THE AGB NEWSLETTER

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

Official publication of the IAU Working Group on Abundances in Red Giants

No. 197 — 1 December 2013

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

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Editorial

Dear Colleagues,

It is a pleasure to present you the 197$^{\rm th}$ issue of the AGB Newsletter. A quick calculation shows that this means that the February issue will be the 199$^{\rm th}$ and the March issue will be the 200$^{\rm th}$ issue. While there is nothing special about the numbers 199 and 200 (except 199 being a prime number and $200 = 2 \cdot 10^2$) it's a good excuse to reflect and contemplate. So please take note of the Food for Thought items below and overwhelm us with your contributions in the form of text, pictures, animations, et cetera, by the end of January (looking back) and the end of February (looking ahead), respectively.

The next issue is planned to be distributed around the 5$^{\rm th}$ of January. With the Season's Greetings and a peaceful entry into the new year,

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

What have been the most significant developments in our field since 2005?
What are the most pressing issues to resolve in the next hundred months?

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

Refereed Journal Papers

Program WWZ: wavelet analysis of astronomical signals with irregularly spaced arguments

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A program WWZ is introduced, which realizes the wavelet analysis using an improved modification of the algorithm of the Morlet wavelet for a general case of irregularly spaced data, which is typical for the databases available in virtual observatories. Contrary to the well-known analogs, working with regularly spaced (equidistant in time) arguments, we have implemented an improved algorithm presented by Andronov (1998, KFNT, 14, 490; 1999, sss. conf, 57), which significantly increases the signal-to-noise ratio. The program has been used to study semi-regular pulsating variable stars (U Del et al.), but can be used for the analysis of signals of any nature.

Accepted for publication in Odessa Astronomical Publications, v.26, No.1 (2013)
Available from arXiv:1310.5031

Identification of new Galactic symbiotic stars with SALT – I. Initial discoveries and other emission line objects

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We introduce the first results from an ongoing, systematic survey for new symbiotic stars in the southern Galactic plane selected from the AAO/UKST SuperCOSMOS Hα Survey (SHS). The survey aims to identify and characterise the fainter population of symbiotic stars underrepresented in extant catalogues. Less than 300 symbiotic stars are known, in stark contrast to population estimates of 10^{3-5} symbiotic stars. The accreting white dwarf (WD) in symbiotic stars, fuelled by their red giant donors with high mass loss rate winds, make them promising candidates for type Ia supernovæ. Several candidates were observed spectroscopically with the Southern African Large Telescope (SALT). A total of 12 bona-fide and 2 possible symbiotic stars were identified. The most remarkable example is a carbon-rich symbiotic star that displays coronal [Fe x] emission, suggesting it may be a supersoft X-ray source with a massive WD, however strong interstellar absorption may severely hinder any supersoft X-ray detection. This is the fifth carbon-rich Galactic symbiotic star found and raises the interesting possibility that carbon-rich giants have a higher rate of occurrence in fainter populations of symbiotic stars. Several other emission line objects with near-infrared colours similar to symbiotic stars were also discovered, including 6 B[e] stars, 4 PNe, 2 possible Be stars, one [WC9] Wolf–Rayet (WR) central star of a PN and one WC9 WR star. Revealing D-type symbiotic stars remains difficult, with only one new D-type found in contrast to 6 B[e] stars that were promising D-type candidates. These discoveries will help shape and refine the candidate selection criteria that we expect will uncover several more symbiotic stars as the survey progresses.

Submitted to MNRAS
Available from arXiv:1311.0797

Unveiling the dust nucleation zone of IRC +10 216 with ALMA

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We report the detection in IRC +10 216 of lines of HNC $J = 3$–2 pertaining to 9 excited vibrational states with energies up to 5300 K. The spectrum, observed with ALMA, also shows a surprising large number of narrow, unidentified lines that arise in the vicinity of the star. The HNC data are interpreted through a 1D-spherical non-local radiative transfer model, coupled to a chemical model that includes chemistry at thermochemical equilibrium for the innermost regions and reaction kinetics for the external envelope. Although unresolved by the present early ALMA data, the radius inferred for the emitting region is $0\farcs06$ (i.e. ~ 3 stellar radii), similar to the size of the dusty clumps reported by IR studies of the innermost region ($r < 0\farcs3$). The derived abundance of HNC relative to H_2 is $10^{-8} < \chi(\mathrm{HNC}) < 10^{-6}$, and drops quickly where the gas density decreases and the gas chemistry is dominated by reaction kinetics. Merging HNC data with that of molecular species present throughout the inner envelope, such as vibrationally excited HCN, SiS, CS, or SiO, should allow us to characterize the physical and chemical conditions in the dust formation zone.

Accepted for publication in ApJL
Available from arXiv:1310.7383

Overshooting by convective settling

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We study a process of slow mixing in stars with convective envelopes, which is driven by the settling of cool downward plumes below the base of the convection zone. If a small fraction (of order 10^{-7}) of the material cooled at the surface retains a significant entropy deficit while descending in plumes, it can reach the depth where lithium burning takes place. The model calculates the thermal response and mixing below the convection zone due to the settling process, assuming that the plumes arrive at the base of the convection zone with a broad range of entropy contrasts. We obtain a good fit to the observed lithium depletion in the Sun by assuming that the settling mass flux is distributed with respect to the entropy contrast as a power law with a slope around -2. We find convective settling to have a negligible influence on the stratification below the convection zone, although mixing induced by it could modify the gradient of helium concentration.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:1310.8117

The gas-rich circumbinary disk of HR 4049 – I: A detailed study of the mid-infrared spectrum

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We present a detailed analysis of the mid-infrared spectrum of the peculiar evolved object HR 4049. The full *Spitzer*-IRS high-resolution spectrum shows a wealth of emission with prominent features from CO_2 and H_2O and possible

contributions from HCN and OH. We model the molecular emission and find that it originates from a massive ($M \gtrsim 8 \times 10^{-3}$ $M_\odot$), warm ($T_{ex} \approx 500$ K) and radially extended gas disk that is optically thick at infrared wavelengths. We also report less enrichment in ^{17}O and ^{18}O than previously found and a comparison of the *Spitzer* observations to earlier data obtained by ISO-SWS reveals that the CO_2 flux has more than doubled in 10 years time, indicating active and ongoing chemical evolution in the circumbinary disk. If the gas originates from interaction between the stellar wind and the dust, this suggests that the dust could be oxygen-rich in nature. The molecular gas plays a crucial role in the thermal properties of the circumbinary disk by allowing visible light to heat the dust and then trapping the infrared photons emitted by the dust. This results in higher temperatures and a more homogeneous temperature structure in the disk.

Accepted for publication in The Astrophysical Journal
Available from arXiv:1310.6361

The impact of updated Zr neutron-capture cross sections and new asymptotic giant branch models on our understanding of the s process and the origin of stardust

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We present model predictions for the Zr isotopic ratios produced by slow neutron captures in C-rich asymptotic giant branch (AGB) stars of masses 1.25 to 4 $M_\odot$ and metallicities $Z = 0.01$ to 0.03, and compare them to data from single meteoritic stardust silicon carbide (SiC) and high-density graphite grains that condensed in the outflows of these stars. We compare predictions produced using the Zr neutron-capture cross section from Bao et al. (2000) and from n_TOF experiments at CERN, and present a new evaluation for the neutron-capture cross section of the unstable isotope ^{95}Zr, the branching point leading to the production of ^{96}Zr. The new cross sections generally presents an improved match with the observational data, except for the $^{92}Zr/^{94}Zr$ ratios, which are on average still substantially higher than predicted. The $^{96}Zr/^{94}Zr$ ratios can be explained using our range of initial stellar masses, with the most ^{96}Zr-depleted grains originating from AGB stars of masses 1.8–3 $M_\odot$, and the others from either lower or higher masses. The $^{90,91}Zr/^{94}Zr$ variations measured in the grains are well reproduced by the range of stellar metallicities considered here, which is the same needed to cover the Si composition of the grains produced by the chemical evolution of the Galaxy. The $^{92}Zr/^{94}Zr$ versus $^{29}Si/^{28}Si$ positive correlation observed in the available data suggests that stellar metallicity rather than rotation plays the major role in covering the $^{90,91,92}Zr/^{94}Zr$ spread.

Accepted for publication in The Astrophysical Jounnal
Available from arXiv:1311.2660

Spatially resolved physical and chemical properties of the planetary nebula NGC 3242

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Optical integral-field spectroscopy was used to investigate the planetary nebula NGC 3242. We analysed the main morphological components of this source, including its knots, but not the halo. In addition to revealing the properties of the physical and chemical nature of this nebula, we also provided reliable spatially resolved constraints that can be used for future photoionisation modelling of the nebula. The latter is ultimately necessary to obtain a fully self-consistent 3D picture of the physical and chemical properties of the object. The observations were obtained with the VIMOS instrument attached to VLT-UT3. Maps and values for specific morphological zones for the detected emission-lines were obtained and analysed with routines developed by the authors to derive physical and chemical conditions of the ionised gas in a 2D fashion. We obtained spatially resolved maps and mean values of the electron densities, temperatures, and chemical abundances, for specific morphological structures in NGC 3242. These results show the pixel-to-pixel variations of the the small- and large-scale structures of the source. These diagnostic maps provide information free from the biases introduced by traditional single long-slit observations. In general, our results are consistent with a uniform abundance distribution for the object, whether we look at abundance maps or integrated fluxes from specified morphological structures. The results indicate that special care should be taken with the calibration of the data and that only data with extremely good signal-to-noise ratio and spectral coverage should be used to ensure the detection of possible spatial variations.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:1311.3201

A search for planetary nebulæ with the SDSS: the outer regions of M 31

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We have developed a method to identify planetary nebula (PN) candidates in imaging data of the Sloan Digital Sky Survey (SDSS). This method exploits the SDSS' five-band sampling of emission lines in PN spectra, which results in a color signature distinct from that of other sources. Selection criteria based on this signature can be applied to nearby galaxies in which PNe appear as point sources. We applied these criteria to the whole area of M 31 as scanned by the SDSS, selecting 167 PN candidates that are located in the outer regions of M 31. The spectra of 80 selected candidates were then observed with the 2.2m telescope at Calar Alto Observatory. These observations and cross-checks with literature data show that our method has a selection rate efficiency of about 90%, but the efficiency is different for the different groups of PNe candidates.
In the outer regions of M 31, PNe trace different well-known morphological features like the Northern Spur, the NGC 205 Loop, the G 1 Clump, etc. In general, the distribution of PNe in the outer region $8 < R < 20$ kpc along the minor axis shows the "extended disk" – a rotationally supported low surface brightness structure with an exponential

scale length of 3.21 ± 0.14 kpc and a total mass of $\sim 10^{10}$ $M_\odot$, which is equivalent to the mass of M 33. We report the discovery of three PN candidates with projected locations in the center of Andromeda NE, a very low surface brightness giant stellar structure in the outer halo of M 31. Two of the PNe were spectroscopically confirmed as genuine PNe. These two PNe are located at projected distances along the major axis of ~ 48 kpc and ~ 41 kpc from the center of M 31 and are the most distant PNe in M 31 found up to now.
With the new PN data at hand we see the obvious kinematic connection between the continuation of the Giant Stream and the Northern Spur. We suggest that 20–30% of the stars in the Northern Spur area may belong to the Giant Stream. In our data we also see a possible kinematic connection between the Giant Stream and PNe in Andromeda NE, suggesting that Andromeda NE could be the core or remnant of the Giant Stream. Using PN data we estimate the total mass of the Giant Stream progenitor to be $\approx 10^9$ $M_\odot$. About 90% of its stars appear to have been lost lost during the interaction with M 31.

Accepted for publication in Astronomical Journal
Available from arXiv:1311.1951

Silicon isotopic abundance toward evolved stars and its application for presolar grains

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Galactic chemical evolution (GCE) is important for understanding the composition of the present-day interstellar medium (ISM) and of our solar system. In this paper, we aim to track the GCE by using the $^{29}Si/^{30}Si$ ratios in evolved stars and tentatively relate this to presolar grain composition.
We used the APEX telescope to detect thermal SiO isotopologue emission toward four oxygen-rich M-type stars. Together with the data retrieved from the *Herschel* science archive and from the literature, we were able to obtain the $^{29}Si/^{30}Si$ ratios for a total of 15 evolved stars inferred from their optically thin ^{29}SiO and ^{30}SiO emission. These stars cover a range of masses and ages, and because they do not significantly alter $^{29}Si/^{30}Si$ during their lifetimes, they provide excellent probes of the ISM metallicity (or $^{29}Si/^{30}Si$ ratio) as a function of time.
The $^{29}Si/^{30}Si$ ratios inferred from the thermal SiO emission tend to be lower toward low-mass oxygen-rich stars (e.g., down to about unity for W Hya), and close to an interstellar or solar value of 1.5 for the higher-mass carbon star IRC +10 216 and two red supergiants. There is a tentative correlation between the $^{29}Si/^{30}Si$ ratios and the mass-loss rates of evolved stars, where we take the mass-loss rate as a proxy for the initial stellar mass or current stellar age. This is consistent with the different abundance ratios found in presolar grains. Before the formation of the Sun, the presolar grains indicate that the bulk of presolar grain already had $^{29}Si/^{30}Si$ ratios of about 1.5, which is also the ratio we found for the objects younger than the Sun, such as VY CMa and IRC +10 216. However, we found that older objects (up to possibly 10 Gyr old) in our sample trace a previous, lower $^{29}Si/^{30}Si$ value of about 1. Material with this isotopic ratio is present in two subclasses of presolar grains, providing independent evidence of the lower ratio. Therefore, the $^{29}Si/^{30}Si$ ratio derived from the SiO emission of evolved stars is a useful diagnostic tool for the study of the GCE and presolar grains.

Published in A&A, 559, L8 (2013)
Available from arXiv:1311.3444

Emission line diagnostics to constrain high temperature populations in early-type galaxies

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Once thought to be devoid of warm and cold interstellar matter, elliptical galaxies are now commonly observed to host extended regions of neutral and ionized gas. Outside of the innermost nuclear regions of these galaxies, the favoured candidate ionizing source remains some component of the stellar population, with mounting evidence suggesting post-asymptotic-giant-branch stars (pAGBs). In a recent paper, we demonstrated that observations of recombination lines of He II (or upper limits thereon) may provide a strong constraint on the presence of any other, higher temperature sources, in particular nuclear-burning white dwarfs in the context of the single degenerate (SD) scenario for type Ia supernovæ. The sensitivity of the He II test is greatest for WD effective temperatures $\sim 2 \times 10^5$ K. Here we extend our analysis to include predictions for all of the "classical" strong optical lines, as well as UV, optical, and infra-red lines of neutral oxygen, nitrogen, and singly-ionized carbon. This allows us to extend the temperature range over which we can meaningfully constrain the collective luminosity of nuclear-burning WDs to 10^5 K $\lesssim T \lesssim 10^6$ K. We then demonstrate how observations of nearby early-type and post-starburst galaxies can place strong limits on the origin of type Ia supernovæ.

Submitted to MNRAS
Available from arXiv:1311.1693

Mid-infrared imaging of the bipolar planetary nebula M 2-9 from SOFIA

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We have imaged the bipolar planetary nebula M 2-9 using SOFIA's FORCAST instrument in six wavelength bands between 6.6 and 37.1 μm. A bright central point source, unresolved with SOFIA's $\sim 4''$-to-$5''$ beam, is seen at each wavelength, and the extended bipolar lobes are clearly seen at 19.7 μm and beyond. The photometry between 10 and 25 μm is well fit by the emission predicted from a stratified disk seen at large inclination, as has been proposed for this source by Lykou et al. and by Smith & Gehrz. The principal new results in this paper relate to the distribution and properties of the dust that emits the infrared radiation. In particular, a considerable fraction of this material is spread uniformly through the lobes, although the dust density does increase at the sharp outer edge seen in higher resolution optical images of M 2-9. The dust grain population in the lobes shows that small (< 0.1 μm) and large (> 1 μm) particles appear to be present in roughly equal amounts by mass. We suggest that collisional processing within the bipolar outflow plays an important role in establishing the particle size distribution.

Accepted for publication in Astrophysical Journal
Available from arXiv:1311.4949

Search for surface magnetic fields in Mira stars. First detection in χ Cyg

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So far, surface magnetic fields have never been detected on Mira stars. Only recently the spectropolarimetric capabilities of measuring it through the Zeeman effect have become available to us. Then, in order to complete the knowledge of the magnetic field and of its influence during the transition from Asymptotic Giant Branch to Planetary Nebulæ stages, we have undertaken a search for magnetic fields at the surface of Mira stars. Our main goal is to constrain – at this stage of stellar evolution – the surface magnetic field (presence and strength) and to precise the magnetic field strength dependence along the radial distance to the star, above the photosphere and across the circumstellar envelope of cool and evolved stars. We used spectropolarimetric observations (Stokes V spectra probing circular polarization), collected with the Narval instrument at TBL, in order to detect – with Least Squares Deconvolution (LSD) method – a Zeeman signature in the visible part of the spectrum. We present the first spectropolarimetric observations of the S-type Mira star χ Cyg, performed around its maximum light. We have detected a polarimetric signal in the Stokes V spectra and we have established its Zeeman origin. We claim that it is likely to be related to a weak magnetic field present at the photospheric level and in the lower part of the stellar atmosphere. We have estimated the strength of its longitudinal component to about 2–3 Gauss. This result favors a $1/r$ law for the variation of the magnetic field strength across the circumstellar envelope of χ Cyg. This is the first detection of a weak magnetic field at the stellar surface of a Mira star and we discuss its origin in the framework of shock waves periodically propagating throughout the atmosphere of these radially pulsating stars. At the date of our observations of χ Cyg, the shock wave reaches its maximum intensity, and it is likely that the shock amplifies a weak stellar magnetic field during its passage through the atmosphere. Without such an amplification by the shock, the magnetic field strength would have been too low to be detected. For the first time, we also report strong Stokes Q and U signatures (linear polarization) centered onto the zero velocity (i.e. at the shock front position). They seem to indicate that the radial direction would be favored by the shock during its propagation throughout the atmosphere.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:1310.4379

H I free–bound emission of planetary nebulæ with large abundance discrepancies: Two-component models versus κ-distributed electrons

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The "abundance discrepancy" problem in the study of planetary nebulæ (PNe), viz., the problem concerning systematically higher heavy-element abundances derived from optical recombination lines relative to those from collisionally excited lines, has been under discussion for decades, but no consensus on its solution has yet been reached. In this paper we investigate the hydrogen free–bound emission near the Balmer jump region of four PNe that are among those with the largest abundance discrepancies, aiming to examine two recently proposed solutions to this problem: two-component models and κ electron energy distributions. We find that the Balmer jump intensities and the spectrum slopes cannot be simultaneously matched by the theoretical calculations based upon single Maxwell–Boltzmann

electron-energy distributions, whereas the fitting can be equally improved by introducing κ electron energy distributions or an additional Maxwell–Boltzmann component. We show that although H I free–bound emission alone cannot distinguish the two scenarios, it can provide important constraints on the electron energy distributions, especially for cold and low-κ plasmas.

Accepted for publication in ApJ
Available from arXiv:1311.4974

Chemical compositions of RV Tauri stars and related objects

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We have undertaken a comprehensive abundance analysis for a sample of relatively unexplored RV Tauri and RV Tauri like stars to further our understanding of post-Asymptotic Giant Branch (post-AGB) evolution. From our study based on high resolution spectra and grid of model atmospheres, we find indications of mild s-processing for V820 Cen and IRAS 06165+3158. On the other hand, SU Gem and BT Lac exhibit the effects of mild dust-gas winnowing. We have also compiled the existing abundance data on RV Tauri objects and find that a large fraction of them are afflicted by dust-gas winnowing and now added by the present work, we find a small group of two RV Tauri stars showing mild s-process enhancement in our Galaxy. With two out of three reported s-process enhanced objects belonging to RV Tauri spectroscopic class C, these intrinsically metal-poor objects appear to be promising candidates to analyse the possible s-processing in RV Tauri stars.

Accepted for publication in Revista Méxicana de Astronomía y Astrofísica
Available from arXiv:1311.6496

Timing of a young mildly recycled pulsar with a massive white dwarf companion

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We report on timing observations of the recently discovered binary pulsar PSR J1952+2630 using the Arecibo Observatory. The mildly recycled 20.7-ms pulsar is in a 9.4-hr orbit with a massive, $M_{\rm WD} > 0.93$ M$_\odot$, white dwarf (WD) companion. We present, for the first time, a phase-coherent timing solution, with precise spin, astrometric, and Keplerian orbital parameters. This shows that the characteristic age of PSR J1952+2630 is 77 Myr, younger by one order of magnitude than any other recycled pulsar–massive WD system. We derive an upper limit on the true age of the system of 150 Myr. We investigate the formation of PSR J1952+2630 using detailed modelling of the mass-transfer process from a naked helium star on to the neutron star following a common-envelope phase (Case BB Roche-lobe overflow). From our modelling of the progenitor system, we constrain the accretion efficiency of the neutron star,

which suggests a value between 100 and 300% of the Eddington accretion limit. We present numerical models of the chemical structure of a possible oxygen–neon–magnesium WD companion. Furthermore, we calculate the past and the future spin evolution of PSR J1952+2630, until the system merges in about 3.4 Gyr due to gravitational wave emission. Although we detect no relativistic effects in our timing analysis we show that several such effects will become measurable with continued observations over the next 10 years; thus PSR J1952+2630 has potential as a testbed for gravitational theories.

Published in M.N.R.A.S. (2013)
Available from arXiv:1310.5857

Collision strengths for [O III] optical and infrared lines

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We present electron collision strengths and their thermally averaged values for the forbidden lines of the astronomically abundant doubly-ionized oxygen ion, O^{2+}, in an intermediate coupling scheme using the Breit–Pauli relativistic terms as implemented in an R-matrix atomic scattering code. We use several atomic targets for the R-matrix scattering calculations including one with 72 atomic terms. We also compare with new results obtained using the intermediate coupling frame transformation method. We find spectroscopically significant differences against a recent Breit–Pauli calculation for the excitation of the [O III] λ4363 transition but confirm the results of earlier calculations.

Submitted to MNRAS
Available from arXiv:1311.6517

Large variety of new pulsating stars in the OGLE-III Galactic disk fields

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We present the results of a search for pulsating stars in the 7.12 deg^2 OGLE-III Galactic disk area in the direction tangent to the Centaurus Arm. We report the identification of 20 Classical Cepheids, 45 RR Lyr type stars, 14 Long-Period Variables, such as Miras and Semi-Regular Variables, and 56 very likely δ Sct type stars. Based on asteroseismic models constructed for one quadruple-mode and six triple-mode δ Sct type pulsators, we estimated masses, metallicities, ages, and distance moduli to these objects. The modeled stars have masses in the range 0.9–2.5 $M_\odot$ and are located at distances between 2.5 kpc and 6.2 kpc. Two triple-mode and one double-mode pulsators seem to be Population II stars of the SX Phe type, probably from the Galactic Halo. All reported pulsating variables but one object are new discoveries. They are included in the OGLE-III Catalog of Variable Stars. Finally, we introduce the on-going OGLE-IV Galactic Disk Survey, which covers half of the Galactic plane. For the purposes of future works on the spiral structure and star formation history of the Milky Way, we have already compiled a list of known Galactic Classical Cepheids.

Submitted to Acta Astronomica
Available from arXiv:1311.5894
and from http://ogle.astrouw.edu.pl/

A radio characterization of Galactic compact bubbles

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We report the radio observations of a sub-sample of the 428 galactic compact bubbles discovered at 24 μm with the MIPSGAL survey. Pervasive through the entire Galactic plane, these objects are thought to be different kinds of evolved stars. The very large majority of the bubbles ($\sim$ 70%) are however not yet classified. We conducted radio observations with the EVLA at 6 cm and 20 cm in order to obtain the spectral index of 55 bubbles. We found that at least 70 per cent of the 31 bubbles for which we were effectively able to compute the spectral index (or its lower limit) are likely to be thermal emitters. We were also able to resolve some bubbles, obtaining that the size of the radio nebula is usually similar to the IR size, although our low resolution (with respect to IR images) did not allow further morphological studies. Comparisons between radio flux densities and IR archive data from Spitzer and IRAS suggest that at least 3 unclassified bubbles can be treated as planetary nebula candidates.

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from arXiv:1311.4753

Cool carbon stars in the Halo and in dwarf galaxies: Hα, colours, and variability

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The population of cool carbon (C) stars located far from the galactic plane is probably made of debris of small galaxies such as the Sagittarius dwarf spheroidal galaxy (Sgr), which are disrupted by the gravitational field of the Galaxy. We aim to know this population better through spectroscopy, 2MASS photometric colours, and variability data. When possible, we compared the Halo results to C star populations in the Fornax dwarf spheroidal galaxy, Sgr, and the solar neighbourhood. We first present a few new discoveries of C stars in the halo and in Fornax. The number of spectra of halo C stars is now 125. Forty percent show Hα in emission. The narrow location in the JHK diagram of the Halo C stars is found to differ from that of similar C stars in the above galaxies. The light curves of the Catalina and LINEAR variability databases were exploited to derive the pulsation periods of 66 Halo C stars. A few supplementary periods were obtained with the TAROT telescopes. We confirm that the period distribution of the Halo strongly resembles that of Fornax, and we found that it is very different from the C stars in the Solar Neighbourhood. There is a larger proportion of short period Mira/SRa variables in the Halo than in Sgr, but the survey for C stars in this dwarf galaxy is not complete, and the study of their variability needs to be continued to investigate the link between Sgr and the cool Halo C stars.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:1311.6977

The problematically short superwind of OH/IR stars

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Spectra of OH/IR stars show prominent spectral bands of crystalline olivine ($Mg_{2-2x}Fe_{2x}SiO_4$). To learn more about the timescale of the outflows of OH/IR stars, we study the spectral band of crystalline olivine at 69 μm.
The 69-μm band is of interest because its width and peak wavelength position are sensitive to the grain temperature and to the exact composition of the crystalline olivine. With *Herschel*/PACS, we observed the 69-μm band in the outflow of 14 OH/IR stars. By comparing the crystalline olivine features of our sample with those of model spectra, we determined the size of the outflow and its crystalline olivine abundance.
The temperature indicated by the observed 69-μm bands can only be reproduced by models with a geometrically compact superwind ($R_{\rm SW} < 2500$ au $= 1400$ R$_\star$). This means that the superwind started less than 1200 years ago (assuming an outflow velocity of 10 km s^{-1}). The small amount of mass lost in one superwind and the high progenitor mass of the OH/IR stars introduce a mass loss and thus evolutionary problem for these objects, which has not yet been understood.

Accepted for publication in A&A
Available from arXiv:1311.6908

Conference Papers

Miras or SRA'S – the Transient Type Variables

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The group of Mira-type and semi-regular variables with similar periodicity (multiperiodicty) is analyzed. They have periods of 230–260 days and 140–150 days and show intervals of periodical (Mira-type) variability with relatively high amplitude and "semi-regular" (SR-type) small-amplitude oscillations. Results of periodogram analysis are represented.

Oral contribution, published in Częstochowski Kalendarz Astronomiczny 2014, eds. Bogdan Wszołek et al.
Available from arXiv:1310.2412

AGB nucleosynthesis at low metallicity: What can we learn from Carbon- and s-elements-enhanced metal-poor stars

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CEMP-s stars are very metal-poor stars with enhanced abundances of carbon and s-process elements. They form a

significant proportion of the very metal-poor stars in the Galactic halo and are mostly observed in binary systems. This suggests that the observed chemical anomalies are due to mass accretion in the past from an asymptotic giant branch (AGB) star. Because CEMP-s stars have hardly evolved since their formation, the study of their observed abundances provides a way to probe our models of AGB nucleosynthesis at low metallicity. To this end we included in our binary evolution model the results of the latest models of AGB nucleosynthesis and we simulated a grid of 100,000 binary stars at metallicity $Z = 0.0001$ in a wide range of initial masses and separations. We compared our modelled stars with a sample of 60 CEMP-s stars from the SAGA database of metal-poor stars. For each observed CEMP-s star of the sample we found the modelled star that reproduces best the observed abundances. The result of this comparison is that we are able to reproduce simultaneously the observed abundance of the elements affected by AGB nucleosynthesis (e.g., C, Mg, s-elements) for about 60% of the stars in the sample.

Oral contribution, published in "Setting a new standard in the analysis of binary stars", Leuven, 16–19 September 2013
Available from arXiv:1310.6859

Magnetic field structure and activity of the He-burning giant 37 Comæ

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We present the first magnetic map of the late-type giant 37 Com. The Least Squares Deconvolution (LSD) method and Zeeman Doppler Imaging (ZDI) inversion technique were applied. The chromospheric activity indicators Hα, S-index, Ca II IRT and the radial velocity were also measured. The evolutionary status of the star has been studied on the basis of state-of-the-art stellar evolutionary models and chemical abundance analysis. 37 Com appears to be in the core Helium-burning phase.

Poster contribution, published in IAU Symposium
Available from arXiv:1310.8083

Magnetic fields in single late-type giants in the Solar vicinity: How common is magnetic activity on the giant branches?

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We present our first results on a new sample containing all single G,K and M giants down to $V = 4$ mag in the

Solar vicinity, suitable for spectropolarimetric (Stokes V) observations with Narval at TBL, France. For detection and measurement of the magnetic field (MF), the Least Squares Deconvolution (LSD) method was applied (Donati et al. 1997) that in the present case enables detection of large-scale MFs even weaker than the solar one (the typical precision of our longitudinal MF measurements is 0.1–0.2 G). The evolutionary status of the stars is determined on the basis of the evolutionary models with rotation (Lagarde et al. 2012; Charbonnel et al., in prep.) and fundamental parameters given by Massarotti et al. (1998). The stars appear to be in the mass range 1–4 $M_{\odot}$, situated at different evolutionary stages after the Main Sequence (MS), up to the Asymptotic Giant Branch (AGB).
The sample contains 45 stars. Up to now, 29 stars are observed (that is about 64% of the sample), each observed at least twice. For 2 stars in the Hertzsprung gap, one is definitely Zeeman detected. Only 5 G and K giants, situated mainly at the base of the Red Giant Branch (RGB) and in the He-burning phase are detected. Surprisingly, a lot of stars ascending towards the RGB tip and in early AGB phase are detected (8 of 13 observed stars). For all Zeeman detected stars $v \sin i$ is redetermined and appears in the interval 2–3 km s^{-1}, but few giants with MF possess larger $v \sin i$.

Oral contribution, published in IAU Symposium 302
Available from arXiv:1311.0482