spectroscopic distance of the visual companion is in agreement with distance estimates to the nebula, the Gaia DR2 parallax of the central star, and the gravity distance of the central star. This supports a physical association between the visual companion and the inner 4.81-d binary, making the nucleus of Sp 3 a likely triple. We determine $T_{\rm eff} = 68^{+12}_{-6}$ kK, $\log g = 4.6 \pm 0.2$ cm s^{-2} and $v_{\rm rot} = 80 \pm 20$ km s^{-1} for the primary from NLTE model atmosphere analysis. The peculiar nebula presents an apparent bipolar morphology, jets and an unexpected 'extreme' oxygen abundance discrepancy factor (adf) of $24.6^{+4.1}_{-3.4}$. The adf is inconsistent with the purported trend for longer orbital period post-CE PNe to exhibit normal adfs, further highlighting the dominant influence of selection effects in post-CE PNe. Lastly, the Type-I nebular abundances of Sp 3, whose origin is often attributed to more massive progenitors, are incongruous with the likely Galactic Thick Disk membership of Sp 3, possibly suggesting that rotation and binarity may play an important role in influencing the AGB nucleosynthesis of PNe.

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Developing a self-consistent AGB wind model: II. Non-classical, non-equilibrium polymer nucleation in a chemical mixture

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Unravelling the composition and characteristics of gas and dust lost by asymptotic giant branch (AGB) stars is important as these stars play a vital role in the chemical life cycle of galaxies. The general hypothesis of their mass loss mechanism is a combination of stellar pulsations and radiative pressure on dust grains. However, current models simplify dust formation, which starts as a microscopic phase transition called nucleation. Various nucleation theories exist, yet all assume chemical equilibrium, growth restricted by monomers, and commonly use macroscopic properties for a microscopic process. Such simplifications for initial dust formation can have large repercussions on the type, amount, and formation time of dust. By abandoning equilibrium assumptions, discarding growth restrictions, and using quantum mechanical properties, we have constructed and investigated an improved nucleation theory in AGB wind conditions for four dust candidates, TiO_2, MgO, SiO, Al_2O_3. This paper reports the viability of these candidates as first dust precursors and reveals implications of simplified nucleation theories. Monomer restricted growth underpredicts large clusters at low temperatures and overpredicts formation times. Assuming the candidates are present, Al_2O_3 is the favoured precursor due to its rapid growth at the highest considered temperatures. However, when considering an initially atomic chemical mixture, only TiO_2-clusters form. Still, we believe Al_2O_3 to be the prime candidate due to substantial physical evidence in presolar grains, observations of dust around AGB stars at high temperatures, and its ability to form at high temperatures and expect the missing link to be insufficient quantitative data of Al-reactions.

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IRC +10°216 mass loss properties through the study of λ3 mm emission: Large spatial scale distribution of SiO, SiS, and CS

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Low-mass evolved stars are major contributors to interstellar medium enrichment as a consequence of the intense mass-loss process these stars experience at the end of their lives. The study of the gas in the envelopes surrounding asymptotic giant branch (AGB) stars through observations in the millimetre wavelength range provides information about the history and nature of these molecular factories. Here we present ALMA observations at subarsecond resolution, complemented with IRAM-30m data, of several lines of SiO, SiS, and CS towards the best-studied AGB circumstellar envelope, IRC +10°216. We aim to characterise their spatial distribution and determine their fractional abundances mainly through radiative transfer and chemical modelling. The three species display extended emission with several enhanced emission shells. CS displays the most extended distribution reaching distances up to approximately 20″. SiS and SiO emission have similar sizes of approximately 11″, but SiS emission is slightly more compact. We have estimated fractional abundances relative to H_2, which on average are equal to $f(\mathrm{SiO}) \sim 10^{-7}$, $f(\mathrm{SiS}) \sim 10^{-6}$, and $f(\mathrm{CS}) \sim 10^{-6}$ up to the photo-dissociation region. The observations and analysis presented here show evidence that the circumstellar material displays clear deviations from an homogeneous spherical wind, with clumps and low density shells that may allow UV photons from the interstellar medium (ISM) to penetrate deep into the envelope, shifting the photo-dissociation radius inwards. Our chemical model predicts photo-dissociation radii compatible with those derived from the observations, although it is unable to predict abundance variations from the starting radius of the calculations ($\sim 10\ R_\star$), which may reflect the simplicity of the model. We conclude that the spatial distribution of the gas proves the episodic and variable nature of the mass-loss mechanism of IRC +10°216, on timescales of hundreds of years.

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Conference Papers

UVIT observations of UV-bright stars in four Galactic globular clusters

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We have performed photometric analysis of four Galactic globular clusters (GGCs): NGC 4147, NGC 4590, NGC 5053 and NGC 7492 using far-UV and near-UV filters of the Ultraviolet Imaging Telescope (UVIT) on-board AstroSat. With the help of color–magnitude diagrams (CMDs), we have identified ~ 150 blue horizontal branch stars (BHBs), and ~ 40 blue straggler stars (BSS) in the four GGCs. We study the temperature and radial distribution of BHBs and BSS for the four GGCs.

Poster contribution, published in IAU Symposium No. 351 "Star Clusters: From the Milky Way to the Early Universe"
Available from https://arxiv.org/abs/1908.02512

Spectroscopic studies of stellar populations in globular clusters and field stars: implications for globular cluster and Milky Way halo formation

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We review spectroscopic results concerning multiple stellar populations in globular clusters. The cluster initial mass is the most important parameter determining the fraction of second generation stars. The threshold for the onset of the multiple population phenomenon is $1\text{–}3 \times 10^5$ M$_\odot$. Nucleosynthesis is influenced by metallicity: Na–O and Mg–Al anti-correlations are more extended in metal-poor than in metal-rich clusters. Massive clusters are more complex systems than the smaller ones, with several populations characterized by different chemical compositions. The high Li abundance observed in the intermediate second generation stars strongly favours intermediate mass AGB stars as polluters for this class of stars; however, it is well possible that the polluters of extreme second generation stars, that often do not have measurable Li, may be fast rotating massive stars or super-massive stars. The mass budget factor should be a function of the cluster mass, and needs to be large only in massive clusters.

Oral contribution, published in IAU Symposium No. 351: "Star Clusters: From the Milky Way to the Early Universe", 2019, eds. A. Bragaglia, M.B. Davies, A. Sills & E. Vesperini
Available from https://arxiv.org/abs/1908.06905

Review Papers

Stars at high spatial resolution

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We summarize some of the compelling new scientific opportunities for understanding stars and stellar systems that can be enabled by sub-milliarcsec (sub-mas) angular resolution, UV–Optical spectral imaging observations, which can reveal the details of the many dynamic processes (e.g., evolving magnetic fields, accretion, convection, shocks, pulsations, winds, and jets) that affect stellar formation, structure, and evolution. These observations can only be provided by long-baseline interferometers or sparse aperture telescopes in space, since the aperture diameters required are in excess of 500 m (a regime in which monolithic or segmented designs are not and will not be feasible) and since they require observations at wavelengths (UV) not accessible from the ground. Such observational capabilities would enable tremendous gains in our understanding of the individual stars and stellar systems that are the building blocks of our Universe and which serve as the hosts for life throughout the Cosmos.

Published in 2020 Astrophysics Decadal Survey White Papers
Available from https://arxiv.org/abs/1908.05665
and from https://ui.adsabs.harvard.edu/abs/2019BAAS...51c..56C/abstract

Angular momentum transport in stellar interiors

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Dear subscribers of the AGB newsletter,

it is a pleasure to offer you free access to the final published version of our ARA&A review paper and its supplemental material (including an electronic file to reproduce Figure 4) via this URL:

http://www.annualreviews.org/eprint/PTFT2M89NRMEAWTEHVE9/full/10.1146/annurev-astro-091918-104359

We kindly ask you not to pass on the PDF of the paper, but rather send the above link to potentially interested readers should you want to distribute the paper for free.

Best regards,
Conny, Stéphane, Tami

Published in Annual Review of Astronomy and Astrophysics, 57, 35 (2019)
Available from https://doi.org/10.1146/annurev-astro-091918-104359

Job Advert

PhD position in evolved stars research

Applications are invited for a Ph.D. position in the Evolved Stars group of the Department of Space, Earth and Environment at Chalmers University of Technology in Gothenburg, Sweden. The position will be hosted within the Galactic astronomy unit of the Astronomy and Plasma Physics division, in the research group of Dr. Elvire De Beck.

The project will make use of instruments such as ALMA, APEX, OSO 20m, and IRAM 30m in the millimeter/submillimeter, as well as the *Herschel* Space Observatory in the far-infrared. The position will focus on the physical and chemical properties of low-mass stars appearing as carbon-enriched AGB stars in the late stages of their evolution. The successful applicant will have the opportunity to influence the details of the research project, with the possibility to combine observational work with theoretical modelling. The Ph.D. student will be expected to lead the work in close collaboration with the other members of the group. The research will mainly be done at Onsala Space Observatory,where Chalmers hosts the Swedish National Facility for Radio Astronomy.

The position may also include teaching at Chalmers or performing other duties corresponding up to 20 per cent of working hours, depending on availability. These duties can extend the position to a maximum of five years.

An M.Sc. in astronomy or physics or similar is required. A good understanding of stellar evolution and/or observational techniques would be an asset. The position requires sound verbal and written communication skills in English.Swedish skills are not required. Chalmers offers Swedish courses for those interested.

Application details can be found via the online application submission form.

Application deadline: October 15, 2019

See also https://www.chalmers.se/en/about-chalmers/Working-at-Chalmers/Vacancies/Pages/default.aspx?rmpage=job&rmjob=7823&rmlang=UK

Announcements

General PN symposium: call for expressions of interest

Dear All,

The PN commission of the IAU and the PN working group that preceded it has arranged for regular symposia on planetary nebulæ. Whilst there are many meetings on subtopics which involve planetary nebulæ, and the commission has always pushed for PNe to be considered a part of meetings on other topics, these general meetings have been very important for the development of the field. The most recent one was in Beijing, in 2016 (https://www.iau.org/science/meetings/past/symposia/1156/).
Previous meetings were in 2011 (Tenerife), 2006 (Hawai'i), 2001 (Canberra), 1996 (Groningen), 1992 (Innsbruck), 1987 (México City), 1982 (London), 1977 (Ithaca), and 1967 (Czechoslovakia).

The Commission would now like to ask for expressions of interest to organise and host the next such meeting, in 2022. The commission will work with the selected applicants in the preparation and organisation. The meeting should cover all aspects of PN research. It may also involve other topics depending on interest of the organizers and the community, relevance, and IAU priorities. The meeting should comply with the IAU rules, where we point in particular at the need for gender and nationality equality and for accessibility. The IAU rules can be found at https://www.iau.org/science/meetings/rules/#21, especially section 3.2–3.4.

The expression of interest should address the location (accessibility for overseas travelers, venue), proposed dates, likely cost, and effort available for the local organising committee. Any already available funding would be a pro, and you may wish to include anything else that may aid your case. The Commission will assess the letters based on the information that is provided, taking into account the requirements for IAU meetings.

The letters should be submitted no later than 30 September 2019, to the email address albert.zijlstra@manchester.ac.uk. The commission may contact you for more information if required. The selection will be made by 31 October. The preparation for the application for IAU status will be during 2020, with a final application due in December 2020.

The IAU General Assembly will be in 2021 (http://www.iauga2021.org), and there is currently a call out by the IAU for focus meetings. If you intend to submit for a focus meeting, please be aware that the deadline for the letter of intent is 15 September. The Commission can provide letters of support for focus meeting that have a PN component to them.

On behalf of the Organizing Committee for Commission H3

Albert Zijlstra

The IAU ombud

Dear Colleagues,

this is to alert you to a new facility set up at the IAU under its Division G (Stars): the IAU ombud. It provides a mechanism to report issues you have encountered or witnessed within the astronomical community. Examples of issues you might wish to bring to the attention of the union include malpractice such as bullying, harassment, sabotage or discrimination, but positive stories are also welcome. You do not need to be a member of the IAU.

The facility is totally anonymous and strictly confidential – we will not know who you are unless you tell us. The comments received will not be passed on to third parties and only be made available in summarised and analysed form to the executive committee of the IAU and in particular its Working Group on Equity and Inclusion. Thereafter, all data will be destroyed.

While the union will not be able to act upon individual cases, it may help define the actions it takes to promote a fair and diverse research culture.

The IAU ombud can be accessed from the link below.

Jacco van Loon, Vice-President of IAU Commission G3 (Stellar Evolution)

See also http://freesuggestionbox.com/pub/qxrqnsf