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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the $153^{\rm rd}$ issue of the AGB Newsletter.

Congratulations to Yannik Libert for his thesis on the circumstellar envelopes of AGB stars. Do read his latest article, posted in this issue, presenting fascinating H I and CO observations of the S-type star RS Cancri: there appears to be a disk, a bipolar outflow, as well as a tail resulting from the interaction with the interstellar medium.

There are two exciting job prospects at the postdoctoral level: at Monash University (Australia) and Uppsala (Sweden).

Please have a look at the announcement of the first Azarquiel School of Astronomy, for university students, in the magnificent city of Granada (Spain, in the region formerly known as Al Andalus). Among its aims are to promote cultural and scientific exchange between Arab and Middle Eastern countries and "the West", which should lead to a better understanding of each other as well as of astronomy, and foster peace and scientific advancement. The school is open to students from any country.

The next issue is planned to be distributed on the $1^{\rm st}$ of May 2010.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

AGB mass-loss rate measurements are severely affected by envelope stripping by the interstellar medium

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

Is extra mixing really needed in Asymptotic Giant Branch stars?

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We demonstrate that the amount of extra mixing required to fit the observed low C/N and $^{12}C/^{13}C$ ratios in first giant branch (FGB) stars is also sufficient to explain the carbon and nitrogen abundances of Galactic asymptotic/second giant branch (AGB) stars. We simulate the effect of extra mixing on the FGB by setting the composition of the envelope to that observed in low-mass ($M \leq 2$ $M_\odot$) FGB stars, and then evolve the models to the tip of the AGB. The inclusion of FGB extra mixing compositional changes has a strong effect on the C and N abundance in our AGB models, leading to compositions consistent with those measured in Galactic carbon-rich stars. The composition of the models is also consistent with C and N abundances measured in mainstream silicon carbide (SiC) grains. While our models cover the range of C abundances measured in carbon stars in the LMC cluster NGC 1846, we cannot simultaneously match the composition of the O and C-rich stars at the same time. A second important result is that our models only match the oxygen isotopic composition of K and some M, MS giants, and are not able to match the oxygen composition of carbon-rich AGB stars. By increasing the abundance of ^{16}O in the intershell (based on observational evidence) it is possible to reproduce the observed trend of increasing $^{16}O/^{18}O$ and $^{16}O/^{17}O$ ratios with evolutionary phase. We also find that some Li production takes place during the AGB and that Li-rich carbon stars ($\log\epsilon(\mathrm{Li})\gtrsim 1$) can be produced. These models show a correlation between increasing Li abundances and C. The models cannot explain the composition of the most Li-enriched carbon stars, nor can we produce a Li-rich carbon star if we assume extra mixing occurs during the FGB owing to ^3He destruction. We tentatively conclude that 1) if extra mixing occurs during the AGB it likely only occurs efficiently in low metallicity objects, or when the stars are heavily obscured making spectroscopic observations difficult, and 2) that the intershell compositions of AGB stars needs further investigation.

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Planetary nebulae in the inner Milky Way: new abundances

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The study of planetary nebulae in the inner-disk and bulge gives important information on the chemical abundances of elements such as He, N, O, Ar, Ne, and on the evolution of these abundances, which is associated with the evolution of intermediate-mass stars and the chemical evolution of the Galaxy. We present accurate abundances of the elements He, N, S, O, Ar, and Ne for a sample of 54 planetary nebulae located towards the bulge of the Galaxy, for which 33 have the abundances derived for the first time. The abundances are derived based on observations in the optical domain made at the National Laboratory for Astrophysics (LNA, Brazil). The data show a good agreement with other results in the literature, in the sense that the distribution of the abundances is similar to those works.

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HD 209621: Abundances of neutron-capture elements

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High resolution spectra obtained from the Subaru Telescope High Dispersion Spectrograph have been used to update the stellar atmospheric parameters and metallicity of the star HD 209621. We have derived a metallicity of [Fe/H] = −1.93 for this star, and have found a large enhancement of carbon and of heavy elements, with respect to iron. Updates on the elemental abundances of four s-process elements (Y, Ce, Pr, Nd) along with the first estimates of abundances for a number of other heavy elements (Sr, Zr, Ba, La, Sm, Eu, Er, Pb) are reported. The stellar atmospheric parameters, the effective temperature, $T_{\rm eff}$, and the surface gravity, $\log g$ (4500 K, 2.0), are determined from LTE analysis using model atmospheres. Estimated [Ba/Eu] = +0.35, places the star in the group of CEMP-(r+s) stars; however, the s-elements abundance pattern seen in HD 209621 is characteristic of CH stars; notably, the 2$^{\rm nd}$-peak s-process elements are more enhanced than the first peak s-process elements. HD 209621 is also found to show a large enhancement of the 3$^{\rm rd}$-peak s-process element lead (Pb) with [Pb/Fe] = +1.88. The relative contributions of the two neutron-capture processes, r- and s- to the observed abundances are examined using a parametric model based analysis, that hints that the neutron-capture elements in HD 209621 primarily originate in s-process.

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A new population of Planetary Nebulae discovered in the Large Magellanic Cloud. III: The luminosity function

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Our previous identification and spectroscopic confirmation of 431 faint, new planetary nebulae in the central 25 deg^2 region of the LMC permits us to now examine the shape of the LMC Planetary Nebula Luminosity Function (PNLF) through an unprecedented 10 magnitude range. The majority of our newly discovered and previously known PNe were observed using the 2dF, multi-object fibre spectroscopy system on the 3.9-m Anglo-Australian Telescope and the FLAMES multi-object spectrograph on the 8-m VLT. We present reliable [O III] 5007 and Hβ flux estimates based on calibrations to well established PN fluxes from previous surveys and spectroscopic standard stars. The bright cutoff ($M^\star$) of the PNLF is found by fitting a truncated exponential curve to the bright end of the PNLF over a 3.4 magnitude range. This cutoff is used to estimate a new distance modulus of 18.46 to the LMC, in close agreement with previous PNLF studies and the best estimates by other indicators. The bright end cutoff is robust to small samples of bright PNe since significantly increased PN samples do not change this fiducial. We then fit a truncated exponential curve directly to the bright end of the function over a 6 magnitude range and test the curve's ability to indicate the position of $M^\star$. Because of the significant increase in the number of LMC PN, the shape of the PNLF is now examined in greater detail than has previously been possible. Newly discovered features include a small increase in the number of PNe over the brightest 4 magnitudes followed by a steep rise over 2 magnitudes, a peak at 6 magnitudes below the bright cutoff and an almost linear drop-off to the faint end. Dips at the bright end of the PNLF are examined in relation to the overall shape of the PNLF and the exponential increase in the number of PNe. Through cumulative functions, the new LMC PNLF is compared to those from the SMC and a new deep local Galactic sample revealing the effects of incompleteness. The new [O III] 5007 LMC PNLF is then compared to our new Hβ LMC PNLF using calibrated and measured fluxes for the same objects, revealing the effects of metallicity on the [O III] 5007 line.

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H I and CO in the circumstellar environment of the S-type star RS Cnc

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Context. The history of mass-loss during the AGB phase is key to understanding the stellar evolution and the gas and dust replenishment of the interstellar medium. The mass loss phenomenon presents fluctuations with a large variety of timescales and spatial scales and requires combining data from multiple tracers.
Aims. We study the respective contributions of the central source and of the external medium to the complex geometry of circumstellar ejecta.
Methods. This paper presents interferometric and single-dish CO rotational line observations along with H I data obtained for the oxygen-rich semi-regular variable RS Cnc, in order to probe its circumstellar environment at different scales.
Results. With the Plateau de Bure Interferometer and the IRAM 30-m telescope, we detect both the CO(1–0) and the CO(2–1) rotational lines from RS Cnc. The line profiles are composite, comprising two components of half-width ~ 2 km s^{-1} and ~ 8 km s^{-1} respectively. Whereas the narrow velocity component seems to originate from an equatorial disk in the central part of the CO envelope, the broad component reveals a bipolar structure, with a north-south velocity gradient. In addition, we obtain new H I data on the source and around it in a field of almost 1 square degree. The H I line is centered at $v_{\rm LSR} = 7$ km s^{-1} in agreement with CO observations. A new reduction process reveals a complex extended structure in the northwest direction, of estimated size $\sim 18'$, with a position angle ($\sim 310°$) opposite to the direction of the stellar proper motion ($\sim 140°$). We derive an H I mass of $\sim 3 \times 10^{-2}$ M$_\odot$ for this structure. Based on a non-spherical simulation, we find that this structure is consistent with arising from the interaction of the star undergoing mass loss at an average rate of $\sim 10^{-7}$ M$_\odot$ yr^{-1} over ~ 2–3×10^5 years with the interstellar medium.
Conclusions. We explore two related but well separated regions of the circumstellar environment around RS Cnc using CO and H I lines. With CO, we probe the recent history of mass loss that shows a bipolar geometry which is probably related to the intrinsic behavior of the mass loss process. In H I, we find a trail of gas, in a direction opposite to the proper motion of RS Cnc lending support to the hypothesis of an interaction with the interstellar medium. This work illustrates the powerful complementarity of CO and H I observations with regard to a more complete description of circumstellar environments around AGB stars.

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Radiative hydrodynamics simulations of red supergiant stars: II. simulations of convection on Betelgeuse match interferometric observations

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Context. The red supergiant (RSG) Betelgeuse is an irregular variable star. Convection may play an important role in understanding this variability. Interferometric observations can be interpreted using sophisticated simulations of stellar convection. Aims. We compare the visibility curves and closure phases obtained from our 3D simulation of

RSG convection with CO5BOLD to various interferometric observations of Betelgeuse from the optical to the H band in order to characterize and measure the convection pattern on this star. Methods. We use 3D radiative-hydrodynamics (RHD) simulation to compute intensity maps in different filters and we thus derive interferometric observables using the post-processing radiative transfer code OPTIM3D. The synthetic visibility curves and closure phases are compared to observations. Results. We provide a robust detection of the granulation pattern on the surface of Betelgeuse in the optical and in the H band based on excellent fits to the observed visibility points and closure phases. Moreover, we determine that the Betelgeuse surface in the H band is covered by small to medium scale (5–15 mas) convection-related surface structures and a large (30 mas) convective cell. In this spectral region, H_2O molecules are the main absorbers and contribute to the small structures and to the position of the first null of the visibility curve (i.e. the apparent stellar radius).

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Discovery of long-period variable stars in the very-metal-poor globular cluster M 15

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We present a search for long-period variable (LPV) stars among giant branch stars in M 15 which, at [Fe/H] ≈ -2.3, is one of the most metal-poor Galactic globular clusters. We use multi-colour optical photometry from the 0.6-m Keele Thornton and 2-m Liverpool Telescopes. Variability of $\Delta V \approx 0.15$ mag is detected in K 757 and K 825 over unusually-long timescales of nearly a year, making them the most metal-poor LPVs found in a Galactic globular cluster. K 825 is placed on the long secondary period sequence, identified for metal-rich LPVs, though no primary period is detectable. We discuss this variability in the context of dust production and stellar evolution at low metallicity, using additional spectra from the 6.5-m Magellan (Las Campanas) telescope. A lack of dust production, despite the presence of gaseous mass loss raises questions about the production of dust and the intra-cluster medium of this cluster.

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Oxygen isotopic ratios in cool R Coronae Borealis stars

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We investigate the relationship between R Coronae Borealis (RCB) stars and hydrogen-deficient carbon (HdC) stars by measuring precise $^{16}O/^{18}O$ ratios for five cool RCB stars. The $^{16}O/^{18}O$ ratios are derived by spectrum synthesis from high-resolution ($R \sim 50,000$) K-band spectra. Lower limits to the $^{16}O/^{17}O$ and $^{14}N/^{15}N$ ratios as well as Na and S abundances (when possible) are also given. RCB stars in our sample generally display less ^{18}O than HdC stars — the derived $^{16}O/^{18}O$ ratios range from 3 to 20. The only exception is the RCB star WX CrA, which seems to be a HdC-like star with $^{16}O/^{18}O$=0.3. Our result of a higher $^{16}O/^{18}O$ ratio for the RCB stars must be accounted for by

a theory of the formation and evolution of HdC and RCB stars. We speculate that a late dredge-up of products of He-burning, principally ^{12}C and ^{16}O, may convert a ^{18}O-rich HdC star into a ^{18}O-poor RCB star as the H-deficient star begins its final evolution from a cool supergiant to the top of the white dwarf cooling track.

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AKARI's infrared view on nearby stars : Using AKARI Infrared Camera All-Sky Survey, 2MASS, and Hipparcos catalogs

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Context: The AKARI, a Japanese infrared space mission, has performed an All-Sky Survey in six infrared-bands from 9 to 180 μm with higher spatial resolutions and better sensitivities than the Infrared Astronomical Satellite (IRAS).
Aims: We investigate the mid-infrared (9 and 18 μm) point source catalog (PSC) obtained with the Infrared Camera (IRC) onboard AKARI, in order to understand the infrared nature of the known objects and to identify previously unknown objects.
Methods: Color–color diagrams and a color–magnitude diagram were plotted with the AKARI-IRC PSC and other available all-sky survey catalogs. We combined the Hipparcos astrometric catalog and the 2MASS all-sky survey catalog with the AKARI-IRC PSC. We furthermore searched literature and SIMBAD astronomical database for object types, spectral types, and luminosity classes. We identified the locations of representative stars and objects on the color–magnitude and color–color diagram schemes. The properties of unclassified sources can be inferred from their locations on these diagrams.
Results: We found that the (B–V) vs. (V–S9W) color–color diagram is useful for identifying the stars with infrared excess emerged from circumstellar envelopes or disks. Be stars with infrared excess are separated well from other types of stars in this diagram. Whereas (J–L18W) vs. (S9W–L18W) diagram is a powerful tool for classifying several object types. Carbon-rich asymptotic giant branch (AGB) stars and OH/IR stars form distinct sequences in this color–color diagram. Young stellar objects (YSOs), pre-main sequence (PMS) stars, post-AGB stars, and planetary nebulae (PNe) have the largest mid-infrared color excess and can be identified in the infrared catalog. Finally, we plot the L18W vs. (S9W–L18W) color–magnitude diagram, using the AKARI data together with Hipparcos parallaxes. This diagram can be used to identify low-mass YSOs and AGB stars. We found that this diagram is comparable to the [24] vs. ([8.0]–[24]) diagram of Large Magellanic Cloud sources using the Spitzer Space Telescope data. Our understanding of Galactic objects will be used to interpret color–magnitude diagram of stellar populations in the nearby galaxies that Spitzer Space Telescope observed.
Conclusions: Our study of the AKARI color–color and color–magnitude diagrams will be used to explore properties of unknown objects in the future. In addition, our analysis highlights a future key project to understand stellar evolution with a circumstellar envelope, once the forthcoming astronometrical data with GAIA are available.

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The envelope mass of red giant donors in Type Ia supernova progenitors

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The Single Degenerate model is the most widely accepted progenitor model of type Ia supernovae (SNe Ia), in which a carbon-oxygen white dwarf (CO WD) accretes hydrogen-rich material from a main sequence or a slightly evolved star (WD + MS) or from a red giant star (WD + RG), to increase its mass and explodes when approaching the Chandrasekhar mass. The explosion ejecta may impact into the envelope of the companion and strip off some hydrogen-rich material from the companion. The stripped-off hydrogen-rich material may reveal itself through a hydrogen line in the nebular spectra of SNe Ia. However, no hydrogen line is detected in the nebular spectra. The purpose of this paper is to compute the remaining amounts of hydrogen in red giabt donors to see whether the conflict between theory and observations can be overcome. Considering the mass-stripping effect from an optically thick wind and the effect of thermally unstable disk, we systemically carried out binary evolution calculation for WD + MS and WD + RG systems. Here, we focus on the evolution of a WD + RG systems. We found that at the time of the supernova explosion, some donor stars almost maintain only very little hydrogen-rich material on top of the helium core (as low as 0.017 $M_{\odot}$), which is smaller than the upper limit of the amount of the stripped-off material by explosion ejecta derived from observations. Thus, no hydrogen line is expected in the nebular spectra of such SN Ia. We also derive the distributions of the envelope mass and the core mass of the companions from WD + RG channel at the moment of supernova explosion via a binary population synthesis approach. We find that a RG companion with a very low-mass envelope is rare. Furthermore, our models suggest that the remnant from WD + RG channel after the supernova explosion is a single low-mass white dwarf (0.15 $M_{\odot}$ − 0.30 $M_{\odot}$). The fact the no hydrogen line was detected in nebular spectra of SNe Ia is possible evidence to uphold the WD + RG system as the progenitor of SNe Ia.

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Strengthening the case for asteroidal accrection: evidence for subtle and diverse disks at white dwarfs

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Spitzer Space Telescope IRAC 3–8 μm and AKARI IRC 2–4 μm photometry are reported for ten white dwarfs with photospheric heavy elements; nine relatively cool stars with photospheric calcium, and one hotter star with a peculiar high carbon abundance. A substantial infrared excess is detected at HE 2221−1630, while modest excess emissions are identified at HE 0106−3253 and HE 0307+0746, implying these latter two stars have relatively narrow ($\Delta r < 0.1$ $R_{\odot}$) rings of circumstellar dust. A likely 7.9 μm excess is found at PG 1225−079 and may represent, together with G 166−58, a sub-class of dust ring with a large inner hole. The existence of attenuated disks at white dwarfs substantiates the connection between their photospheric heavy elements and the accretion of disrupted minor planets, indicating many polluted white dwarfs may harbor orbiting dust, even those lacking an obvious infrared excess.

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Dwarf spheroidals in the M 81 Group — Metallicity distribution functions and population gradients

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We study the dwarf spheroidal galaxies in the nearby M 81 group in order to construct their photometric metallicity distributions and to investigate the potential presence of population gradients. We select all the dwarf spheroidals with available Hubble Space Telescope/Advanced Camera for Surveys archival observations, nine in total. We interpolate isochrones so as to assign a photometric metallicity to each star within a selection box in the color–magnitude diagram of each dwarf galaxy. We assume that the dwarf spheroidals contain mainly an old stellar population. In order to search for metallicity gradients, we examine the spatial distribution of two stellar populations that we separate according to their metallicities. As a result, we present the photometric metallicity distribution functions, the cumulative histograms and smoothed density maps of the metal-poor and metal-rich stars as well as of the intermediate-age stars. From our photometric data we find that all the dwarf spheroidals show a wide range in metallicities, with mean values that are typical for old and metal-poor systems, with the exception of one dwarf spheroidal, namely IKN. Some of our dwarf spheroidals exhibit characteristics of transition-type dwarfs. Compared to the Local Group transition type dwarfs, the M 81 group ones appear to have mean metallicity values slightly more metal-rich at a given luminosity. All the dwarf spheroidals considered here appear to exhibit either population gradients or spatial variations in the centroids of their metal-poor and metal-rich population. In addition, there are luminous AGB stars detected in all of them with spatial distributions suggesting that they are well mixed with the old stars.

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The double-degenerate nucleus of the Planetary Nebula TS 01. A close binary evolution showcase

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We present a detailed investigation of SBS 1150+599 A, a close binary star hosted by the planetary nebula PN G 135.9+55.9 (TS 01, Stasińska et al. 2009). The nebula, located in the Galactic halo, is the most oxygen-poor one known to date and is the only one known to harbor a double degenerate core. We present XMM-Newton observations of this object, which allowed the detection of the previously invisible component of the binary core, whose existence was inferred so far only from radial velocity and photometric variations. The parameters of the binary system were deduced from a wealth of information via three independent routes using the spectral energy distribution (from the infrared to X-rays), the light and radial velocity curves, and a detailed model atmosphere fitting of the stellar absorption features of the optical/UV component. We find that the cool component must have a mass of 0.54 ± 0.2 $\mathrm{M}_\odot$, an average effective temperature, $T_{\rm eff}$, of 58000 ± 3000 K, a mean radius of 0.43 ± 0.3 $\mathrm{R}_\odot$, a gravity $\log g = 5.0 \pm 0.3$, and that it nearly fills its Roche lobe. Its surface elemental abundances are found to be: $12 + \log \mathrm{He/H} = 10.95 \pm 0.04$ dex, $12 + \log \mathrm{C/H} = 7.20 \pm 0.3$ dex, $12 + \log \mathrm{N/H} < 6.92$ and $12 + \log \mathrm{O/H} < 6.80$, in overall agreement with the chemical

composition of the planetary nebula. The hot component has $T_{\text{eff}} = 160$–180 kK, a luminosity of about $\sim 10^4$ L$_\odot$ and a radius slightly larger than that of a white dwarf. It is probably bloated and heated as a result of intense accretion and nuclear burning on its surface in the past. The total mass of the binary system is very close to Chandrasekhar limit. This makes TS 01 one of the best type Ia supernova progenitor candidates. We propose two possible scenarios for the evolution of the system up to its present stage.

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Testing a pulsating binary model for long secondary periods in red variables

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The origin of the long secondary periods (LSPs) in red variables remains a mystery up to now, although there exist many models. The light curves of some LSPs stars mimic an eclipsing binary with a pulsating red giant component. To test this hypothesis, the observational data of two LSP variable red giants, 77.7795.29 and 77.8031.42, discovered by the MACHO project from the LMC, are collected and analyzed. The probable eclipsing features of the light curves are simulated by the Wilson–Devinney (W–D) method. The simulation yields a contact and a semidetached geometry for the two systems, respectively. In addition, the pulsation constant of the main pulsating component in each binary system is derived. By combining the results of the binary model and the pulsation component, we investigate the feasibility of the pulsating binary model. It is found that the radial velocity curve expected from the binary model has a much larger amplitude than the observed one and a period double the observed one. Furthermore, the masses of the components based on the density derived from the binary orbit solution are too low to be compatible with both the evolutionary stage and the high luminosity. Although the pulsation mode identified by the pulsation constant which is dependent on the density from the binary-model is consistent with the first or second overtone radial pulsation, we conclude that the pulsating binary model is a defective model for the LSP.

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Determining the forsterite abundance of the dust around Asymptotic Giant Branch stars

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Aims: We present a diagnostic tool to determine the abundance of the crystalline silicate forsterite in AGB stars surrounded by a thick shell of silicate dust. Using six infrared spectra of high mass-loss oxygen rich AGB stars we obtain the forsterite abundance of their dust shells.
Methods: We use a monte carlo radiative transfer code to calculate infrared spectra of dust enshrouded AGB stars. We vary the dust composition, mass-loss rate and outer radius. We focus on the strength of the 11.3 and the 33.6 μm forsterite bands, that probe the most recent (11.3 μm) and older (33.6 μm) mass-loss history of the star. Simple diagnostic diagrams are derived, allowing direct comparison to observed band strengths.

Results: Our analysis shows that the 11.3 μm forsterite band is a robust indicator for the forsterite abundance of the current mass-loss period for AGB stars with an optically thick dust shell. The 33.6 μm band of forsterite is sensitive to changes in the density and the geometry of the emitting dust shell, and so a less robust indicator. Applying our method to six high mass-loss rate AGB stars shows that AGB stars can have forsterite abundances of 12% by mass and higher, which is more than the previously found maximum abundance of 5%.

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Variations in the Na–O anti-correlation in globular clusters: Evidence for a deep mixing episode in red giant branch

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The Na–O anti-correlation seen in almost all globular clusters ever studied using high-resolution spectroscopy is now generally explained by the primordial pollution from the first generation of the intermediate-mass asymptotic giant branch stars to the proto-stellar clouds of the second generation of stars. However, the primordial pollution scenario may not tell the whole story for the observed Na–O anti-correlations in globular clusters. Using the recent data by Carretta and his collaborators, the different shapes of the Na–O anti-correlations for red giant branch stars brighter than and fainter than the red giant branch bump can be clearly seen. If the elemental abundance measurements by Carretta and his collaborators are not greatly in error, this variation in the Na–O anticorrelation against luminosity indicates an internal deep mixing episode during the ascent of the low-mass red giant branch in globular clusters. Our result implies that the multiple stellar population division scheme solely based on [O/Fe] and [Na/Fe] ratios of a globular cluster, which is becoming popular, is not reliable for stars brighter than the red giant branch bump. Our result also suggests that sodium supplied by the deep mixing may alleviate the sodium under-production problem within the primordial asymptotic giant branch pollution scenario.

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The core helium flash revisited III. From Pop I to Pop III stars

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Degenerate ignition of helium in low-mass stars at the end of the red giant branch phase leads to dynamic convection in their helium cores. One-dimensional (1D) stellar modeling of this intrinsically multi-dimensional dynamic event is likely to be inadequate. Previous hydrodynamic simulations imply that the single convection zone in the helium core of metal-rich Pop I stars grows during the flash on a dynamic timescale. This may lead to hydrogen injection into the core, and a double convection zone structure as known from one-dimensional core helium flash simulations of low-mass Pop III stars. We perform hydrodynamic simulations of the core helium flash in two and three dimensions to better constrain the nature of these events. To this end we study the hydrodynamics of convection within the helium cores of a 1.25 $M_{\odot}$ metal-rich Pop I star ($Z = 0.02$), and a 0.85 $M_{\odot}$ metal-free Pop III star ($Z = 0$) near the peak of the flash. These models possess single and double convection zones, respectively. We use 1D stellar models of the core helium flash computed with state-of-the-art stellar evolution codes as initial models for our multidimensional hydrodynamic study, and simulate the evolution of these models with the Riemann solver based hydrodynamics code Herakles which integrates the Euler equations coupled with source terms corresponding to gravity and nuclear burning.

The hydrodynamic simulation of the Pop I model involving a single convection zone covers 27 hours of stellar evolution, while the first hydrodynamic simulations of a double convection zone, in the Pop III model, span 1.8 hours of stellar life. We find differences between the predictions of mixing length theory and our hydrodynamic simulations. The simulation of the single convection zone in the Pop I model shows a strong growth of the size of the convection zone due to turbulent entrainment. Hence we predict that for the Pop I model a hydrogen injection phase (i.e. hydrogen injection into the helium core) will commence after about 23 days, which should eventually lead to a double convection zone structure known from 1D stellar modeling of low-mass Pop III stars. Our two and three-dimensional hydrodynamic simulations of the double (Pop III) convection zone model show that the velocity field in the convection zones is different from that predicted by stellar evolutionary calculations. The simulations suggest that the double convection zone decays quickly, the flow eventually being dominated by internal gravity waves.

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The central star of the planetary nebula PB 8: a Wolf-Rayet-type wind of an unusual WN/WC chemical composition

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A considerable fraction of the central stars of planetary nebulæ (CSPNe) are hydrogen-deficient. As a rule, these CSPNe exhibit a chemical composition of helium, carbon, and oxygen with the majority showing Wolf-Rayet-like emission line spectra. These stars are classified as CSPNe of a spectral type [WC]. We perform a spectral analysis of CSPN PB 8 with the Potsdam Wolf-Rayet (PoWR) models for expanding atmospheres. The source PB 8 displays wind-broadened emission lines from strong mass loss. Most strikingly, we find that its surface composition is hydrogen-deficient, but not carbon-rich. With mass fractions of 55% helium, 40% hydrogen, 1.3% carbon, 2% nitrogen, and 1.3% oxygen, it differs greatly from the 30–50% of carbon which are typically seen in [WC]-type central stars. The atmospheric mixture in PB 8 has an analogy in the WN/WC transition type among the massive Wolf-Rayet stars. Therefore we suggest to introduce a new spectral type [WN/WC] for CSPNe, with PB 8 as its first member. The central star of PB 8 has a relatively low temperature of $T_\star = 52$ kK, as expected for central stars in their early evolutionary stages. Its surrounding nebula is less than 3000 years old, i.e. relatively young. Existing calculations for the post-AGB evolution can produce hydrogen-deficient stars of the [WC] type, but do not predict the composition found in PB 8. We discuss various scenarios that might explain the origin of this unique object.

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The origin of carbon: Low-mass stars and an evolving, initially top-heavy IMF?

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Multi-zone chemical evolution models (CEMs), differing in the nucleosynthesis prescriptions (yields) and prescriptions of star formation, have been computed for the Milky Way. All models fit the observed O/H and Fe/H gradients well and reproduce the main characteristics of the gas distribution, but they are also designed to do so. For the C/H gradient the results are inconclusive with regards to yields and star formation. The C/Fe and O/Fe vs. Fe/H, as well as C/O vs. O/H trends predicted by the models for the solar neighbourhood zone were compared with stellar

abundances from the literature. For O/Fe vs. Fe/H all models fit the data, but for C/O vs. O/H, only models with increased carbon yields for zero-metallicity stars or an evolving initial mass function provide good fits. Furthermore, a steep star formation threshold in the disc can be ruled out since it predicts a steep fall-off in all abundance gradients beyond a certain galactocentric distance ($\sim$ 13 kpc) and cannot explain the possible flattening of the C/H and Fe/H gradients in the outer disc seen in observations. Since in the best-fit models the enrichment scenario is such that carbon is primarily produced in low-mass stars, it is suggested that in every environment where the peak of star formation happened a few Gyr back in time, winds of carbon-stars are responsible for most of the carbon enrichment. However, a significant contribution by zero-metallicity stars, especially at very early stages, and by winds of high-mass stars, which are increasing in strength with metallicity, cannot be ruled out by the CEMs presented here. In the solar neighbourhood, as much as 80%, or as little as 40% of the carbon may have been injected to the interstellar medium by low- and intermediate-mass stars. The stellar origin of carbon remains an open question, although production in low- and intermediate-mass stars appears to be the simplest explanation of observed carbon abundance trends.

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The Galactic structure and chemical evolution traced by the population of planetary nebulae

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We use an extended and homogeneous data set of Galactic planetary nebulae (PNe) to study the metallicity gradients and the Galactic structure and evolution. The most up-to-date abundances, distances (calibrated with Magellanic Cloud PNe) have been employed, together with a novel homogeneous morphological classification, to characterize the different PN populations. We confirm that morphological classes have a strong correlation with PN Peimbert's Type, and also with their distribution on the Galactic landscape. We studied the α-element distribution within the Galactic disk, and found that the best selected disk population, together with the most reliable PN distance scale yields to a radial oxygen gradient of $\mathrm{d}[\log(\mathrm{O/H})]/\mathrm{d}R = -0.023 \pm 0.006$ dex kpc^{-1} for the whole disk sample, and of $\mathrm{d}[\log(\mathrm{O/H})]/\mathrm{d}R = -0.035 \pm 0.024$, -0.023 ± 0.005, and -0.011 ± 0.013 dex kpc^{-1} respectively for Type I, II, and III PNe. Neon gradients for the same PN types confirm the trend. Accurate statistical analysis show moderately high uncertainties in the slopes, but also confirm the trend of steeper gradient for PNe with more massive progenitors, indicating a possible steepening with time of the Galactic disk metallicity gradient. The PN metallicity gradients presented here are consistent with the local metallicity distribution; furthermore, oxygen gradients determined with young and intermediate age PNe show good consistency with oxygen gradients derived respectively from other young (OB stars, H II regions) and intermediate (open cluster) Galactic populations. We also extend the Galactic metallicity gradient comparison by revisiting the open cluster [Fe/H] data from high resolution spectroscopy. The analysis suggests that they could be compliant with the same general picture of a steepening of gradient with time.

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Chemical composition of A–F type post-AGB candidates

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An abundance analysis has been conducted for a sample of nine post-AGB candidate stars; eight of them have not been explored before. We find four very promising objects like HD 105262, HD 53300 and CpD $-62°$5428 among them. We find strong evidence of dust-gas separation through selective depletion of refractive elements in HD 105262. The same effect is also observed in HD 53300, CpD $-62°$5428 and HD 114855 although abundance peculiarities are relatively smaller for the last two stars. We find strong enrichment of nitrogen for HD 725, HD 842, HD 1457, HD 9233 and HD 61227 but no further evidence to support their post-AGB nature. We have compared the observed [N/C] ratios of these stars with the predictions of evolutionary models which include the rotation induced mixing.

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Asymptotic Giant Branch stars in the Leo I dwarf spheroidal galaxy

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Twenty six Asymptotic Giant Branch (AGB) variables are identified in the Local Group galaxy Leo I. These include 7 Mira and 5 semi-regular variables for which periods, amplitudes and mean magnitudes are determined. The large range of periods for the Miras, $158 < P < 523$ days, suggests an AGB spanning a significant age range. The youngest must be around 1.6 Gyr while the oldest could be 10 Gyr or more. Two of these old Miras are found in the outer regions of Leo I ($> 490''$ from the centre) where stars on the extended AGB are rare. They could provide an interesting test of third dredge-up and mass loss in old stars with low metallicity and are worth further detailed investigation. At least two stars, one a Mira, the other an irregular variable, are undergoing obscuration events due to dust ejection. An application of the Mira period–luminosity relation to these stars yields a distance modulus for Leo I of $(m-M)_0 = 21.80 \pm 0.11$ mag (internal), ± 0.12 (total) (on a scale that puts the LMC at 18.39 mag) in good agreement with other determinations.

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Conference Paper

High-resolution spectroscopy of the R Coronae Borealis and other hydrogen deficient stars

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High-resolution spectroscopy is a very important tool for studying stellar physics, perhaps, particularly so for such enigmatic objects like the R Coronae Borealis and related hydrogen deficient stars that produce carbon dust in addition to their peculiar abundances. Examples of how high-resolution spectroscopy is used in the study of these stars to address the two major puzzles are presented: (i) How are such rare H-deficient stars created? and (ii) How and where are the obscuring soot clouds produced around the R Coronae Borealis stars?

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Available from arXiv:1002.3433

Thesis

Observations and modeling of circumstellar envelopes around AGB stars

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Circumstellar shells around red giants are built over long periods of time that may reach several 10^6 years. They may therefore be extended over large sizes (~ 1 pc, possibly more) and different complementary tracers are needed to describe their global properties. I present here a program designed to gauge the properties of matter in the external parts of circumstellar shells around AGB stars and to relate them to those of the inner envelope. Therefore, I will present 21-cm H I and CO rotational line data obtained on several type of AGB stars. Our interpretation of the H I line-profiles is that the outflow is slowed-down by the ambient interstellar medium. We have designed a spherical model to predict the H I emission, and I will discuss its results. In some cases, the H I source is elongated in a direction compatible with the central-star proper motion, a phenomenon that is being recognized in more and more cases and that is in favor of an interaction with the local material.

partly in French
Available from http://tel.archives-ouvertes.fr/tel-00455657/fr/

Job Adverts

Monash University, Australia Postdoctoral Fellow

Stellar Interiors and NucleoSynthesis Group
Centre for Stellar and Planetary Astrophysics
Monash University
Melbourne
Australia

A position exists for a Postdoctoral Fellow within the SINS group at Monash University's Centre for Stellar and Planetary Astrophysics. We are seeking someone with expertise on stellar modelling, stellar evolution and especially mixing and convection models for stellar conditions. Experience with mutli-dimensional hydrodynamics would be an advantage. The successful applicant will work directly with John Lattanzio, Peter Wood (Mt. Stromlo Observatory, ANU) and David Arnett (Steward Observatory, U. Arizona) on problems involving hydrodynamical simulations of convection, casting these into a form suitable for 1D stellar models, incorporating such algorithms into an existing stellar evolution and pulsation code, examining the results and comparing with the original hydrodynamical calculations and observational constraints. The Fellow will be expected to work closely with, and frequently visit, collaborators Wood and Arnett.

The position is available now and is for 4 years. The successful applicant is also required to help update and teach a first year astrobiology unit. This runs for one semester each year and should take no more than 33% of the applicant's time. Experience with teaching or coordinating large classes would be an advantrage.

Salary will be in the range \$64,002 – \$68,702 (Australian Dollars). A generous superannuation payment is made in addition. The Fellow will be part of the SINS group, a very active and growing group consisting of Prof. John Lattanzio, Dr. Maria Lugaro, Dr. Herbert Lau and Dr. Richard Stancliffe, as well as postgraduate students and other members of CSPA.

The CSPA is housed at the main campus of Monash University in the suburbs of Melbourne. Monash is Australia's largest University and one of the prestigious "Group of Eight" most active research institutions in the country.

Melbourne is the capital of the state of Victoria, and the second largest city in Australia (population nearly 4 million). It is regularly rated as one the world's most livable cities, coming second in the 2008 list. It is an extremely multi-cultural city with excellent cultural life, restaurants, beaches and vineyards very nearby.

Applications, including three letters of reference, should arrive by May 21 either by email to J. Lattanzio or by hard-copy at the following address:

Prof. John Lattanzio
CSPA
School of Mathematical Sciences
Building 28
Monash University
3800
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Further information is available from
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http://www.maths.monash.edu.au/ johnl/
SINS: http://web.maths.monash.edu.au/~johnl/sins/index.shtml
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http://www.melbourne.com.au/
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See also http://www.maths.monash.edu.au/~johnl/

Division of Astronomy and Space Physics, Uppsala University, Sweden Schönberg Post-Doctoral Fellowship

The fellowship will cover 1+1 years with a starting date during 2010. The successful candidate should have obtained a PhD in astronomy or a related field no earlier than in 2005, and should additionally have a strong research record in stellar physics. Preference will be given to applicants who are experienced in modelling dynamical processes involving hydrodynamics and radiative transfer in the context of late-type stars (in particular stellar winds), or in relating such models to observational data.

Applications should consist of Curriculum Vitae, list of publications, three names of reference and a short description of past, current and planned research. Women are particularly encouraged to apply. The application should be received by April 15, 2010. For further information, please see the full announcement text.

Contacts:

Prof. B. Gustafsson (e-mail: Bengt.Gustafsson@fysast.uu.se),
Assoc. Prof. S. Höfner (e-mail: Susanne.Hoefner@fysast.uu.se)

See also http://www.fysast.uu.se/astro/en/page/vacancy-schoenberg-post-doctoral-fellowship

Announcement

Azarquiel School of Astronomy

Azarquiel School of Astronomy. A bridge between East and West

Dear All, we are pleased to announce the First Azarquiel School of Astronomy for university students that will be held in Granada (Spain), July 4–11 2010.

The Azarquiel School is devoted to promote cultural exchange, bridging the gap between the East and the West, and to promote advanced-level teaching in Astronomy, motivating future research activities. Special attention will be given to the historical contribution of Arabs to Astronomy and Science.

The number of participants will be limited to above 40, half of them are expected to come from Arab and Middle East countries.

For registration and detailed information: http://www.azarquiel-school.org/

Please circulate this announcement among potential candidates

Best regards

Inma Domínguez
Universidad de Granada

on behalf of the Board of the School

See also http://www.azarquiel-school.org/