THE AGB NEWSLETTER

An electronic publication dedicated to Asymptotic Giant Branch stars and related phenomena

Official publication of the IAU Working Group on Red Giants and Supergiants

No. 268 — 1 November 2019

https://www.astro.keele.ac.uk/AGBnews

Editors: Jacco van Loon, Ambra Nanni and Albert Zijlstra

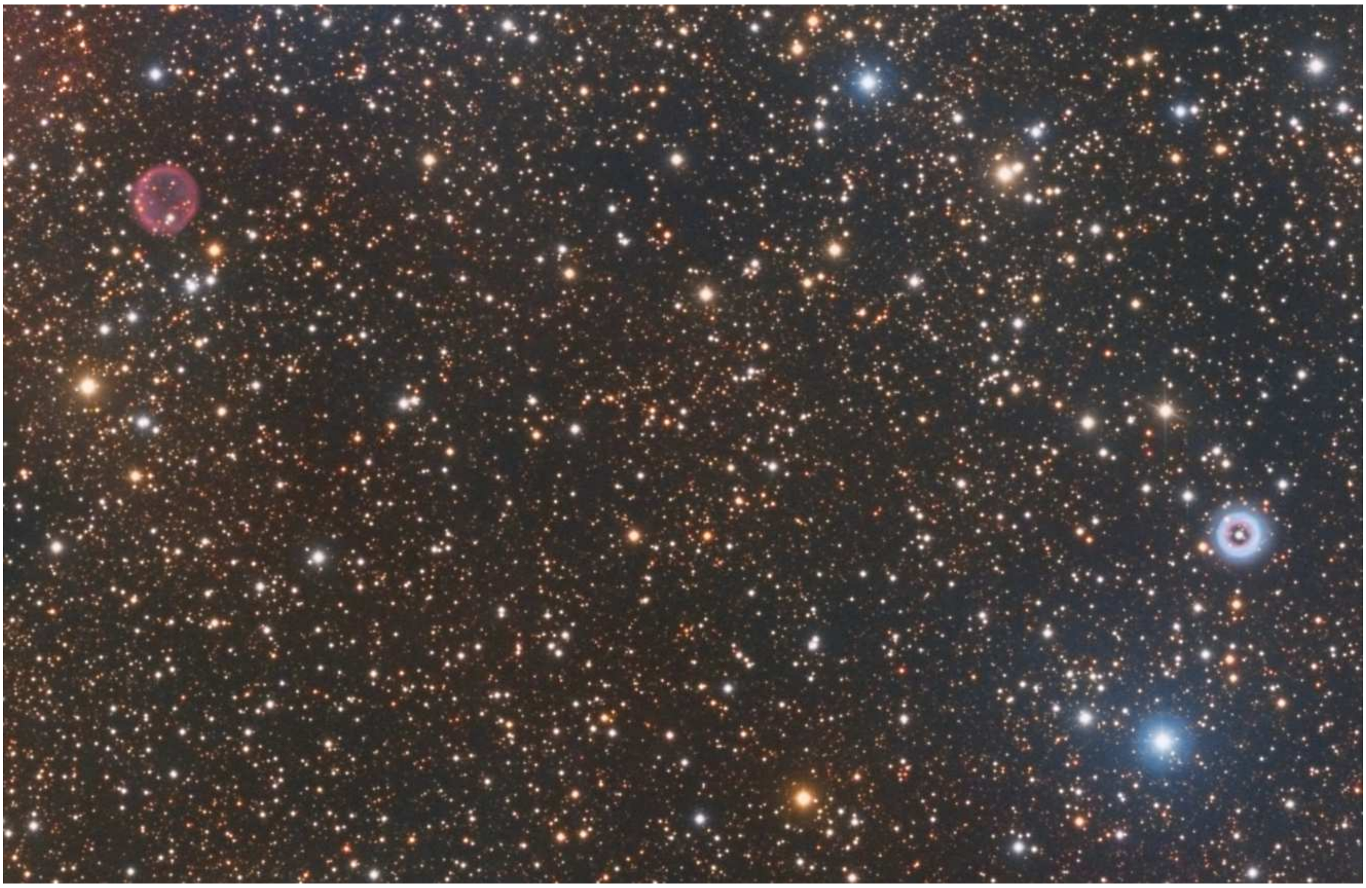


Figure 1: Planetary nebulæ VBRC 7, on the left, and Shapley 1, on the right, imaged by the Atacama Photographic Observatory and suggested by Sakib Rasool. The image is a composite of white-light (in blue), Hα (in red) and [O III] (in green) with a total integration time of 37.3 hours. For more details see http://www.atacama-photographic-observatory.com/page_photo.php?id=79.

Editorial

Dear Colleagues,

It is a pleasure to present you the 268[th] issue of the AGB Newsletter.

If you are looking for a postdoc position, have a look at the advertisement for an opportunity in Barcelona (Catalunya).

If you are interested in polarimetry, have a look at the announcement for a meeting in Hiroshima (Japan).

We are introducing a new feature in the newsletter: the "What am I thinking?" opinion piece (see overleaf). Maria Lugaro has been kind (and brave?) enough to write the first one – we hope you find it provoking and inspiring. Reactions are welcome – just e-mail astro.agbnews@keele.ac.uk.

The next issue is planned to be distributed around the 1[st] of December.

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

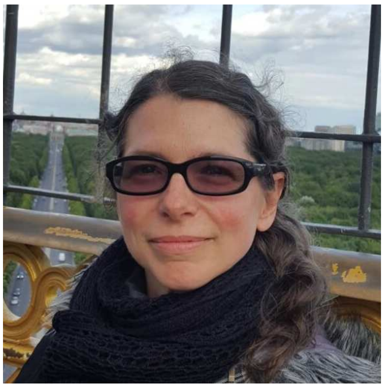
Food for Thought

This month's thought-provoking statement is:

Is convection scale free?

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

What am I thinking?



Maria Lugaro

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One of the most prominent features of AGB stars is the dust production. All of us in the AGB community are well aware of this feature and many of us research it, both observationally and theoretically, and particularly in relation to the crucial question of the AGB mass loss. Most of us also are aware of the fact that physical samples of such dust are represented by microscopic stardust grains that originated in AGB stars and are found in meteorites. We have all most likely heard the fantastic story of these microcrystals: as they formed within AGB atmospheres and spent some time in the interstellar medium, then survived the formation of the Solar System, when they were trapped inside asteroids, the parent bodies of meteorites from which they are now extracted. However, even after more than 30 years since their discovery, it appears that still very few researchers in the AGB community effectively consider information from stardust as a driver of their work.

I have been often wondering the reason for this impasse. One of the main problems may be the fact that the study of stardust is effectively part of the field of cosmochemistry, a branch of geochemistry. Similar methodologies are applied in the two fields except typically to terrestrial rocks in geochemistry, and to extra-terrestrial rocks in cosmochemistry. The barrier between a laboratory chemistry topic and an astronomy and astrophysics topic appears for some reason very difficult to break through. Perhaps the two communities are also geographically separated, with much research on stardust happening in the USA, published in ApJ, and much research on AGB stars happening in Europe, published in A&A. I did not make any statistical study about this and the question gives me the same kind of feeling of when I ask myself why there are more women astronomers in traditionally Catholic than Protestant countries. It would need a Ph.D. to try to work it out. Perhaps some of us in the community have some convincing answers, or can direct me to where I can find them.

It seems to me in any case that with the advent of ALMA together with the amazing technological developments in the study of meteoritic stardust grains, we should be able at some point soon to harvest from a huge potential: that offered to us by trying to interpret these two different, independent observational constraints within the same light.

(Note from the editor: see also the paper by Nittler et al. on page 9 in this newsletter)

Refereed Journal Papers

Discovery of a red supergiant donor star in SN2010da/NGC 300 ULX-1

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SN2010da/NGC 300 ULX-1 was first detected as a supernova impostor in May 2010 and was recently discovered to be a pulsating ultraluminous X-ray source. In this letter, we present VLT/X-shooter spectra of this source obtained in October 2018, covering the wavelength range 350–2300 nm. The J- and H-bands clearly show the presence of a red supergiant donor star that is best matched by a MARCS stellar atmosphere with $T_{\rm eff} = 3650$–3900 K and $\log(L_{\rm bol}/{\rm L}_\odot) = 4.25 \pm 0.10$, which yields a stellar radius $R = 310 \pm 70$ ${\rm R}_\odot$. To fit the full spectrum, two additional components are required: a blue excess that can be fitted either by a hot blackbody ($T \gtrsim 20,000$ K) or a power law (spectral index $\alpha \approx 4$) and is likely due to X-ray emission reprocessed in the outer accretion disk or the donor star; and a red excess that is well fitted by a blackbody with a temperature of ~ 1100 K, and is likely due to warm dust in the vicinity of SN2010da. The presence of a red supergiant in this system implies an orbital period of at least 0.8–2.1 years, assuming Roche lobe overflow. Given the large donor-to-compact object mass ratio, orbital modulations of the radial velocity of the red supergiant are likely undetectable. However, the radial velocity amplitude of the neutron star is large enough (up to 40–60 km s^{-1}) to potentially be measured in the future, unless the system is viewed at a very unfavorable inclination.

Published in ApJ Letters
Available from https://arxiv.org/abs/1909.02171
and from https://doi.org/10.3847/2041-8213/ab4139

The complete evolution of a neutron-star binary through a common envelope phase using 1D hydrodynamic simulations

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Over forty years of research suggests that the common envelope phase, in which an evolved star engulfs its companion upon expansion, is the critical evolutionary stage forming short-period, compact-object binary systems, such as coalescing double compact objects, X-ray binaries, and cataclysmic variables. In this work, we adapt the one-dimensional hydrodynamic stellar evolution code, MESA, to model the inspiral of a 1.4-$M_{\odot}$ neutron star (NS) inside the envelope of a 12-$M_{\odot}$ red supergiant star. We self-consistently calculate the drag force experienced by the NS and the back-reaction onto the expanding envelope as the NS spirals in. Nearly all of the hydrogen envelope escapes, expanding to large radii ($\sim 10^2$ au) where it forms an optically thick envelope with temperatures low enough that dust formation occurs. We simulate the NS orbit until only 0.8 $M_{\odot}$ of the hydrogen envelope remains around the giant star's core. Our results suggest that the inspiral will continue until another ≈ 0.3 $M_{\odot}$ are removed, at which point the remaining envelope will retract. Upon separation, a phase of dynamically stable mass transfer onto the NS accretor is likely to ensue, which may be observable as an ultraluminous X-ray source. The resulting binary, comprised of a detached 2.6-$M_{\odot}$ helium-star and a NS with a separation of 3.3–5.7 $R_{\odot}$, is expected to evolve into a merging double neutron-star, analogous to those recently detected by LIGO/Virgo. For our chosen combination of binary parameters, our estimated final separation (including the phase of stable mass transfer) suggests a very high $\alpha_{\rm CE}$-equivalent efficiency of ≈ 5.

Published in The Astrophysical Journal Letters
Available from https://arxiv.org/abs/1907.12573
and from https://doi.org/10.3847/2041-8213/ab40d1

Abundances of disk and bulge giants from high-resolution optical spectra – IV. Zr, La, Ce, Eu

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Stellar mass and metallicity are factors that affect the neutron-capture process. Due to this, the enrichment of the ISM and the abundance of neutron-capture elements vary with time, making them suitable probes for the Galactic chemical evolution. In this work we make a differential comparison of neutron-capture element abundances determined in the local disk(s) and the bulge, focusing on minimising possible systematic effects in the analysis, with the aim of finding possible differences/similarities between the populations. Abundances are determined for Zr, La, Ce and Eu in 45 bulge giants and 291 local disk giants, from high-resolution optical spectra. The abundances are determined by fitting synthetic spectra using the SME code. The disk sample is separated into thin/thick disk components using a combination of abundances and kinematics. We find flat Zr, La, Ce trends in the bulge, with a ~ 0.1 dex higher La abundance compared with the disk, possibly indicating a higher *s*-process contribution for La in the bulge. [Eu/Fe] decreases with increasing [Fe/H], with a plateau at around [Fe/H] ~ -0.4, pointing at similar enrichment as α-elements in all populations. We find that the *r*-process dominated the neutron-capture production at early times both in the disks and bulge. [La/Eu] for the bulge are systematically higher than the thick disk, pointing to either a) a different amount of SN II or b) a different contribution of the *s*-process in the two populations. Considering [(La+Ce)/Zr], the bulge and the thick disk follow each other closely, suggesting a similar ratio of high/low-mass asymptotic giant branch-stars.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1909.10535

A stellar census in globular clusters with MUSE: multiple populations chemistry in NGC 2808

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Context: Galactic globular clusters (GCs) are now known to host multiple populations displaying particular abundance variations. The different populations within a GC can be well distinguished following their position in the pseudo two-color diagrams, also referred to as "chromosome maps." These maps are constructed using optical and near-UV photometry available from the *Hubble* Space Telescope (HST) UV survey of GCs. However, the chemical tagging of the various populations in the chromosome maps is hampered by the fact that HST photometry and elemental abundances are both only available for a limited number of stars.
Aims: The spectra collected as part of the MUSE survey of globular clusters provide a spectroscopic counterpart to the HST photometric catalogs covering the central regions of GCs. In this paper, we use the MUSE spectra of 1115 red giant branch (RGB) stars in NGC 2808 to characterize the abundance variations seen in the multiple populations of this cluster.
Methods: We used the chromosome map of NGC 2808 to divide the RGB stars into their respective populations. We then combined the spectra of all stars belonging to a given population, resulting in one high signal-to-noise ratio spectrum representative of each population.
Results: Variations in the spectral lines of O, Na, Mg, and Al are clearly detected among four of the populations. In order to quantify these variations, we measured equivalent width differences and created synthetic populations spectra that were used to determine abundance variations with respect to the primordial population of the cluster. Our results are in good agreement with the values expected from previous studies based on high-resolution spectroscopy. We do not see any significant variations in the spectral lines of Ca, K, and Ba. We also do not detect abundance variations among the stars belonging to the primordial population of NGC 2808.
Conclusions: We demonstrate that in spite of their low resolution, the MUSE spectra can be used to investigate abundance variations in the context of multiple populations.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1909.04959

Characterisation of the planetary nebula Tc 1 based on VLT X-Shooter observations

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We present a detailed analysis of deep VLT/X-Shooter observations of the planetary nebula Tc 1. We calculate gas temperature, density, extinction, and abundances for several species from the empirical analysis of the total line fluxes. In addition, a spatially resolved analysis of the most intense lines provides the distribution of such quantities across the nebula. The new data reveal that several lines exhibit a double peak spectral profile consistent with the blue- and red-shifted components of an expanding spherical shell. The study of such components allowed us to construct for the first time a three-dimensional morphological model, which reveals that Tc 1 is a slightly elongated spheroid with an equatorial density enhancement seen almost pole on. A few bright lines present extended wings (with velocities up to a few hundred km s^{-1}), but the mechanism producing them is not clear. We constructed photo-ionization models for the main shell of Tc 1. The models predict the central star temperature and luminosity, as well as the nebular density and abundances similar to previous studies. Our models indicate that Tc 1 is located at a distance of approximately 2 kpc. We report the first detection of the [Kr III] 6825Å emission line, from which we determine the krypton abundance. Our model indicates that the main shell of Tc 1 is matter bounded; leaking H ionizing photons may explain the ionization of its faint AGB-remnant halo.

Accepted for publication in MNRAS
Available from https://arxiv.org/abs/1909.09768

A well-balanced scheme for the simulation tool-kit A-MaZe: implementation, tests, and first applications to stellar structure

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Characterizing stellar convection in multiple dimensions is a topic at the forefront of stellar astrophysics. Numerical simulations are an essential tool for this task. We present an extension of the existing numerical tool-kit A-MaZe that enables such simulations of stratified flows in a gravitational field. The finite-volume based, cell-centered, and time-explicit hydrodynamics solver of A-MaZe was extended such that the scheme is now well-balanced in both momentum and energy. The algorithm maintains an initially static balance between gravity and pressure to machine precision. Quasi-stationary convection in slab-geometry preserves gas energy (internal plus kinetic) on average, despite strong

local up- and down-drafts. By contrast, a more standard numerical scheme is demonstrated to result in substantial gains of energy within a short time on purely numerical grounds. The test is further used to point out the role of dimensionality, viscosity, and Rayleigh number for compressible convection. Applications to a young sun in 2D and 3D, covering a part of the inner radiative zone, as well as the outer convective zone, demonstrate that the scheme meets its initial design goal. Comparison with results obtained for a physically identical set-up with a time-implicit code show qualitative agreement.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1909.02428

A rapidly declining transient discovered with Subaru/Hyper Suprime-Cam

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We perform a high-cadence transient survey with Subaru Hyper Suprime-Cam (HSC), which we call the Subaru HSC survey Optimized for Optical Transients (SHOOT). We conduct HSC imaging observations with time intervals of about one hour on two successive nights, and spectroscopic and photometric follow-up observations. A rapidly declining blue transient SHOOT14di at $z = 0.4229$ is found in observations on two successive nights with an image subtraction technique. The rate of brightness change is $+1.28^{+0.40}_{-0.27}$ mag day^{-1} ($+1.83^{+0.57}_{-0.39}$ mag day^{-1}) in the observer (rest) frame and the rest-frame color between 3400 and 4400 Å is $M_{3400\text{Å}} - M_{4400\text{Å}} = -0.4$ mag. The nature of the object is investigated by comparing its peak luminosity, decline rate, and color with those of transients and variables previously observed, and those of theoretical models. None of the transients or variables share the same properties as SHOOT14di. Comparisons with theoretical models demonstrate that, while the emission from the cooling envelope of a Type IIb supernova shows a slower decline rate than SHOOT14di, and the explosion of a red supergiant star with a dense circumstellar wind shows a redder color than SHOOT14di, the shock breakout at the stellar surface of the explosion of a 25-$M_\odot$ red supergiant star with a small explosion energy of $\leq 0.4 \times 10^{51}$ erg reproduces the multicolor light curve of SHOOT14di. This discovery shows that a high-cadence, multi-color optical transient survey at intervals of about one hour, and continuous and immediate follow-up observations, is important for studies of normal core-collapse supernovæ at high redshifts.

Accepted for publication in The Astrophysical Journal
Available from https://arxiv.org/abs/1909.03191

Presolar grains in primitive ungrouped carbonaceous chondrite Northwest Africa 5958

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We report a correlated NanoSIMS-transmission electron microscopy study of the ungrouped carbonaceous chondrite Northwest Africa (NWA) 5958. We identified 10 presolar SiC grains, 2 likely presolar graphite grains, and 20 presolar silicate and/or oxide grains in NWA 5958. We suggest a slight modification of the commonly used classification system for presolar oxides and silicates that better reflects the grains' likely stellar origins. The matrix-normalized presolar SiC abundance in NWA 5958 is 18^{+15}_{-10} ppm (2σ), similar to that seen in many classes of unmetamorphosed chondrites. In contrast, the matrix-normalized abundance of presolar O-rich phases (silicates and oxides) is $30.9^{+17.8}_{-13.1}$ ppm (2σ), much lower than seen in interplanetary dust particles and the least altered CR, CO and ungrouped C chondrites, but close to that reported for CM chondrites. NanoSIMS mapping also revealed an unusual ^{13}C-enriched (δ^13C $\sim$ 100–200 permil) carbonaceous rim surrounding a 1.4-μm diameter phyllosilicate grain. TEM analysis of two presolar grains with a likely origin in asymptotic giant branch stars identified one as enstatite and one as Al–Mg spinel with minor Cr. The enstatite grain amorphized rapidly under the electron beam, suggesting partial hydration. TEM data of NWA 5958 matrix confirm that it has experienced aqueous alteration and support the suggestion of Jacquet et al. (2016) that this meteorite has affinities to CM2 chondrites.

Accepted for publication in Meteoritics and Planetary Science

Available from https://arxiv.org/abs/1909.07225

Overall variation of the H_2O masers around W Hydræ in 28 years

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In this paper, we present the distribution of H_2O masers associated with a semi-regular variable star W Hydræ (W Hya). We have collected the radio interferometric data of the maser distribution taken with the Very Large Array (VLA), the Kashima–Nobeyama InterFErometer (KNIFE), Multi-Element Radio Link Network (MERLIN), the VLBI Exploration of Radio Astrometry (VERA), and the combined array of Korean VLBI Network (KVN) and VERA (KaVA) in order to trace the maser distribution variation in two decades. Even though differences in the sensitivities and angular resolutions of the interferometric observations should be taken into account, we attempt to find possible correlation of the maser distribution with the stellar light curve. Our failure in measurement of the annual parallax of the masers with VERA is likely caused by the properties of the maser features, which have been spatially resolved by the synthesized beam and survived for only half year or shorter. No dependence of the maser spot flux density on its size is found in the KNIFE data, suggesting that maser spot size is determined by the physical boundary as expected for a clump affected by outward propagation of a stellar pulsation shock wave rather than the (spherical) geometry of maser beaming in the maser gas clump.

Accepted for publication in Publications of the Astronomical Society of Japan

A spatio-kinematic model for jets in post-AGB stars

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Aims: We aim to determine the geometry, density gradient, and velocity structure of jets in post-asymptotic giant branch (post-AGB) binaries.
Methods: Our high cadence time series of high-resolution optical spectra of jet-creating post-AGB binary systems provide us with a unique tomography of the jet. We determine the spatio-kinematic structure of the jets based on these data by fitting the synthetic spectral line profiles created by our model to the observed, orbital phase-resolved, Hα-line profiles of these systems. The fitting routine is provided with an initial spectrum and is allowed to test three configurations, derived from three specific jet launching models: a stellar jet launched by the star, an X-wind, and a disk wind configuration. We apply a Markov-chain Monte Carlo routine in order to fit our model to the observations. Our fitting code is tested on the post-AGB binary IRAS 19135+3937.
Results: We find that a model using the stellar jet configuration gives a marginally better fit to our observations. The jet has a wide half-opening angle of about 76° and reaches velocities up to 870 km s^{-1}.
Conclusions: Our methodology is successful in determining some parameters for jets in post-AGB binaries. The model for IRAS 19135+3937 includes a transparent, low density inner region (for a half-opening angle $< 40°$). The source feeding the accretion disk around the companion is most likely the circumbinary disk. We will apply this jet fitting routine to other jet-creating post-AGB stars in order to provide a more complete description of these objects.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1909.08867

A stellar census in globular clusters with MUSE: A spectral catalogue of emission-line sources

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Globular clusters produce many exotic stars due to a much higher frequency of dynamical interactions in their dense stellar environments. Some of these objects were observed together with several hundred thousands other stars in our MUSE survey of 26 Galactic globular clusters. Assuming that at least a few exotic stars have exotic spectra, that means spectra that contain emission lines, we can use this large spectroscopic data set of over a million stellar spectra as a blind survey to detect stellar exotica in globular clusters. To detect emission lines in each spectrum, we model the expected shape of an emission line as a Gaussian curve. This template is used for matched filtering on the differences between each observed 1D spectrum and its fitted spectral model. The spectra with the most significant detections of Hα emission are checked visually and cross-matched with published catalogues. We find 156 stars with Hα emission, including several known cataclysmic variables (CV) and two new CVs, pulsating variable stars, eclipsing binary stars, the optical counterpart of a known black hole, several probable sub-subgiants and red stragglers, and 21 background emission-line galaxies. We find possible optical counterparts to 39 X-ray sources, as we detect Hα emission in several spectra of stars that are close to known positions of *Chandra* X-ray sources. This spectral catalogue can be used to supplement existing or future X-ray or radio observations with spectra of potential optical counterparts to classify the sources.

Accepted for publication in Astronomy & Astrophysics
Available from https://arxiv.org/abs/1909.05872

Numerical simulations of wind-driven protoplanetary nebulæ – I. near-infrared emission

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To understand how the circumstellar environments of post-AGB stars develop into planetary nebulæ, we initiate a systematic study of 2D axisymmetric hydrodynamic simulations of protoplanetary nebulæ (pPN) with a modified ZEUS code. The aim of this first work is to compare the structure of prolate ellipsoidal winds into a stationary ambient medium where both media can be either atomic or molecular. We specifically model the early twin-shock phase which generates a decelerating shell. A thick deformed and turbulent shell grows when an atomic wind expands into an atomic medium. In all other cases, the interaction shell region fragments into radial protrusions due to molecular cooling and chemistry. The resulting fingers eliminate any global slip parallel to the shell surface. This rough surface implies that weak shocks are prominent in the excitation of the gas despite the fast speed of advance. This may explain why low excitation molecular hydrogen is found towards the front of elliptical pPN. We constrain molecular dissociative fractions and timescales of fast H_2 winds and the pPN lifetime with wind densities $\sim 10^5$ m^{-3} and shock speeds of 80$\sim$200 km s^{-1}. We identify a variety of stages associated with thermal excitation of H_2 near-infrared emission. Generated line emission maps and position-velocity diagrams enable a comparison and distinction with post-AGB survey results. The $1 \rightarrow 0$ S(1) & $2 \rightarrow 1$ S(1) lines are lobe-dominated bows rather than bipolar shells.

Published in MNRAS
Available from https://arxiv.org/abs/1910.02252
and from http://astro.kent.ac.uk/∼in32/ppn.html

Numerical simulations of wind-driven protoplanetary nebulæ – II. Signatures of atomic emission

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We follow-up on our systematic study of axisymmetric hydrodynamic simulations of protoplanetary nebulæ. The aim of this work is to generate the atomic analogues of the H_2 near-infrared models of Paper I with the ZEUS code modified to include molecular and atomic cooling routines. We investigate stages associated with strong [Fe II] 1.64-μm and [S II] 6716-Å forbidden lines, the [O I] 6300-Å airglow line, and Hα 6563-Å emission. We simulate (80$\sim$200 km s^{-1}) dense ($\sim 10^5$ m^{-3}) outflows expanding into a stationary ambient medium. In the case of an atomic wind interacting with an atomic medium, a decelerating advancing turbulent shell thickens with time. This contrasts with all other cases where a shell fragments into a multitude of cometary-shaped protrusions with weak oblique shocks as the main source of gas excitation. We find that the atomic wind-ambient simulation leads to considerably higher excitation, stronger peak, and integrated atomic emission as the nebula expands. The weaker emission when one component is molecular is due to the shell fragmentation into fingers so that the shock surface area is increased and oblique shocks are prevalent. Position–velocity diagrams indicate that the atomic-wind model may be most easy to distinguish with more emission at higher radial velocities. With post-AGB winds and shells often highly obscured and the multitude of configurations that are observed, this study suggests and motivates selection criteria for new surveys.

Published in MNRAS
Available from https://arxiv.org/abs/1909.13159
and from http://astro.kent.ac.uk/∼in32/ppn.html

Enrichment of strontium in dwarf galaxies

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Light trans-iron elements such as Sr serve as the key to understanding the astrophysical sites of heavy elements. Spectroscopic studies of metal-poor stars have revealed large star-to-star scatters in the ratios of [Sr/Ba], which indicates that there are multiple sites for the production of Sr. Here we present the enrichment history of Sr by a series of the N-body/smoothed particle hydrodynamics simulations of a dwarf galaxy with a stellar mass of 3×10^6 $M_\odot$. We show that binary neutron star mergers (NSMs) and asymptotic giant branch (AGB) stars contribute to the enrichment of Sr in the metallicity ranges [Fe/H] $\gtrsim -3$ and [Fe/H] $\gtrsim -1$, respectively. It appears insufficient, however, to explain the overall observational trends of Sr by considering only these sites. We find that the models including electron-capture supernovæ (ECSNe) and rotating massive stars (RMSs), in addition to NSMs and AGBs, reasonably reproduce the enrichment histories of Sr in dwarf galaxies. The contributions of both ECSNe and NSMs create scatters of ≈ 0.2 dex in [Sr/Fe], [Sr/Ba], and [Sr/Zn] as can be seen for observed stars in the metallicity range [Fe/H] < -2. We also find that the mass range of ECSN progenitors should be substantially smaller than 1 $M_\odot$ (e.g., 0.1–0.2 $M_\odot$) to avoid overprediction of [Sr/Ba] and [Sr/Zn] ratios. Our results demonstrate that NSMs, AGB stars, ECSNe, and RMSs all play roles in the enrichment histories of Local Group dwarf galaxies, although more observational data are required to disentangle the relative contributions of these sources.

Accepted for publication in ApJ

Available from https://arxiv.org/abs/1909.09163

On the pressure equilibrium and timescales in the scale-free convection theory

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Convection is one of the fundamental energy transport processes in physics and astrophysics, and its description is central to all stellar models. In the context of stellar astrophysics, the mixing length theory is the most successful approximation to handle the convection zones inside the stars because of its simplicity and rapidity. The price to pay is the mixing length parameter that is introduced to derive the velocity of convective elements, the temperature gradients in the convective regions and finally the energy flux carried by convection. The mixing length is a free parameter that needs to be calibrated on observational data. Pasetto et al. (2014) have proposed a new theory that determines all the properties of convective regions and the convective transport of energy with no need for a free parameter. In this study, we aim to discuss the merits of this new approach and the limits of its applicability in comparison with the mixing length theory. We present an analytical and numerical investigation of the main physical assumptions made by Pasetto et al. (2014) and compare them with the counterparts of the mixing length theory. We also present here the homogeneous isotropic limit of the Pasetto et al. (2014) theory and discuss some numerical examples to address

and clarify misconceptions often associated with the new formalism.

Submitted to New Astronomy
Available from https://arxiv.org/abs/1909.13513

The survey of planetary nebulæ in Andromeda (M 31) II. Age–velocity dispersion relation in the disc from planetary nebulæ

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Context: The age–velocity dispersion relation is an important tool to understand the evolution of the disc of the Andromeda galaxy (M 31) in comparison with the Milky Way.
Aims: We use Planetary Nebulæ (PNe) to obtain the age–velocity dispersion relation in different radial bins of the M 31 disc.
Methods: We separate the observed PNe sample based on their extinction values into two distinct age populations in the M 31 disc. The observed velocities of our high- and low-extinction PNe, which correspond to higher and lower mass progenitors respectively, are fitted in de-projected elliptical bins to obtain their rotational velocities, v_ϕ, and corresponding dispersions, σ_ϕ We assign ages to the two PNe populations by comparing central-star properties of an archival sub-sample of PNe, having models fitted to their observed spectral features, to stellar evolution tracks.
Results: For the high- and low-extinction PNe, we find ages of $\sim$ 2.5 Gyr and $\sim$ 4.5 Gyr respectively, with distinct kinematics beyond a deprojected radius $R_{\rm GC} = 14$ kpc. At $R_{\rm GC} = 17$–20 kpc, which is the equivalent distance in disc scale lengths of the Sun in the Milky Way disc, we obtain $\sigma_{\phi,\ \sim 2.5\ \rm Gyr} = 61 \pm 14$ km s^{-1} and $\sigma_{\phi,\ \sim 4.5\ \rm Gyr} = 101 \pm 13$ km s^{-1}. The age–velocity dispersion relation for the M 31 disc is obtained in two radial bins, $R_{\rm GC} = 14$–17 and 17–20 kpc.
Conclusions: The high- and low-extinction PNe are associated with the young thin and old thicker disc of M 31 respectively, whose velocity dispersion values increase with age. These values are almost twice and thrice that of the MilkyWay disc stellar population of corresponding ages. From comparison with simulations of merging galaxies, we find that the age–velocity dispersion relation in the M 31 disc measured using PNe is indicative of a single major merger that occurred 2.5–4.5 Gyr ago with an estimated merger mass ratio $\approx$ 1:5.

Accepted for publication in A&A
Available from https://arxiv.org/abs/1909.09724

A nitrogen-enhanced metal-poor star discovered in the globular cluster ESO 280-SC06

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We report the discovery of the only very nitrogen-enhanced metal-poor star known in a Galactic globular cluster. This star, in the very metal-poor cluster ESO 280-SC06, has [N/Fe] $> +2.5$, while the other stars in the cluster show no obvious enhancement in nitrogen. Around 80 NEMP stars are known in the field, and their abundance patterns are believed to reflect mass transfer from a binary companion in the asymptotic giant branch phase. The dense environment of globular clusters is detrimental to the long term survival of binary systems, resulting in a low observed binary fraction among red giants and the near absence of NEMP stars. We also identify the first known horizontal branch members of ESO 280-SC06, which allow for a much better constraint on its distance. We calculate an updated orbit for the cluster based on our revised distance of 20.6 ± 0.5 kpc, and find no significant change to its orbital properties.

Published in Monthly Notices of the Royal Astronomical Society
Available from https://arxiv.org/abs/1909.06314
and from https://doi.org/10.1093/mnras/stz2611

Revised simulations of the planetary nebulæ luminosity function

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We describe a revised procedure for the numerical simulation of planetary nebulæ luminosity functions (PNLFs), improving on previous work (Mendez & Soffner 1997). The procedure now is based on new H-burning post-AGB evolutionary tracks (Miller Bertolami 2016). For a given stellar mass, the new central stars are more luminous and evolve faster. We have slightly changed the distribution of the [O III] 5007 intensities relative to those of Hβ and the generation of absorbing factors, while still basing the numerical modeling on empirical information extracted from studies of Galactic planetary nebulæ (PNe) and their central stars. We argue that the assumption of PNe being completely optically thick to H-ionizing photons leads to conflicts with observations and show that to account for optically thin PNe is necessary. We then use the new simulations to estimate a maximum final mass, clarifying its meaning, and discuss the effect of internal dust extinction as a possible way of explaining the persistent discrepancy between PNLF and surface brightness fluctuation (SBF) distances. By adjusting the range of minimum to maximum final mass, it is also possible to explain the observed variety of PNLF shapes at intermediate magnitudes. The new PN formation rates are calculated to be slightly lower than suggested by previous simulations based on older post-AGB evolutionary tracks.

Accepted for publication in The Astrophysical Journal
Available from https://arxiv.org/abs/1910.08748

Mass loss on the red giant branch: plasmoid-driven winds above the RGB bump

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The onset of cool massive winds in evolved giants is correlated with an evolutionary feature on the red giant branch (RGB) known as the "bump". Also at the bump, shear instability in the star leads to magnetic fields that occur preferentially on small length-scales. Pneuman (1983) has suggested that the emergence of small-scale flux tubes in the Sun can give rise to enhanced acceleration of the solar wind as a result of plasmoid acceleration (the so-called "melon-seed mechanism"). In this paper, we examine Pneuman's formalism to determine if it may shed some light on the process that drives mass-loss in stars above the RGB bump. Because we do not currently have detailed information for some of the relevant physical parameters, we are not yet able to derive a detailed model: instead, our goal in this paper is to explore a "proof-of-concept". Using parameters that are known to be plausible in cool giants, we find that the total mass-loss rate from such stars can be replicated. Moreover, we find that the radial profile of the wind speed in such stars can be steep or shallow depending on the fraction of the mass-loss rate which is contained in the

plasmoids: this is consistent with empirical data which indicate that the velocity profiles of winds from cool giants span a range of steepnesses.

Accepted for publication in The Astrophysical Journal
Available from https://arxiv.org/abs/1909.09204

Coupling 1D stellar evolution with 3D-hydrodynamical simulations on-the-fly II: stellar evolution and asteroseismic applications

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Models of stellar structure and evolution are an indispensable tool in astrophysics, yet they are known to incorrectly reproduce the outer convective layers of stars. In the first paper of this series, we presented a novel procedure to include the mean structure of 3D hydrodynamical simulations on-the-fly in stellar models, and found it to significantly improve the outer stratification and oscillation frequencies of a standard solar model. In the present work, we extend the analysis of the method; specifically how the transition point between envelope and interior affects the models. We confirm the versatility of our method by successfully repeating the entire procedure for a different grid of 3D hydro-simulations. Furthermore, the applicability of the procedure was investigated across the HR diagram and an accuracy comparable to the solar case was found. Moreover, we explored the implications on stellar evolution and find that the red-giant branch is shifted about 40 K to higher effective temperatures. Finally, we present for the first time an asteroseismic analysis based on stellar models fully utilising the stratification of 3D simulations on-the-fly. These new models significantly reduce the asteroseismic surface term for the two selected stars in the *Kepler* field. We extend the analysis to red giants and characterise the shape of the surface effect in this regime. Lastly, we stress that the interpolation required by our method would benefit from new 3D simulations, resulting in a finer sampling of the grid.

Accepted for publication in MNRAS
Available from https://arxiv.org/abs/1910.10163

Stellar pulsation and the production of dust and molecules in Galactic carbon stars

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New infrared spectra of 33 Galactic carbon stars from FORCAST on SOFIA reveal strong connections between stellar pulsations and the dust and molecular chemistry in their circumstellar shells. A sharp boundary in overall dust content, which predominantly measures the amount of amorphous carbon, separates the semi-regular and Mira variables, with

the semi-regulars showing little dust in their spectra and the Miras showing more. In semi-regulars, the contribution from SiC dust increases rapidly as the overall dust content grows, but in Miras, the SiC dust feature grows weaker as more dust is added. A similar dichotomy is found with the absorption band from CS at ~ 7.3 μm, which is generally limited to semi-regular variables. Observationally, these differences make it straightforward to distinguish semiregular and Mira variables spectroscopically without the need for long-term photometric observations or knowledge of their distances. The rapid onset of strong SiC emission in Galactic carbon stars in semi-regulars variables points to a different dust-condensation process before strong pulsations take over. The break in the production of amorphous carbon between semi-regulars and Miras seen in the Galactic sample is also evident in Magellanic carbon stars, linking strong pulsations in carbon stars to the strong mass-loss rates which will end their lives as stars across a wide range of metallicities.

Accepted for publication in The Astrophysical Journal
Available from https://arxiv.org/abs/1910.11401

Infrared spectroscopy of the recent outburst in V1047 Cen (Nova Centauri 2005)

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Fourteen years after its eruption as a classical nova (CN), V1047 Cen (Nova Cen 2005) began an unusual re-brightening in 2019 April. The amplitude of the brightening suggests that this is a dwarf nova (DN) eruption in a CN system. Very few CNe have had DN eruptions within decades of the main CN outburst. The 14 years separating the CN and DN eruptions of V1047 Cen is the shortest of all instances recorded thus far. Explaining this rapid succession of CN and DN outbursts in V1047 Cen may be challenging within the framework of standard theories for DN outbursts. Following a CN eruption, the mass-accretion rate is believed to remain high ($\dot{M} \sim 10^{-8}$ $M_\odot$ yr^{-1}) for a few centuries, due to the irradiation of the secondary star by the still-hot surface of the white dwarf. Thus a DN eruption is not expected to occur during this high mass accretion phase as DN outbursts, which result from thermal instabilities in the accretion disk, and arise during a regime of low mass-accretion rate ($\dot{M} \sim 10^{-10}$ $M_\odot$ yr^{-1}). Here we present

near-infrared spectroscopy to show that the present outburst is most likely a DN eruption, and discuss the possible reasons for its early occurrence. Even if the present re-brightening is later shown to be due to a cause other than a DN outburst, the present study provides invaluable documentation of this unusual event.

Accepted for publication in The Astrophysical Journal Letters
Available from https://arxiv.org/abs/1910.12786

The January 2016 eruption of recurrent nova LMC 1968

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We present a comprehensive review of all observations of the eclipsing recurrent Nova LMC 1968 in the Large Magellanic Cloud which was previously observed in eruption in 1968, 1990, 2002, 2010, and most recently in 2016. We derive a probable recurrence time of 6.2 ± 1.2 years and provide the ephemerides of the eclipse. In the ultraviolet-optical-IR photometry the light curve shows high variability right from the first observation around two days after eruption. Therefore no colour changes can be substantiated. Outburst spectra from 2016 and 1990 are very similar and are dominated by H and He lines longward of 2000Å. Interstellar reddening is found to be $E(B-V) = 0.07 \pm 0.01$ mag. The super soft X-ray luminosity is lower than the Eddington luminosity and the X-ray spectra suggest the mass of the WD is larger than 1.3 $M_{\odot}$. Eclipses in the light curve suggest that the system is at high orbital inclination. On day four after the eruption a recombination wave was observed in Fe II ultraviolet absorption lines. Narrow line components are seen after day 6 and explained as being due to reionisation of ejecta from a previous eruption. The UV spectrum varies with orbital phase, in particular a component of the He II 1640Å emission line, which leads us to propose that early-on the inner WD Roche lobe might be filled with a bound opaque medium prior to the re-formation of an accretion disk. Both this medium and the ejecta can cause the delay in the appearance of the soft X-ray source.

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from https://arxiv.org/abs/1909.03281

Review Paper

Exploring regularized maximum likelihood reconstruction for stellar imaging with the ngVLA

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The proposed next-generation Very Large Array (ngVLA) will enable the imaging of astronomical sources in unprecedented detail by providing an order of magnitude improvement in sensitivity and angular resolution compared with radio interferometers currently operating at 1.2–116 GHz. However, the current ngVLA array design results in a highly non-Gaußian dirty beam that may make it difficult to achieve high-fidelity images with both maximum sensitivity and maximum angular resolution using traditional CLEAN deconvolution methods. This challenge may be overcome with regularized maximum-likelihood (RML) methods, a new class of imaging techniques developed for the Event Horizon Telescope. RML methods take a forward-modeling approach, directly solving for the images without using either the dirty beam or the dirty map. Consequently, this method has the potential to improve the fidelity and effective angular resolution of images produced by the ngVLA. As an illustrative case, we present ngVLA imaging simulations of stellar radio photospheres performed with both multi-scale (MS-) CLEAN and RML methods implemented in the CASA and SMILI packages, respectively. We find that both MS-CLEAN and RML methods can provide high-fidelity images recovering most of the representative structures for different types of stellar photosphere models. However, RML methods show better performance than MS-CLEAN for various stellar models in terms of goodness-of-fit to the data, residual errors of the images, and in recovering representative features in the ground truth images. Our simulations support the feasibility of transformative stellar imaging science with the ngVLA, and simultaneously demonstrate that RML methods are an attractive choice for ngVLA imaging.
(Note: movies from simulated observations are available in `http://library.nrao.edu/ngvla66sppl.shtml`)

Published in Next Generation Very Large Array Memo Series, No. 66 (2019)
Available from https://arxiv.org/abs/1910.00013
and from https://library.nrao.edu/public/memos/ngvla/NGVLA_66.pdf

Job Advert

Postdoctoral position in observational astronomy

We offer a postdoctoral research assistant position at the Astronomy and Astrophysics group of the Universitat Politècnica de Catalunya, Barcelona, Spain. The candidate will work on the observational project "The age–metallicity relation in the Galactic disk: innovative constraints from white dwarf-main sequence binaries".

The candidate should hold a Ph.D. in astronomy. Researchers from both theoretical and observational background are encouraged to apply, although experience in reducing and analyzing spectroscopic data is preferable. A white dwarf research background is also a plus.

The position is for one year with the possibility of further extending the contract depending on performance. The salary will be around 22.000–25.000 Euros.

Applications are open until the position is filled. The starting date is expected to be in early 2020.

To submit your application please send a Curriculum Vitæ including a list of publications to Dr. Alberto Rebassa Mansergas: alberto.rebassa@upc.edu

Announcement

IAU Symposium 360 – Astronomical Polarimetry 2020
New Era of Multi-Wavelength Multi-Wavelength Polarimetry

We are pleased to announce IAU Symposium 360, "Astronomical Polarimetry 2020 – New Era of Multi-Wavelength Multi-Wavelength Polarimetry", which will be held at Hiroshima, Japan, 23–27 March, 2020.

Please feel free to circulate this along within your department or institution. Please find more information at https://astropol2020-iau.jp, which is still being updated.

Important Dates

- Abstract submission deadline: November 25$^{\text{th}}$ 2019
- Early registration deadline: November 25$^{\text{th}}$ 2019
- Travel grant application deadline: November 20$^{\text{th}}$ 2019
- Late registration deadline: January 25$^{\text{th}}$ 2020
- On-site registration: TBD

Scientific Rationale
Astronomical Polarimetry 2020 (AstroPol 2020) is the next in a series of international conferences. The aim of this series of conferences is to bring researchers interested in astronomical polarimetry together to share and discuss recent results and advances in technical and scientific aspects in all relevant astronomical fields.

Since 2014, when the latest AstroPol took place in Grenoble, a number of sophisticated instruments and datasets have become available to the community. ALMA was inaugurated in and started polarization observations in 2014. Adaptive optics aided 8-m class telescopes, such as Subaru, VLT and Gemini have been providing high-contrast spectropolarimetry. There is also the *Robert Stobie* Spectrograph (RSS) spectropolarimeter on the 11-m SALT telescope and the mid-infrared CanariCam polarimeter on the Gran Telescopio Canarias (GTC), that may become available to the public in the future. Data release of the all-sky radio and submillimeter polarization mapping by the *Planck* satellite has had a strong impact in many astronomical fields. The SOFIA/HAWC+ FIR polarimeter is available to the community. In addition, Astrosat and Hitomi and balloon experiments have offered us new insights into the polarized sky in X-rays and γ-rays.

AstroPol 2020 will demonstrate that a new era of polarimetry has come to the astronomical community.

The Symposium poster can be seen/downloaded from:
https://astropol2020-iau.jp/wordpress/wp-content/uploads/2019/09/astropol2020-iau360_wo_logos.pages-7.pdf

See also https://astropol2020-iau.jp