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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 135$^{\rm th}$ issue of the AGB Newsletter. Despite holidays in the editorial office (which were very nice!) you have not sat still, resulting in the thickest-but-one issue ever. There is a surprising abundance of work presented on globular clusters. Exciting new results further include the discovery of three eclipsing binary central stars of Planetary Nebulae, and detailed studies of the bowshocks in front of Betelgeuse and Mira.

There is good news also for our young colleagues looking for a postdoctoral fellowship: two such positions are available at the South African Astronomical Observatory — who operate the largest optical telescope of the world — and another one at the Université Libre in Brussels, in wonderful Europe.

Two workshops are announced as well, one to take place in Granada and another one in Japan.

The next issue will be distributed on the 1$^{\rm st}$ of November; the deadline for contributions is the 31$^{\rm st}$ of October.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

A fraction of the dust produced by AGB stars is destroyed before it mixes with the ISM

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

Chemical abundances in giants stars of the tidally disrupted globular cluster NGC 6712 from high-resolution infrared spectroscopy

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We present abundances of C, N, O, F, Na, and Fe in six giant stars of the tidally disrupted globular cluster NGC 6712. The abundances were derived by comparing synthetic spectra with high resolution infrared spectra obtained with the Phoenix spectrograph on the Gemini South telescope. We find large star-to-star abundance variations of the elements C, N, O, F, and Na. NGC 6712 and M 4 are the only globular clusters in which F has been measured in more than two stars, and both clusters reveal F abundance variations whose amplitude is comparable to, or exceeds, that of O, a pattern which may be produced in $M \gtrsim 5$ $M_{\odot}$ AGB stars. Within the limited samples, the F abundance in globular clusters is lower than in field and bulge stars at the same metallicity. NGC 6712 and Pal 5 are tidally disrupted globular clusters whose red giant members exhibit O and Na abundance variations not seen in comparable metallicity field stars. Therefore, globular clusters like NGC 6712 and Pal 5 cannot contribute many field stars and/or field stars do not form in environments with chemical enrichment histories like that of NGC 6712 and Pal 5. Although our sample size is small, from the amplitude of the O and Na abundance variations, we infer a large initial cluster mass and tentatively confirm that NGC 6712 was once one of the most massive globular clusters in our Galaxy.

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Available from arXiv:0807.4558

Distribution and kinematics of the HCN (3–2) emission down to the innermost region in the envelope of the O-rich star W Hya

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We report high angular resolution observations of the HCN (3–2) line emission in the circumstellar envelope of the O-rich star W Hya with the Submillimeter Array. The proximity of this star allows us to image its molecular envelope with a spatial resolution of just ∼40 AU, corresponding to about 10 times the stellar diameter. We resolve the HCN (3–2) emission and find that it is centrally peaked and has a roughly spherically symmetrical distribution. This shows that HCN is formed in the innermost region of the envelope (within ∼10 stellar radii), which is consistent with predictions from pulsation-driven shock chemistry models, and rules out the scenario in which HCN forms through photochemical reactions in the outer envelope. Our modelsuggests that the envelope decreases steeply in temperature and increases smoothly in velocity with radius, inconsistent with the standard model for mass-loss driven by radiative pressure on dust grains. We detect a velocity gradient of ∼5 km s^{-1} in the NW–SE direction over the central 40 AU. This velocity gradient is reminescent of that seen in OH maser lines, and could be caused by the rotation of the envelope or by a weak bipolar outflow.

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Discovery of Eclipsing Binary Central Stars in the Planetary Nebulae M 3-16, H 2-29 and M 2-19

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Progress in understanding the formation and evolution of planetary nebulae (PN) has been restricted by a paucity of well-determined central star masses. To address this deficiency we aim to (i) significantly increase the number of known eclipsing binary central stars of PN (CSPN), and subsequently (ii) directly obtain their masses and absolute dimensions by combining their light-curve parameters with planned radial velocity data. Using photometric data from the third phase of the Optical Gravitational Lensing Experiment (OGLE) we have searched for periodic variability in a large sample of PN towards the Galactic Bulge using Fourier and phase-dispersion minimisation techniques. Among some dozen periodically variable CSPN found, we report here on three new eclipsing binaries: M 3-16, H 2-29 and M 2-19.

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Available from arXiv:0808.0526

Distance to VY Canis Majoris with VERA

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We report astrometric observations of H_2O masers around the red supergiant VY Canis Majoris (VY CMa) carried out with VLBI Exploration of Radio Astrometry (VERA). Based on astrometric monitoring for 13 months, we successfully measured a trigonometric parallax of 0.88 ± 0.08 mas, corresponding to a distance of $1.14\ ^{+0.11}_{-0.09}$ kpc. This is the most accurate distance to VY CMa and the first one based on an annual parallax measurement. The luminosity of VY CMa has been overestimated due to a previously accepted distance. With our result, we re-estimate the luminosity of VY CMa to be $(3 \pm 0.5) \times 10^5$ $L_\odot$ using the bolometric flux integrated over optical and IR wavelengths. This improved luminosity value makes location of VY CMa on the Hertzsprung-Russel (HR) diagram much closer to the theoretically allowable zone (i.e. the left side of the Hayashi track) than previous ones, though uncertainty in the

effective temperature of the stellar surface still does not permit us to make a final conclusion.

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A new search for variable stars in the globular cluster NGC 6366

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New CCD photometry of NGC 6366 has lead to the discovery of some variable stars. Two possible Anomalous Cepheids (or Pop II Cepheids), three long period variables, one SX Phe and one eclipsing binary have been found. Also a list of 10 candidate variables is reported. The light curve of the RRab star, V1, has been decomposed into its Fourier harmonics, and the Fourier parameters were used to estimate the star's metallicity and distance; [Fe/H]$= -0.87 \pm 0.14$ and $d = 3.2 \pm 0.1$ kpc. It is argued that V1 may not be a member of the cluster but rather a more distant object. If this is so, an upper limit for the distance to the cluster of 2.8 ± 0.1 kpc can be estimated. The P–L relationship for SX Phe stars and the identified modes in the newly discovered SX Phe variable, V6, allow yet another independent determination of the distance to the cluster of $d = 2.7 \pm 0.1$ kpc. The M_V–[Fe/H] relationship for RR Lyrae stars is addressed and the case of V1 is discussed.

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Semi-empirical white dwarf initial-final mass relationships: a thorough analysis of systematic uncertainties due to stellar evolution models

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Using the most recent results about white dwarfs in 10 open clusters, we revisit semi-empirical estimates of the initial-final mass relation in star clusters, with emphasis on the use of stellar evolution models. We discuss the influence of these models on each step of the derivation. One intention of our work is to use consistent sets of calculations both for the isochrones and the white dwarf cooling tracks. The second one is to derive the range of systematic errors arising from stellar evolution theory. This is achieved by using different sources for the stellar models and by varying physical assumptions and input data. We find that systematic errors, including the determination of the cluster age, are dominating the initial mass values, while observational uncertainties influence the final mass primarily. After having determined the systematic errors, the initial-final mass relation allows us finally to draw conclusions about the physics of the stellar models, in particular about convective overshooting.

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Rotational velocities of the giants in symbiotic stars: III. Evidence of fast rotation in S-type symbiotics

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We have measured the projected rotational velocities ($v \sin i$) in a number of symbiotic stars and M giants using high resolution spectroscopic observations. On the basis of our measurements and data from the literature, we compare the rotation of mass-donors in symbiotics with vsini of field giants and find that: (1) the K giants in S-type symbiotics rotate at $v \sin i > 4.5$ km s^{-1}, which is 2–4 times faster than the field K giants; (2) the M giants in S-type symbiotics rotate on average 1.5 times faster than the field M giants. Statistical tests show that these differences are highly significant — p-value < 0.001 in the spectral type bins K2 III–K5 III, M0 III–M6 III, and M2 III–M5 III; (3) our new observations of D′-type symbiotics also confirm that they are fast rotators.

As a result of the rapid rotation, the cool giants in symbiotics should have 3–30 times larger mass-loss rates. Our results suggest also that bipolar ejections in symbiotics seem to happen in objects where the mass donors rotate faster than the orbital period.

All spectra used in our series of papers can be obtained upon request from the authors (e-mail: rkz@astro.bas.bg).

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VLBI Astrometry of AGB Variables with VERA — A Semiregular Variable S Crateris

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We present a distance measurement for the semiregular variable S Crateris (S Crt) based on its annual parallax. With the unique dual beam system of the VLBI Exploration for Radio Astrometry (VERA) telescopes, we measured the absolute proper motion of a water maser spot associated with S Crt, referred to the quasar J 1147−0724 located at an angular separation of 1.23°. In observations spanning nearly two years, we have detected the maser spot at the LSR velocity of 34.7 km s^{-1}, for which we measured the annual parallax of 2.33±0.13 mas corresponding to a distance of 430^{+25}_{-23} pc. This measurement has an accuracy one order of magnitude better than the parallax measurements of HIPPARCOS. The angular distribution and three-dimensional velocity field of maser spots indicate a bipolar outflow

with the flow axis along northeast-southwest direction. Using the distance and photospheric temperature, we estimate the stellar radius of S Crt and compare it with those of Mira variables.

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The temporal changes of the pulsational periods of the pre-white dwarf PG 1159−035

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PG 1159−035, a pre-white dwarf with $T = 140\,000$ K, is the prototype of the PG 1159 spectroscopic class and the DOV pulsating class. Changes in the star cause variations in its oscillation periods. The measurement of temporal change in the oscillation periods, $\mathrm{d}\,P/\mathrm{d}\,t$, allows us to estimate directly rates of stellar evolutionary changes, such as the cooling rate and the envelope contraction rate, providing a way to test and refine evolutionary models for pre-white dwarf pulsating stars. We measured 27 pulsation modes period changes. The periods varied at rates of between 1 and 100 ms yr^{-1}, and several can be directly measured with a relative standard uncertainty below 10%. For the 516.0 s mode (the highest in amplitude) in particular, not only the value of $\mathrm{d}\,P/\mathrm{d}\,t$ can be measured directly with a relative standard uncertainty of 2%, but the second order period change, $\mathrm{d}^2P/\mathrm{d}\,t^2$, can also be calculated reliably. By using the (O–C) method we refined the $\mathrm{d}\,P/\mathrm{d}\,t$ and estimated the $\mathrm{d}^2P/\mathrm{d}\,t^2$ for six other pulsation periods. As a first application, we calculated the change in the PG 1559−035 rotation period, $\mathrm{d}\,P_{\mathrm{rot}}/\mathrm{d}\,t = -2.13 \times 10^{-6}$ s s^{-1}, the envelope contraction rate $\mathrm{d}\,R/\mathrm{d}\,t = -2.2 \times 10^{-13}$ $\mathrm{R}_\odot$ s^{-1}, and the cooling rate $\mathrm{d}\,T/\mathrm{d}\,t = -1.42 \times 10^{-3}$ K s^{-1}.

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The Properties of Long-Period Variables in the Large Magellanic Cloud from MACHO

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We present a new analysis of the long-period variables in the Large Magellanic Cloud (LMC) from the MACHO *Variable Star Catalog*. Three-quarters of our sample of evolved, variable stars have periodic light curves. We characterize the stars in our sample using the multiple periods found in their frequency spectra. Additionally, we use single-epoch Two Micron All Sky Survey measurements to construct the average infrared light curves for different groups of these stars. Comparison with evolutionary models shows that stars on the red giant branch (RGB) or the early asymptotic giant branch (AGB) often show non-periodic variability, but begin to pulsate with periods on the two shortest period-luminosity sequences (3 & 4) when they brighten to $K_{\mathrm{s}} \approx 13$. The stars on the thermally pulsing AGB are more likely to pulsate with longer periods that lie on the next two P–L sequences (1 & 2), including the sequence associated with the Miras in the LMC. The Petersen diagram and its variants show that multi-periodic stars on each pair of these sequences (3 & 4, and 1 & 2) typically pulsate with periods associated only with that pair. The periods in these multi-periodic stars become longer and stronger as the star evolves. We further constrain the mechanism behind the long secondary periods (LSPs) seen in half of our sample, and find that there is a close match between the luminosity functions of the LSP stars and all of the stars in our sample, and that these star's pulsation amplitudes are relatively wavelength independent. Although this is characteristic of stellar multiplicity, the large number of these variables is problematic for that explanation.

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Extremely red stellar objects revealed by IPHAS

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We present photometric analysis and follow-up spectroscopy for a population of extremely red stellar objects extracted from the point-source catalogue of the INT Photometric Hα Survey (IPHAS) of the northern galactic plane. The vast majority of these objects have no previous identification. Analysis of optical, near- and mid-infrared photometry reveals that they are mostly highly-reddened asymptotic giant branch stars, with significant levels of circumstellar material. We show that the distribution of these objects traces galactic extinction, their highly reddened colours being a product of both interstellar and circumstellar reddening. This is the first time that such a large sample of evolved low-mass stars has been detected in the visual and allows optical counterparts to be associated with sources from recent infrared surveys.

Follow-up spectroscopy on some of the most interesting objects in the sample has found significant numbers of S-type stars which can be clearly separated from oxygen-rich objects in the IPHAS colour-colour diagram. We show that this is due to the positions of different molecular bands relative to the narrow-band Hα filter used for IPHAS observations. The IPHAS ($r'-$Hα) colour offers a valuable diagnostic for identifying S-type stars. A selection method for identifying S-type stars in the galactic plane is briefly discussed and we estimate that over a thousand new objects of this type may be discovered, potentially doubling the number of known objects in this short but important evolutionary phase.

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A Spectroscopic and Photometric Study of the Metal-Poor, Pulsating, Post-AGB Binary HD 46703

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The metal-poor post-AGB star HD 46703 is shown to be a single-line spectroscopic binary with a period of 600 days, a high velocity of -94 km s^{-1}, and an orbital eccentricity of 0.3. Light curve studies show that it also pulsates with a period of 29 days. High-resolution, high signal-to-noise spectra were used for a new abundance study. The atmospheric model determined is $T_{\rm eff} = 6250$ K, $\log g = 1.0$, $V_{\rm t} = 3.0$ km s^{-1}, and a metal abundance of [M/H]$= -1.5$. A low carbon abundance and lack of s-process element enhancement indicate that the star has not experienced third dredge-up on the AGB. The sulfur and zinc abundances are high compared with iron, and the chemical abundances show a clear anti-correlation with condensation temperature. The abundance depletion pattern is similar to that seen in other post-AGB binaries, and, like them, is attributed to the chemical fractionation of refractory elements onto dust stored in a circumbinary disk and the re-accretion of volatiles in the stellar atmosphere. The infrared excess is

small but the excess energy distribution is very similar to what can expected from a disk. HD 46703 joins the growing list of depleted, post-AGB stars which are likely surrounded by a dusty and stable circumbinary disk.

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A Study of H_2 Emission in Three Proto-Planetary Nebulae: IRAS 16594−4656, Hen 3-401, Rob 22

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We have carried out a spatial-kinematical study of three proto-planetary nebulae, IRAS 16594−4656, Hen 3-401, and Rob 22. High-resolution H_2 images were obtained with NICMOS on the HST and high-resolution spectra were obtained with the Phoenix spectrograph on Gemini-South. IRAS 16594−4656 shows a "peanut-shaped" bipolar structure with H_2 emission from the walls and from two pairs of more distant, point-symmetric faint blobs. The velocity structure shows the polar axis to be in the plane of the sky, contrary to the impression given by the more complex visual image and the visibility of the central star, with an ellipsoidal velocity structure. Hen 3-401 shows the H_2 emission coming from the walls of the very elongated, open-ended lobes seen in visible light, along with a possible small disk around the star. The bipolar lobes appear to be tilted 10–15° with respect to the plane of the sky and their kinematics display a Hubble-like flow. In Rob 22, the H_2 appears in the form of an "S" shape, approximately tracing out the similar pattern seen in the visible. H_2 is especially seen at the ends of the lobes and at two opposite regions close to the unseen central star. The axis of the lobes is nearly in the plane of the sky. Expansion ages of the lobes are calculated to be approximately 1600 yr (IRAS 16594−4656), 1100 yr (Hen 3-401), and 640 yr (Rob 22), based upon approximate distances.

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Chemical Analysis of Five Red Giants in the Globular Cluster M 10 (NGC 6254)

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We have determined Al, α, Fe–peak, and neutron capture elemental abundances for five red giant branch (RGB) stars in the Galactic globular cluster M 10. Abundances were determined using equivalent width analyses of moderate resolution ($R \sim 15\,000$) spectra obtained with the Hydra multifiber positioner and bench spectrograph on the WIYN telescope. The data sample the upper RGB from the luminosity level near the horizontal branch to about 0.5 mag below the RGB tip. We find in agreement with previous studies that M 10 is moderately metal–poor with [Fe/H]= −1.45 ($\sigma = 0.04$). All stars appear enhanced in Al with $\langle$[Al/Fe]$\rangle = +0.33$ ($\sigma = 0.19$), but no stars have [Al/Fe]$\gtrsim +0.55$. We find the α elements to be enhanced by +0.20 to +0.40 dex and the Fe-peak elements to have [el/Fe]~ 0, which are consistent with predictions from type II SNe ejecta. Additionally, the cluster appears to be r-process rich with $\langle$[Eu/La]$\rangle = +0.41$.

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Heavy element abundances in giant stars of the globular clusters M 4 and M 5

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We present a comprehensive abundance analysis of 27 heavy elements in bright giant stars of the globular clusters M 4 and M 5 based on high resolution, high signal-to-noise ratio spectra obtained with the Magellan Clay Telescope. We confirm and expand upon previous results for these clusters by showing that (1) all elements heavier than, and including, Si have constant abundances within each cluster, (2) the elements from Ca to Ni have indistinguishable compositions in M 4 and M 5, (3) Si, Cu, Zn, and all s-process elements are approximately 0.3 dex overabundant in M 4 relative to M 5, and (4) the r-process elements Sm, Eu, Gd, and Th are slightly overabundant in M 5 relative to M 4. The cluster-to-cluster abundance differences for Cu and Zn are intriguing, especially in light of their uncertain nucleosynthetic origins. We confirm that stars other than Type Ia supernovae must produce significant amounts of Cu and Zn at or below the clusters' metallicities. If intermediate-mass AGB stars or massive stars are responsible for the Cu and Zn enhancements in M 4, the similar [Rb/Zr] ratios and (preliminary) Mg isotope ratios in both clusters may be problematic for either scenario. For the elements from Ba to Hf, we assume that the s- and r-process contributions are scaled versions of the solar s- and r-process abundances. We quantify the relative fractions of s- and r-process material for each cluster and show that they provide an excellent fit to the observed abundances.

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The Acceleration of the Nebular Shells in Planetary Nebulae in the Milky Way Bulge

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We present a systematic study of line widths in the [O III] λ5007 and Hα lines for a sample of 86 planetary nebulae in the Milky Way bulge based upon spectroscopy obtained at the Observatorio Astronómico Nacional in the Sierra San Pedro Mártir (OAN-SPM) using the Manchester Echelle Spectrograph. The planetary nebulae were selected with the intention of simulating samples of bright extragalactic planetary nebulae. We separate the planetary nebulae into two samples containing cooler and hotter central stars, defined by the absence or presence, respectively, of the He II λ6560 line in the Hα spectra. This division separates samples of younger and more evolved planetary nebulae. The sample of planetary nebulae with hotter central stars has systematically larger line widths, larger radii, lower electron densities, and lower Hβ luminosities. The distributions of these parameters in the two samples all differ at significance levels exceeding 99%. These differences are all in agreement with the expectations from hydrodynamical models, but for the first time confirmed for a homogeneous and statistically significant sample of galactic planetary nebulae. We interpret these differences as evidence for the acceleration of the nebular shells during the early evolution of these intrinsically bright planetary nebulae. As is the case for planetary nebulae in the Magellanic Clouds, the acceleration of the nebular shells appears to be the direct result of the evolution of the central stars.

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AKARI/FIS Mapping of the ISM-Wind Bow Shock around α Ori

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We present $10' \times 50'$ scan maps around an M supergiant α Ori at 65, 90, 140 and 160 μm obtained with the AKARI Infrared Astronomy Satellite. Higher spatial resolution data with the exact analytic solution permit us to fit the deprojected shape of the stellar wind bow shock around α Ori to have the stand-off distance of $4.8'$, position angle of 55° and inclination angle of 56°. The shape of the bow shock suggests that the peculiar velocity of α Ori with respect to the local medium is $v_\star = 40 n_{\rm H}^{-1/2}$, where $n_{\rm H}$ is the hydrogen nucleus density at α Ori. We find that the local medium is of $n_{\rm H} = 1.5$ to 1.9 cm^{-3} and the velocity of the local flow is at 11 km s^{-1} by using the most recent astrometric solutions for α Ori under the assumption that the local medium is moving away from the Orion OB 1 association. AKARI images may also reveal a vortex ring due to instabilities on the surface of the bow shock as demonstrated by numerical models. This research exemplifies the potential of AKARI All-Sky data as well as follow-up observations with Herschel Space Telescope and Stratospheric Observatory for Infrared Astronomy for this avenue of research in revealing the nature of interaction between the stellar wind and interstellar medium.

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On the formation and abundance of CO in the envelopes of AGB stars

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It is generally considered, as a rule of thumb, that carbon monoxide forms very early in envelopes of AGB stars, and that it consumes most of the carbon, or most of the oxygen, depending on whether the photosphere is oxygen-rich or carbon-rich, respectively. This work focuses on the latter case , with the purpose of quantifying the remaining fraction of gaseous carbon which is then available for forming carbonaceous grains. Since AGB stars are (probably) the main providers of cosmic carbon grains, this residual fraction is essential in establishing the validity of current grain models. Here, we use a kinetic treatment to follow the chemical evolution of circumstellar shells towards steady state. It is shown that the residual fraction depends essentially on the atomic ratio of pristine gaseous carbon and oxygen, and on the cross-section for CH formation by collision of C and H atoms. It lies between 55 and 144 C atoms per 10^6 H atoms, depending on the values adopted for unknown reaction rates and cosmic C abundance. This is much larger than predicted by the rule of thumb recalled above.
The present results depend strongly on the rate of the reaction C+H→CH: far from thermodynamic equilibrium (which is the case here), CO cannot be formed if this rate is as low as generally assumed. We have, therefore, estimated this rate by chemically modelling the reaction and found it indeed much higher, and high enough to yield CO abundances compatible with observations. An accurate experimental rate determination is highly desirable.

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AKARI IRC survey of the Large Magellanic Cloud: Outline of the survey and initial results

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We observed an area of 10 deg^2 of the Large Magellanic Cloud using the Infrared Camera on board AKARI. The observations were carried out using five imaging filters (3, 7, 11, 15, and 24 μm) and a dispersion prism (2–5 μm, $\lambda/\Delta\lambda \sim 20$) equipped in the IRC. This paper describes the outline of our survey project and presents some initial results using the imaging data that detected over 5.9×10^5 near-infrared and 6.4×10^4 mid-infrared point sources. The 10 σ detection limits of our survey are about 16.5, 14.0, 12.3, 10.8, and 9.2 in Vega-magnitude at 3, 7, 11, 15, and 24 μm, respectively. The 11 and 15 μm data, which are unique to AKARI IRC, allow us to construct color-magnitude diagrams that are useful to identify stars with circumstellar dust. We found a new sequence in the color-magnitude diagram, which is attributed to red giants with luminosity fainter than that of the tip of the first red giant branch. We suggest that this sequence is likely to be related to the broad emission feature of aluminium oxide at 11.5 μm. The 11 and 15 μm data also indicate that the ([11]–[15]) μm color of both oxygen-rich and carbon-rich red giants once becomes blue and then turns red again in the course of their evolution, probably due to the change in the flux ratio of the silicate or silicon carbide emission feature at 10 or 11.3 μm to the 15 μm flux.

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The lack of carbon stars in the Galactic bulge

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In order to explain the lack of carbon stars in the Galactic bulge, we carry out a detailed study of TP-AGB stars based on a population synthesis code. The effects of the oxygen overabundance and the mass loss rate on the ratio of the number of carbon stars to oxygen stars in the Galactic bulge are discussed. We obtain the oxygen overabundance which is about two times of that in the solar neighborhood (close to the present observations) is insufficient to explain the rareness of carbon stars in the bulge. We suggest the large mass loss rate may be a possible controlling factor in the ratio of the number of carbon to oxygen stars.

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Kinematics of the H_2O masers at the centre of the PN K 3-35

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We have studied the kinematics traced by the water masers located at the centre of the planetary nebula (PN) K 3-35, using data from previous Very Large Array (VLA) observations. An analysis of the spatial distribution and line-of-sight velocities of the maser spots allows us to identify typical patterns of a rotating and expanding ring in the position-velocity diagrams, according to our kinematical model. We find that the distribution of the masers is compatible with tracing a circular ring with a $\simeq 0\farcs021$ ($\simeq$100 AU) radius, observed with an inclination angle with respect to the line of sight of 55°. We derive expansion and rotation velocities of 1.4 and 3.1 km s^{-1}, respectively. The orientation of the ring projected on the plane of the sky, at PA$\simeq$ 158°, is almost orthogonal to the direction of the innermost region of the jet observed in K 3-35, suggesting the presence of a disc or torus that may be related to the collimation of the outflow.

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A red supergiant nebula at 25 μm: arcsecond scale mass-loss asymmetries of μ Cep

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We present diffraction limited ($0.6''$) 24.5 μm Subaru/COMICS images of the red supergiant μ Cep. We report the detection of a circumstellar nebula, that was not detected at shorter wavelengths. It extends to a radius of at least $6''$ in the thermal infrared. On these angular scales, the nebula is roughly spherical, in contrast, it displays a pronounced asymmetric morphology closer in. We simultaneously model the azimuthally averaged intensity profile of the nebula and the observed spectral energy distribution (SED) using spherical dust radiative transfer models. The models indicate a constant mass-loss process over the past 1000 years, for mass-loss rates a few times 10^{-7} M$_\odot$ yr^{-1}. This work supports the idea that at least part of the asymmetries in shells of evolved massive stars and supernovae may be due to the mass-loss process in the red supergiant phase.

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VLA observations of the "water fountain" IRAS 16552−3050

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We present Very Large Array (VLA) observations of the water maser emission towards IRAS 16552−3050. The maser emission shows a velocity spread of $\simeq$ 170 km s^{-1}, and a bipolar distribution with a separation between the red and blueshifted groups of $\simeq 0.08''$. These observations and the likely post-AGB nature of the source indicate that IRAS 16552−3050 can be considered as a member of the "water fountain" class of sources (evolved stars showing H_2O maser emission with a velocity spread $\gtrsim$100 km s^{-1}, probably tracing collimated jets). The water maser emission in IRAS 16552−3050 does not seem to be associated with with any known optical counterpart. Moreover, this source does not have a near-IR 2MASS counterpart, as it happens in about half of the water fountains known. This suggests that these sources tend to be heavily obscured objects, probably with massive precursors ($\gtrsim 4-5$ M$_\odot$). We suggest that the water maser emission in IRAS 16552−3050 could be tracing a rapidly precessing bipolar jet.

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A Molecular Line Survey of the Highly Evolved Carbon Star CIT 6

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We present a spectral line survey of the C-rich envelope CIT 6 in the 2mm and 1.3mm bands carried out with the Arizona Radio Observatory (ARO) 12m telescope and the Heinrich Hertz Submillimeter Telescope (SMT). The observations cover the frequency ranges of 131–160 GHz, 219–244 GHz, and 252–268 GHz with typical sensitivity limit of $T_{\rm R} < 10$ mK. A total of 74 individual emission features are detected, of which 69 are identified to arise from 21 molecular species and isotopologues, with 5 faint lines remaining unidentified. Two new molecules (C_4H and CH_3CN) and seven new isotopologues ($C^{17}O$, $^{29}SiC_2$, ^{29}SiO, ^{30}SiO, ^{13}CS, $C^{33}S$, and $C^{34}S$) are detected in this object for the first time. The column densities, excitation temperatures, and fractional abundances of the detected molecules are determined using rotation diagram analysis. Comparison of the spectra of CIT 6 to that of IRC +10216 suggests that the spectral properties of CIT 6 are generally consistent with those of IRC +10216. For most of the molecular species, the intensity ratios of the lines detected in the two objects are in good agreement with each other. Nevertheless, there is evidence suggesting enhanced emission from CN and HC_3N and depleted emission from HCN, SiS, and C_4H in CIT 6. Based on their far-IR spectra, we find that CIT 6 probably has a lower dust-to-molecular gas ratio than IRC +10216. To investigate the chemical evolution of evolved stars, we compare the molecular abundances in the AGB envelopes CIT 6 and IRC +10216 and those in the bright proto-planetary nebula CRL 618. The implication on the circumstellar chemistry is discussed.

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Origin of multiple stellar populations in globular clusters and their helium enrichment

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The various scenarios proposed for the origin of the multiple, helium-enriched populations in massive globular clusters

are critically compared to the relevant constraining observations. Among accretion of helium-rich material by pre-existing stars, star formation out of ejecta from massive AGB stars or from fast rotating massive stars, and pollution by Population III stars, only the AGB option appears to be viable. Accretion or star formation out of outflowing disks would result in a spread of helium abundances, thus failing to produce the distinct, chemically homogeneous sub-populations such as those in the clusters ω Cen and NGC 2808. Pollution by Population III stars would fail to produce sub-populations selectively enriched in helium, but maintaining the same abundance of heavy elements. Still, it is argued that for the AGB option to work two conditions should be satisfied: i) AGB stars experiencing the hot bottom burning process (i.e., those more massive than $\sim$ 3 $M_{\odot}$) should rapidly eject their envelope upon arrival on the AGB, thus experiencing just a few third dredge-up episodes, and ii) clusters with multiple, helium enriched populations should be the remnants of much more massive systems, such as nucleated dwarf galaxies, as indeed widely assumed.

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Intrinsically Red Sources observed by *Spitzer* in the Galactic Mid-Plane

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We present a highly reliable flux-limited census of 18,949 point sources in the Galactic mid-plane that have intrinsically red mid-infrared colors. These sources were selected from the *Spitzer Space Telescope* GLIMPSE I and II surveys of 274 deg^2 of the Galactic mid-plane, and consist mostly of high- and intermediate-mass young stellar objects (YSOs) and asymptotic giant branch (AGB) stars. The selection criteria were carefully chosen to minimize the effects of position-dependent sensitivity, saturation, and confusion. The distribution of sources on the sky and their location in IRAC and MIPS 24 μm color–magnitude and color–color space are presented. Using this large sample, we find that YSOs and AGB stars can be mostly separated by simple color-magnitude selection criteria into approximately $50-70\%$ of YSOs and $30-50\%$ of AGB stars. Planetary nebulae and background galaxies together represent at most $2-3\%$ of all the red sources. 1,004 red sources in the GLIMPSE II region, mostly AGB stars with high mass-loss rates, show significant ($\geq$0.3 mag) variability at 4.5 and/or 8.0 μm. With over 11,000 likely YSOs and over 7,000 likely AGB stars, this is to date the largest uniform census of AGB stars and high- and intermediate mass YSOs in the Milky-Way Galaxy.

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Modeling He-rich subdwarfs through the Hot-Flasher Scenario

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We present 1D numerical simulations aimed at studying the Hot-Flasher scenario for the formation of He-rich subdwarf

stars. Sequences have been calculated for a wide range of metallicities and physical assumptions, like the stellar mass at the moment of the helium core flash. This allows us to study the two previously proposed flavors of the Hot-Flasher scenario ("deep" and "shallow" mixing cases) and to identify a third transition type. Our sequences are calculated by simultaneously solving the mixing and burning equations within a diffusive convection picture, in the context of the standard mixing length theory. This allows us to follow the chemical evolution during deep mixing events where hydrogen is violently burnt and to present a homogeneous set of abundances for different metallicities and all kinds of Hot-Flashers. We extend the scope of our work by analyzing the effects of non-standard assumptions such as the effect of chemical gradients, extra-mixing at convective boundaries, possible reductions in convective velocities or the interplay between difussion and mass loss. Particular emphasis is put on the predicted surface properties of the models. We find that the hot-flasher scenario is a viable explanation for the formation and surface properties of He-sdO stars. Also, our results show that, during the early He-core burning stage, element diffusion may produce the transformation of (post Hot-flasher) He-rich atmospheres into He-deficient ones. If this is so, then we find that He-sdO stars would be the progenitors of some of the hottest sdB stars.

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Discovery in IC 10 of the farthest known symbiotic star

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We report the discovery of the first known symbiotic star in IC 10, a starburst galaxy belonging to the Local Group, at a distance of ∼750 kpc. The symbiotic star was identified during a survey of emission-line objects. It shines at $V = 24.62 \pm 0.0$, $V - R_{\rm C} = 2.77 \pm 0.05$ and $R_{\rm C} - I_{\rm C} = 2.39 \pm 0.02$ and suffers from $E(B-V) = 0.85 \pm 0.05$ reddening. The spectrum of the cool component well matches that of solar neighborhood M8 III giants. The observed emission lines belong to Balmer series, [S II], [N II] and [O III]. They suggest a low electronic density, negligible optical depth effects and $35,000K < T_{\rm eff} < 90,000$ K for the ionizing source. The spectrum of the new symbiotic star in IC 10 is an almost perfect copy of that of Hen 2-147, a well known Galactic symbiotic star and Mira.

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Cometary Astropause of Mira Revealed in the Far-Infrared

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Evolved mass-losing stars such as Mira enrich the interstellar medium (ISM) significantly by their dust-rich molecular wind. When these stars move fast enough relative to the ISM, the interaction between the wind and ISM generates the structure known as the astropause (a stellar analog of the heliopause), which is a cometary stellar wind cavity bounded by the contact discontinuity surface between the wind and ISM. Far-infrared observations of Mira spatially resolve the structure of its astropause for the first time, distinguishing the contact surface between Mira's wind and the ISM and the termination shock due to Mira's wind colliding with the ISM. The physical size of the astropause

and the estimated speed of the termination shock suggest the age of the astropause to be about 40,000 yr, confirming a theoretical prediction of the shock re-establishment time after Mira has entered the Local Bubble.

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SPITZER survey of dust grain processing in stable discs around binary post-AGB stars

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Aims: We investigate the mineralogy and dust processing in the circumbinary discs of binary post-AGB stars using high-resolution TIMMI2 and SPITZER infrared spectra. Methods: We perform a full spectral fitting to the infrared spectra using the most recent opacities of amorphous and crystalline dust species. This allows for the identification of the carriers of the different emission bands. Our fits also constrain the physical properties of different dust species and grain sizes responsible for the observed emission features. Results: In all stars the dust is oxygen-rich: amorphous and crystalline silicate dust species prevail and no features of a carbon-rich component can be found, the exception being EP Lyr, where a mixed chemistry of both oxygen- and carbon-rich species is found. Our full spectral fitting indicates a high degree of dust grain processing. The mineralogy of our sample stars shows that the dust is constituted of irregularly shaped and relatively large grains, with typical grain sizes larger than 2 μm. The spectra of nearly all stars show a high degree of crystallinity, where magnesium-rich end members of olivine and pyroxene silicates dominate. Other dust features of e.g. silica or alumina are not present at detectable levels. Temperature estimates from our fitting routine show that a significant fraction of grains must be cool, significantly cooler than the glass temperature. This shows that radial mixing is very efficient is these discs and/or indicates different thermal conditions at grain formation. Our results show that strong grain processing is not limited to young stellar objects and that the physical processes occurring in the discs are very similar to those in protoplanetary discs.

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The Cosmic Crystallinity Conundrum: Clues from IRAS 17495−2534

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Since their discovery, cosmic crystalline silicates have presented several challenges to understanding dust formation and evolution. The mid-infrared spectrum of IRAS 17495−2534, a highly obscured oxygen-rich asymptotic giant branch (AGB) star, is the only source observed to date which exhibits a clear crystalline silicate absorption feature. This provides an unprecedented opportunity to test competing hypotheses for dust formation. Observed spectral features suggest that both amorphous and crystalline dust is dominated by forsterite (Mg_2SiO_4) rather than enstatite ($MgSiO_3$) or other silicate compositions. We confirm that high mass-loss rates should produce more crystalline material, and show why this should be dominated by forsterite. The presence of Mg_2SiO_4 glass suggests that another factor (possibly C/O) is critical in determining astromineralogy. Correlation between crystallinity, mass-loss rate and initial stellar mass suggests that only the most massive AGB stars contribute significant quantities of crystalline material to the interstellar medium, resolving the conundrum of its low crystallinity.

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The fraction of second generation stars in Globular Clusters from the analysis of the Horizontal Branch

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Most Globular Clusters (GC) show chemical inhomogeneities in the composition of their stars, apparently due to a second stellar generation (SG) in which the forming gas is enriched by hot-CNO cycled material processed in stars belonging to a first stellar generation (FG). We propose to use the horizontal branch (HB) to infer which is today the relative number fraction of "normal" and anomalous stars in clusters. We assume that the anomalies also include enhanced helium abundance. Helium variations have been recognized to be able to explain several puzzling peculiarities (gaps, RR Lyr periods and period distribution, ratio of blue to red stars, blue tails) in HBs. We extend the analysis to as many clusters as possible. We show that, with few exceptions, 50% or more of the stars belong to the SG. In other cases, where one would think of a simple stellar population, we suggest that the stars might all belong to the SG. We fit the optical and UV data of NGC 2808, including a reproduction of the main sequence splittings and an exam of the problem of "blue hook" stars. We also show a detailed fit of the totally blue HB of M 13, one among the clusters that are possibly fully made up by SG stars. We conclude that the formation of the SG is a crucial event in the life of GCs. A high fraction of SG stars can be achieved only if the initial cluster was much more massive than the present one and most of the FG low mass stars have been lost. As shown by D'Ercole et al., the mass loss due to type II supernovae of the FG may be the process responsible for triggering the expansion of the cluster, the stripping of its outer layers and the loss of most of the FG low-mass stars.

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Horizontal Branch Morphology and Mass Loss in Globular Clusters

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The connection between mass loss on the red giant branch (RGB) and horizontal branch (HB) morphology in globular clusters (GCs) has long been acknowledged but the mechanisms governing mass loss remains poorly understood from a theoretical perspective. The present study uses synthetic HB models to demonstrate for the first time that α-enhancement and a simple relation between mass loss and metallicity can explain the entire range of HB morphology (characterized by the HB type index) observed in old, coeval GCs. The mass loss-metallicity relation accounts naturally for the fact that the most metal poor GCs ([Fe/H]< -2) have redder HBs than is typical of GCs with $-2 <$[Fe/H]< -1.5 without invoking younger ages. These results may prove useful in studying the contribution of HB stars to integrated light via stellar population synthesis.

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Determining Parameters of Cool Giant Stars by Modeling Spectrophotometric and Interferometric Observations Using the SAtlas Program

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Context: Optical interferometry is a powerful tool for observing the intensity structure and angular diameter of stars.

When combined with spectroscopy and/or spectrophotometry, interferometry provides a powerful constraint for model stellar atmospheres. Aims: The purpose of this work is to test the robustness of the spherically symmetric version of the Atlas stellar atmosphere program, SAtlas, using interferometric and spectrophotometric observations. Methods: Cubes (three dimensional grids) of model stellar atmospheres, with dimensions of luminosity, mass, and radius, are computed to fit observations for three evolved giant stars, ψ Phoenicis, γ Sagittae, and α Ceti. The best-fit parameters are compared with previous results. Results: The best-fit angular diameters and values of χ^2 are consistent with predictions using Phoenix and plane-parallel Atlas models. The predicted effective temperatures, using SAtlas, are about 100 to 200 K lower, and the predicted luminosities are also lower due to the differences in effective temperatures. Conclusions: It is shown that the SAtlas program is a robust tool for computing models of extended stellar atmospheres that are consistent with observations. The best-fit parameters are consistent with predictions using Phoenix models, and the fit to the interferometric data for ψ Phe differs slightly, although both agree within the uncertainty of the interferometric observations.

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On the Enhancement of Mass Loss in Cepheids Due to Radial Pulsation. II. The Effect of Metallicity

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It has been observed that Cepheids in the Magellanic Clouds have lower masses for the same luminosity than those in the Milky Way. The model, from Neilson & Lester (2008), of pulsation-driven mass loss for Cepheids is applied to theoretical models of Cepheids with metallicity consistent with the Milky Way and Large and Small Magellanic Clouds. The mass-loss model is analyzed using the metallicity correction of the Period-Luminosity relation to compare the ratio of mass loss of Cepheids with lower metallicity to that of Cepheids with solar metallicity. It is determined that mass loss may be larger for the lower metallicity Cepheids, counterintuitive to radiative driving estimates. Also the mass-loss rates of theoretical Cepheid models are found to be up to 5×10^{-9} for Galactic Cepheids, 5×10^{-8} for Large Magellanic Cloud Cepheids, and 2×10^{-7} $M_\odot$ yr^{-1} for Small Magellanic Cloud Cepheids. It is argued that mass loss increases as metallicity decreases for Cepheids with periods less than 20 days and that mass loss decreases for longer periods. Assuming dust forms in the wind of a Cepheid at some distance, the infrared excess of the models is computed, finding the infrared brightness is approximately a magnitude larger due to mass loss. The infrared magnitudes are compared to recently published Period–Luminosity relations as a test of our predictions.

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Formation and Dynamical Evolution of Multiple Stellar Generations in Globular Clusters

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We study the formation and dynamical evolution of clusters with multiple stellar generations. Observational studies have found that some globular clusters host a population of second generation (SG) stars which show chemical anomalies and must have formed from gas containing matter processed in the envelopes of first generation (FG) cluster

stars. We study the SG formation process by means of 1D hydrodynamical simulations, starting from a FG already in place and assuming that the SG is formed by the gas ejected by the Asymptotic Giant Branch (AGB) stars. This gas collects in a cooling flow into the cluster core, where it forms SG stars. The SG subsystem emerging from this process is initially strongly concentrated in the cluster innermost regions and its structural properties are largely independent of the FG initial properties. We also present the results of a model in which pristine gas contributes to the SG formation. In this model a very helium-rich SG population and one with a moderate helium enrichment form; the resulting SG bimodal helium distribution resembles that observed for SG stars in NGC 2808.
By means of N-body simulations, we then study the two-population cluster dynamical evolution and mass loss. In our simulations, a large fraction of FG stars are lost early in the cluster evolution due to the expansion and stripping of the cluster outer layers resulting from early mass loss associated with FG SN ejecta. The SG population, initially concentrated in the innermost cluster regions, is largely unscathed by this early mass loss, and this early evolution leads to values of the number ratio of SG to FG stars consistent with observations. We also demonstrate possible evolutionary routes leading to the loss of most of the FG population, leaving an SG-dominated cluster. As the cluster evolves and the two populations mix, the local ratio of SG to FG stars, initially a decreasing function of radius, tends to a constant value in the inner parts of the cluster. Until mixing is complete, the radial profile of this number ratio is characterized by a flat inner part and a declining portion in the outer cluster regions.

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Stellar populations in a standard ISOGAL field in the Galactic disc

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We identify the stellar populations (mostly red giants and young stars) detected in the ISOGAL survey at 7 and 15 μm towards a field (LN 45) in the direction $\ell = -45, b = 0.0$. The sources detected in the survey of the Galactic plane by the Infrared Space Observatory are characterised based on colour–colour and colour–magnitude diagrams. We combine the ISOGAL catalogue with the data from surveys such as 2MASS and GLIMPSE. Interstellar extinction and distance are estimated using the red clump stars detected by 2MASS in combination with the isochrones for the AGB/RGB branch. Absolute magnitudes were thus derived and the stellar populations were identified from their absolute magnitudes and their infrared excess. A standard approach to analysing of ISOGAL disk observations has been established. We identify several hundred RGB/AGB stars and 22 candidate young stellar objects in the direction of this field in an area of 0.16 deg^2. An overdensity of stellar sources is found at distances corresponding to the distance of the Scutum-Crux spiral arm. In addition, we determined mass-loss rates of AGB-stars using dust radiative transfer models from the literature.

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Abundances of Planetary Nebulae NGC 3242 and NGC 6369

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The spectra of the planetary nebulae NGC 3242 and NGC 6369 are reanalysed using spectral measurements made in the mid-infrared with the Spitzer Space Telescope and the Infrared Space Observatory (ISO). The aim is to determine

the chemical composition of these objects. We also make use of International Ultraviolet Explorer (IUE) and ground based spectra. These elliptical PNe are interesting because they are well-studied, nearby, bright objects and therefore allow a reasonably complete comparison of this type of nebulae. Abundances determined from the mid-infrared lines, which are insensitive to electron temperature, are used as the basis for the determination of the composition, which are found to differ somewhat from earlier results. The abundances found, especially the low value of helium and oxygen, indicate that the central star was originally of rather low mass. The abundance of phosphorus has been determined for the first time in NGC 3242. The electron temperature in both of these nebulae is roughly constant unlike NGC 6302 and NGC 2392 where a strong temperature gradient is found. The temperature of the central star is discussed for both nebulae. Finally a comparison of the element abundances in these nebulae with the solar abundance is made. The low abundance of Fe and P is noted and it is suggested that these elements are an important constituent of the nebular dust.

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SDSS J084539.17+225728.0: the first DBZ white dwarf with a metal-rich gaseous debris disc

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We report the discovery of a third white dwarf hosting a gaseous debris disc, SDSS J084539.17+225728.0. The typical double-peaked Ca II 8498,8542,8662 Å emission lines can be modelled in terms of a Keplerian gas disc with a radial extent from ~ 0.5 R$_\odot$ to ~ 1.0 R$_\odot$. The effective temperature of SDSS 0845+2257, $T_{\rm eff} \simeq 18600 \pm 500$ K, is comparable to the two other white dwarfs with gaseous discs, SDSS 1043+0855 and SDSS 1228+1040, and hence substantially hotter than the bulk of white dwarfs where dusty debris discs were identified through the presence of infrared excess flux. This may suggest that the conditions to produce emission lines from debris discs in the optical wavelength range are only met for a relatively narrow range in $T_{\rm eff}$. The observed asymmetry in the line profiles indicates a substantial eccentricity in the disc. Two spectra obtained four years apart reveal a significant change in the shapes and equivalent widths of the line profiles, implying that the circumstellar disc evolves on relatively short time scales. In contrast to SDSS 1043+0855 and SDSS 1228+1040, SDSS 0845+2257 has a helium-dominated atmosphere. We detect photospheric absorption lines of He, Ca, Mg, and Si in the Sloan Digital Sky Survey spectrum, and hence classify SDSS 0845+2257 as DBZ white dwarf. The abundances for the three metals determined from model atmosphere fits are Ca/He$\simeq 1.3 \times 10^{-7}$, Mg/He$\simeq 6.0 \times 10^{-6}$, and Si/He$\simeq 8.0 \times 10^{-6}$. From the non-detection of Hα we derive H/He$< 3 \times 10^{-5}$, which implies that the hydrogen-to-metal abundance ratio of the circumstellar material is $\gtrsim$1000 times lower than in the Sun. This lends strong support to the hypothesis that the gaseous and dusty debris discs found around roughly a dozen white dwarfs originate from the disruption of rocky planetary material.

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Nucleosynthesis Predictions for Intermediate-Mass AGB Stars: Comparison to Observations of Type I Planetary Nebulae

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Type I planetary nebulae (PNe) have high He/H and N/O ratios and are thought to be descendants of stars with

initial masses of ∼3–8 $M_\odot$. These characteristics indicate that the progenitor stars experienced proton-capture nucleosynthesis at the base of the convective envelope, in addition to the *slow* neutron capture process operating in the He-shell (the *s*-process). We compare the predicted abundances of elements up to Sr from models of intermediate-mass asymptotic giant branch (AGB) stars to measured abundances in Type I PNe. In particular, we compare predictions and observations for the light trans-iron elements Se and Kr, in order to constrain convective mixing and the *s*-process in these stars. A partial mixing zone is included in selected models to explore the effect of a ^{13}C pocket on the *s*-process yields. The solar-metallicity models produce enrichments of [(Se, Kr)/Fe] $\lesssim$0.6, consistent with Galactic Type I PNe where the observed enhancements are typically $\lesssim$0.3 dex, while lower metallicity models predict larger enrichments of C, N, Se, and Kr. O destruction occurs in the most massive models but it is not efficient enough to account for the $\gtrsim$0.3 dex O depletions observed in some Type I PNe. It is not possible to reach firm conclusions regarding the neutron source operating in massive AGB stars from Se and Kr abundances in Type I PNe; abundances for more *s*-process elements may help to distinguish between the two neutron sources. We predict that only the most massive ($M\gtrsim$5 $M_\odot$) models would evolve into Type I PNe, indicating that extra-mixing processes are active in lower-mass stars (3–4 $M_\odot$), if these stars are to evolve into Type I PNe.

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Convective hydrocodes for radial stellar pulsation. Physical and numerical formulation.

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In this paper we describe our convective hydrocodes for radial stellar pulsation. We adopt the Kuhfuss (1986) model of convection, reformulated for the use in stellar pulsation hydrocodes. Physical as well as numerical assumptions of the code are described in detail. Described tests show, that our models are numerically robust and reproduce basic observational constraints.
We discuss the effects of different treatment of some quantities in other pulsation hydrocodes. Our most important finding concerns the treatment of the turbulent source function in convectively stable regions. In our code we allow for negative values of source function in convectively stable zones, which reflects negative buoyancy. However, some authors restrict the source term to non-negative values. We show that this assumption leads to very high turbulent energies in convectively stable regions. The effect looks like overshooting, but it is not, because turbulence is generated by pulsations. Also, turbulent elements do not carry kinetic nor thermal energy, into convectively stable layers. The range of this artificial overshooting (as we shall call it) is as large as 6 local pressure scale heights, leading to unphysical internal damping through the eddy-viscous forces, in deep, convectively stable parts of the star.

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A collimated, ionized bipolar structure and a high density torus in the young planetary nebula IRAS 17347−3139

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We present observations of continuum (λ = 0.7, 1.3, 3.6 and 18 cm) and OH maser (λ = 18 cm) emission toward

the young planetary nebula IRAS 17347−3139, which is one of the three planetary nebulae that are known to harbor water maser emission. From the continuum observations we show that the ionized shell of IRAS 17347−3139 consists of two main structures: one extended (size ∼1.″5) with bipolar morphology along PA=−30°, elongated in the same direction as the lobes observed in the near-infrared images, and a central compact structure (size ∼0.″25) elongated in the direction perpendicular to the bipolar axis, coinciding with the equatorial dark lane observed in the near-infrared images. Our image at 1.3 cm suggests the presence of dense walls in the ionized bipolar lobes. We estimate for the central compact structure a value of the electron density at least ∼5 times higher than in the lobes. A high resolution image of this structure at 0.7 cm shows two peaks separated by about 0.″13 (corresponding to 100–780 AU, using a distance range of 0.8−6 kpc). This emission is interpreted as originating in an ionized equatorial torus-like structure, from whose edges the water maser emission might be arising. We have detected weak OH 1612 MHz maser emission at $V_{\rm LSR} \sim -70$ km s^{-1} associated with IRAS 17347−3139. We derive a 3σ upper limit of $< 35\%$ for the percentage of circularly polarized emission. Within our primary beam, we detected additional OH 1612 MHz maser emission in the LSR velocity ranges −5 to −24 and −90 to −123 km s^{-1}, associated with the sources 2MASS J17380406−3138387 and OH 356.65−0.15, respectively.

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H I and CO in the circumstellar environment of the oxygen-rich AGB star RX Lep

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Context. Circumstellar shells around AGB stars are built over long periods of time that may reach several million years. They may therefore be extended over large sizes (∼1 pc, possibly more), and different complementary tracers are needed to describe their global properties.
Aims. We set up a program to explore the properties of matter in the external parts of circumstellar shells around AGB stars and to relate them to those of the central sources (inner shells and stellar atmospheres).
Methods. In the present work, we combined 21-cm H I and CO rotational line data obtained on an oxygen-rich semi-regular variable, RX Lep, to describe the global properties of its circumstellar environment.
Results. With the SEST, we detected the CO(2–1) rotational line from RX Lep. The line profile is parabolic and implies an expansion velocity of ∼4.2 km s^{-1} and a mass-loss rate $\sim 1.7 \times 10^{-7}$ M$_\odot$ yr^{-1} (d = 137 pc). The H I line at 21 cm was detected with the Nançay Radiotelescope on the star position and at several offset positions. The linear shell size is relatively small, ∼0.1 pc, but we detect a trail extending southward to ∼0.5 pc. The line profiles are approximately Gaussian with an FWHM ∼ 3.8 km s^{-1} and interpreted with a model developed for the detached shell around the carbon-rich AGB star Y CVn. Our H I spectra are well-reproduced by assuming a constant outflow ($\dot{M} = 1.65 \times 10^{-7}$ M$_\odot$ yr^{-1}) of $\sim 4 \times 10^4$ years duration, which has been slowed down by the external medium. The spatial offset of the H I source is consistent with the northward direction of the proper motion measured by Hipparcos, lending support to the presence of a trail resulting from the motion of the source through the ISM, as already suggested for Mira, RS Cnc, and other sources detected in H I. The source was also observed in SiO (3 mm) and OH (18 cm), but not detected.
Conclusions. A detached shell, similar to the one around Y CVn, was discovered in H I around RX Lep. We also found evidence of an extension in the direction opposite to the star proper motion. The properties of the external parts of circumstellar shells around AGB stars should be dominated by the interaction between stellar outflows and external matter for oxygen-rich, as well as for carbon-rich, sources, and the 21-cm H I line provides a very useful tracer of these regions.

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Deep Mixing and Metallicity: Carbon Depletion in Globular Cluster Giants

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We present the results of an observational study of the efficiency of deep mixing in globular cluster red giants as a function of stellar metallicity. We determine [C/Fe] abundances based on low-resolution spectra taken with the Kast spectrograph on the 3m Shane telescope at Lick Observatory. Spectra centered on the 4300Å CH absorption band were taken for 42 bright red giants in 11 Galactic globular clusters ranging in metallicity from M 92 ([Fe/H]= −2.29) to NGC 6712 ([Fe/H]= −1.01). Carbon abundances were derived by comparing values of the CH bandstrength index S_2(CH) measured from the data with values measured from a large grid of SSG synthetic spectra. Present-day abundances are combined with theoretical calculations of the time since the onset of mixing, which is also a function of stellar metallicity, to calculate the carbon depletion rate across our metallicity range. We find that the carbon depletion rate is twice as high at a metallicity of [Fe/H]= −2.3 than at [Fe/H]= −1.3, which is a result qualitatively predicted by some theoretical explanations of the deep mixing process.

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New Variable Stars on Digitized Moscow Collection Plates. Field 66 Ophiuchi (Northern Half)

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We initiated digitization of the Moscow collection of astronomical plates using flatbed scanners. Techniques of photographic photometry of the digital images were applied, enabling an effective search for new variable stars. Our search for new variables among 140000 stars in the $10^\circ \times 5^\circ$ northern half of the field centered at 66 Oph, photographed with the Sternberg Institute's 40-cm astrograph in 1976–1995, gave 274 new discoveries, among them: 2 probable Population II Cepheids; 81 eclipsing variables; 5 high-amplitude δ Sct stars (HADSs); 82 RR Lyr stars; 62 red irregular variables and 41 red semiregular stars; 1 slow irregular variable not red in color. Light elements were determined for periodic variable stars. We detected about 30 variability suspects for follow-up CCD observations, confirmed 11 stars from the New Catalogue of Suspected Variable Stars, and derived new light elements for 2 stars already contained in the General Catalogue of Variable Stars.

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Discovery of Extreme Carbon Stars in the Large Magellanic Cloud

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Using *Spitzer* IRAC and MIPS observations of the Large Magellanic Cloud, we have identified 13 objects that have

extremely red mid-IR colors. Follow-up *Spitzer* IRS observations of seven of these sources reveal varying amounts of SiC and C_2H_2 absorption as well as the presence of a broad MgS feature in at least two cases, indicating that these are extreme carbon stars. Preliminary estimates find these objects have luminosities of 4–11$\times 10^3$ $L_\odot$ and preliminary model fitting gives mass-loss rates between 4×10^{-5} and 2×10^{-4} $M_\odot$ yr^{-1}, higher than any known carbon-rich AGB star in the LMC. These spectral and physical properties require careful reconsideration of dust condensation and mass-loss processes for carbon stars in low metallicity environments.

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Hydrodynamical Velocity Fields in Planetary Nebulae

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Based on axi-symmetric hydrodynamical simulations and 3D reconstructions with Shape, we investigate the kinematic signatures of deviations from homologous ("Hubble-type") outflows in some typical shapes of planetary nebulae. We find that, in most situations considered in our simulations, the deviations from a Hubble-type flow are significant and observable. The deviations are systematic and a simple parameterization of them considerably improves morpho-kinematical models of the simulations. We describe such extensions to a homologous expansion law that capture the global velocity structure of hydrodynamical axi-symmetric nebulae during their wind-blown phase. It is the size of the poloidal velocity component that strongly influences the shape of the position velocity diagrams that are obtained, not so much the variation of the radial component. The deviations increase with the degree of collimation of the nebula and they are stronger at intermediate latitudes. We describe potential deformations which these deviations might produce in 3D reconstructions that assume "Hubble-type" outflows. The general conclusion is that detailed morpho-kinematic observations and modeling of planetary nebulae can reveal whether a nebula is still in a hydrodynamically active stage (windy phase) or whether it has reached ballistic expansion.

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Conference Papers

Three-dimensional models of metal-poor stars

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I present here the main results of recent realistic, 3D, hydrodynamical simulations of convection at the surface of metal-poor red giant stars. I discuss the application of these convection simulations as time-dependent, 3D, hydrodynamical model atmospheres to spectral line formation calculations and abundance analyses. The impact of 3D models on derived elemental abundances is investigated by means of a differential comparison of the line strengths predicted in 3D under the assumption of local thermodynamic equilibrium (LTE) with the results of analogous line formation calculations performed with classical, 1D, hydrostatic model atmospheres. The low surface temperatures encountered in the upper photospheric layers of 3D model atmospheres of very metal-poor stars cause spectral lines of neutral metals and molecules to appear stronger in 3D than in 1D calculations. Hence, 3D elemental abundances derived from such lines are significantly lower than estimated by analyses with 1D models. In particular, differential 3D–1D LTE abundances for C, N, and O derived from CH, NH, and OH lines are found to be in the range -0.5 to -1 dex.

Large negative differential 3D–1D corrections to the Fe abundance are also computed for weak low-excitation neutral Fe lines. The application of metal-poor 3D models to the spectroscopic analysis of extremely iron-poor halo stars is discussed.

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^{26}Al production from magnetically induced extramixing in AGB stars

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We discuss nucleosynthesis results obtained following the recent suggestion that extramixing phenomena in red giants might be driven by magnetic buoyancy. We explore for this model the production of the short-lived radioactive isotope ^{26}Al and of stable light nuclei, considering both the case of the general buoyancy of flux tubes and that of the intermittent release of magnetized unstable structures. We show that abundant ^{26}Al can be produced, up to, and above, the highest levels measured in presolar grains. This level would be also sufficient to explain the early solar system ^{26}Al as coming from a nearby AGB star of low mass. The case of fastmoving instabilities is the most efficient, reaching almost the same effectiveness as hot bottom burning (HBB).

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Chemical evolution of the Magellanic Clouds based on planetary nebulae

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Planetary nebulae (PN) are an essential tool in the study of the chemical evolution of the Milky Way and galaxies of the Local Group, particularly the Magellanic Clouds. In this work, we present some recent results on the determination of chemical abundances from PN in the Large and Small Magellanic Clouds, and compare these results with data from our own Galaxy and other galaxies in the Local Group. As a result of our continuing long term program, we have a large database comprising about 300 objects for which reliable abundances of several elements from He to Ar have been obtained. Such data can be used to derive constraints to the nucleosynthesis processes in the progenitor stars in galaxies of different metallicities. We also investigate the time evolution of the oxygen abundances in the SMC by deriving the properties of the PN progenitor stars, which include their masses and ages. We have then obtained an age-metallicity relation taking into account both oxygen and [Fe/H] abundances. We show that these results have an important consequence on the star formation rate of the SMC, in particular by suggesting a star formation burst in the last 2–3 Gyr.

Poster contribution, published in IAU Symposium 256: The Magellanic System: Stars, Gas, and Galaxies, eds. J.Th. van Loon & J.M. Oliveira, CUP
Available from arXiv:0808.1872
and from http://www.astro.iag.usp.br/∼maciel

The eSMA: description and first results

Sandrine Bottinelli[1], *Ken H. Young*[2], *Richard Chamberlin*[3], *Remo P.J. Tilanus*[4,9], *Mark A. Gurwell*[2], *David J. Wilner*[2], *Hiroko Shinnaga*[3], *Hiroshige Yoshida*[3], *Per Friberg*[4], *Huib Jan van Langevelde*[5,1], *Ewine F. van Dishoeck*[1,6], *Michiel R. Hogerheijde*[1], *A. Meredith Hughes*[2], *Robert D. Christensen*[8], *Richard E. Hills*[7], *John S. Richer*[7], *Emily Curtis*[7] *and the eSMA commissioning team*

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The eSMA ("extended SMA") combines the SMA, JCMT and CSO into a single facility, providing enhanced sensitivity and spatial resolution owing to the increased collecting area at the longest baselines. Until ALMA early science observing (2011), the eSMA will be the facility capable of the highest angular resolution observations at 345 GHz. The gain in sensitivity and resolution will bring new insights in a variety of fields, such as protoplanetary/transition disks, high-mass star formation, solar system bodies, nearby and high-z galaxies. Therefore the eSMA is an important facility to prepare the grounds for ALMA and train scientists in the techniques.

Over the last two years, and especially since November 2006, there has been substantial progress toward making the eSMA into a working interferometer. In particular, (i) new 345-GHz receivers, that match the capabilities of the SMA system, were installed at the JCMT and CSO; (ii) numerous tests have been performed for receiver, correlator and baseline calibrations in order to determine and take into account the effects arising from the differences between the three types of antennas; (iii) first fringes at 345 GHz were obtained on August 30 2007, and the array has entered the science-verification stage.

We report on the characteristics of the eSMA and its measured performance at 230 GHz and that expected at 345 GHz. We also present the results of the commissioning and some initial science-verification observations, including the first absorption measurement of the C/CO ratio in a galaxy at $z = 0.89$, located along the line of sight to the lensed quasar PKS 1830−211, and on the imaging of the vibrationally excited HCN line towards IRC +10216.

Oral contribution, published in SPIE vol. 7012: "Ground-based and Airborne Telescopes II", SPIE conference on Astronomical Instrumentation, Marseille, 23–28 June 2008 (paper number 7012-12)
Available from arXiv:0808.2554

N/O-trends in Late-Type Galaxies: AGB-stars, IMFs, Abundance Gradients and the Origin of Nitrogen

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Models of galactic chemical evolution (CEMs) show that the shape of the stellar initial mass function (IMF) and other assumptions regarding star formation affect the resultant abundance gradients in models of late-type galaxies. Furthermore, intermediate mass (IM) stars undeniably play an important role in the buildup of nitrogen abundances in galaxies. Here I specifically discuss the nitrogen contribution from IM/AGB stars and how it affects the N/O-gradient. For this purpose I have modelled the chemical evolution of a few nearby disc galaxies using different IMFs and star formation prescriptions. It is demonstrated that N/O-gradients may be used to constrain the nitrogen contribution from IM/AGB-stars.

Poster contribution, published in IAU Symposium 254: The Galaxy Disk in Cosmological Context, Copenhagen 9–13 June 2008, eds. J. Andersen, J. Bland-Hawthorn & B. Nordström, CUP
Available from arXiv:0808.2115

H I and CO study of circumstellar environments

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[3]IRAM, France

Circumstellar shells around red giants are built over long periods of time that may reach several 10^6 years. They may therefore extend over large sizes (∼1 pc, possibly more) and different complementary tracers are needed to describe their global properties. We have undertaken a programme 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 central sources. We present 21-cm H I and CO rotational line data obtained on an oxygen-rich semi-regular variable, RX Lep. These emissions indicate a stellar outflow at a velocity of ~ 4 km s^{-1} and a rate of $\sim 2 \times 10^{-7}$ M$_\odot$ yr^{-1}, for a duration of $\sim 5 \times 10^4$ years. The modeling of the H I line-profiles obtained at several different positions shows that the outflow is slowed-down by the ambient ISM, and that the external parts of the circumstellar shell are dominated by gas at ∼200 K, as in the well-known "detached shell" around the carbon star Y CVn. The H I source is elongated in a direction opposite to the proper motion of the central star, as it is being recognized in more and more cases.

Oral contribution, published in SF2A-2008 (Paris, June 30–July 4)
Available from http://aramis.obspm.fr/∼lebertre/libert.pdf

Job Adverts

Postdoctoral Research Fellow

Applications are invited for two postdoctoral research fellowships at the South African Astronomical Observatory (SAAO). The appointments will be for two years, with consideration for tenure after that period.

Preference will be given to candidates whose research interests are relevant to South Africa's exploitation of SALT, and/or the 1.4m Infrared Survey Facility, and who have some experience in astronomical instrumentation and/or programming.

The SAAO is the National Facility for optical/infrared astronomy in South Africa. Its headquarters are in Cape Town where the successful applicant will be based. Observing facilities, situated 360 km away at Sutherland, comprise six telescopes with apertures ranging from 0.5 to 1.9m. The primary facility is the 10-m class Southern African Large Telescope (SALT), currently in the final stages of commissioning. SALT is operated by SAAO on behalf of an international consortium and about one third of its observing time is available to the South African research community.

While the successful applicant will spend most of her/his time on research, he/she will also be encouraged to contribute to instrumentation and/or software development programmers and/or postgraduate teaching and supervision.

Applicants must have a PhD in astrophysics or a related subject. They should submit a curriculum vitae, with a statement of research and instrumentation interests to: The Personnel Officer, Ms Linda Tobin, SAAO, P O Box 9, Observatory, 7935, South Africa, phone: +27 21 4470025; fax: +27 21 4473639; email: linda@saao.ac.za. Applicants should arrange for three professional referees to supply letters of recommendation by due date 30 September 2008.

SAAO is committed to equity.

See also http://www.saao.ac.za/about/vacancies/post-doctoral-research-fellow/

Postdoctoral Position: Abundance peculiarities in stellar atmospheres

Applications are invited for a Postdoctoral Research Position at the Institute of Astronomy and Astrophysics (IAA) of the Université Libre de Bruxelles, Belgium.

We are looking for candidates having a good background in radiative transfer in stellar atmospheres, preferably with expertise in non-LTE and/or three-dimensional radiative hydrodynamical modeling.

The successful candidate will participate in a research project entitled "Heavy elements in the universe: stellar evolution, nucleosynthesis and abundance determinations". This research group involves a dozen researchers, with a broad but coherent range of expertise, including derivation of surface abundances in low- and solar-metallicity cool stars — studied through high-resolution spectroscopy and dedicated model atmospheres — as well as nuclear astrophysics, nucleosynthesis, stellar evolution, mixing processes and hydrodynamical modeling.

The team has a priviledged access to the HERMES high-resolution spectrograph (first light: early 2009).

Within the team, the successful candidate will pursue a research program aiming at understanding abundance patterns in stars with peculiar abundances. Depending on the candidate's expertise, his research will focus on one or more stellar classes among the following: low- and solar-metallicity cool stars (Miras, S and C stars, carbon-enriched metal-poor stars), as well as Ap stars. This ambitious research program will require the use and/or development of efficient tools (non-LTE, dynamical atmospheres, stratified atmospheres).

The position is available from October 2008 on and is for 2 years initially, with the possibility of extension to a third year.

Further information is available from:

Alain Jorissen: ajorisse@astro.ulb.ac.be
Sophie Van Eck: svaneck@astro.ulb.ac.be
Institut d'Astronomie et d'Astrophysique (IAA): http://www.astro.ulb.ac.be/
IAA Staff: http://www.astro.ulb.ac.be/Html/staff.html
HERMES spectrograph: http://hermes.ster.kuleuven.ac.be/
Université Libre de Bruxelles: http://www.ulb.ac.be/

Interested applicants should send (by electronic or regular mail) a curriculum vitae, a list of publications, a one-page maximum statement of research interests and contact information for three references to:

Alain Jorissen
ajorisse@astro.ulb.ac.be
Institut d'Astronomie et d'Astrophysique
Université libre de Bruxelles
Campus Plaine C.P. 226
Boulevard du Triomphe
B-1050 Bruxelles
Belgium

Applications will be considered until the position is filled. All applications received by Oct. $5^{\rm th}$, 2008 will receive equal consideration.

See also http://www.astro.ulb.ac.be/

VLTI Workshop — Nov 5–7, IAA Granada — extend your observing techniques

Dear OLBIN'ers,

I am happy to promote an upcoming VLTI-workshop in beautiful Granada, Spain. The main topic is to bring experienced VLTI-observers and newbies together, and to discuss do's and don't's for the near future of VLTI-observations. Bring your projects, ideas and spirit for collaborations to Andalucia:

http://www.riastronomia.es/opencms/opencms/Workshops/R_20080819.html

(click on the English flag for an English version of the announcement)

The list of participents is restricted to 50 attendees to keep it informal.

Mahalo
j-uwe

Dr. Jorg-Uwe Pott
Interferometer scientist
W.M. Keck Observatory & UCLA

See also http://www.riastronomia.es/opencms/opencms/Workshops/R_20080819.html

AGB Stars and Related Phenomena: 11/12–14/08 @ NAOJ

AGB Stars and Related Phenomena, 1st circular:

Date: 2008 November 12 (Wed.) – 14 (Fri.)

Location: National Astronomical Observatory of Japan, Mitaka Campus, COSMOS kaikan
http://www.nao.ac.jp/E/MTK/travel.html

Scientific rationale: Asymptotic Giant Branch (AGB) stars are exciting objects to study because they are associated with various interesting physical and chemical phenomena such as pulsation, masing, formation of molecules and dust grains, etc. However, these stimulating issues are those that make AGB stars complicated non-linear systems that are difficult to understand. Meanwhile, AGB stars are excellent, widely-used tracers in the Milky Way and nearby galaxies because of their high luminosities and well-established period-luminosity relation (of Miras) which yields distances.

Presently, there are a number of on-going Japanese projects (e.g. AKARI by JAXA/ISAS and VERA by NAOJ) that are strongly related to the AGB star science, and we want to maximize science returns from these projects by having this conference. Therefore, we will focus on the following three themes in this conference, allowing an ample amount of time for inspiring discussion:
(1) AGB circumstellar phenomena
(2) AGB stars as diagnostic tools of galaxies
(3) AGB stars as distance scale indicators

We receive financial supports from the following funds: Global COE Program "the Physical Sciences Frontier", MEXT, Japan, JSPS Bilateral Joint Project between Japan and South Africa.

Invited speakers (partial):
Michael Feast (UCT, South Africa)
Patricia Whitelock (SAAO/UCT, South Africa)

Registration: We invite both talks and posters. Please send your abstract and other information by using the Registration Form

Deadlines:
14^{th} of Octover: Abstract submittion deadline
14^{th} of Octover: Deadline for financial assistance
31^{st} of Octover: Registration deadline

Banquet: After the sessions on Thursday 13^{th}, in COSMOS-kaikan. The participation fee is expected to be around JPY 3,000 for students and JYP 5,000 for others.

Accommodation: We have booked several rooms at COSMOS-kaikan in NAOJ. Those who wish to stay are asked to let us know your request by using the Registration Form.

Financial assistance: We have a limited fund available to assist participants whose attendence is made difficult based on the resources at their home institutes. Please use the Registration Form to apply for the support. However, we regret to say we do not have enough budget to support participants from abroad except invited speakers.

Proceedings: We plan to compile the proceedings. Details are to be discussed.

Contact address: e-mail: matsunaga@kusastro.kyoto-u.ac.jp

Organizing committee:
Nakada, Yoshikazu (Univ. of Tokyo, Japan)
Miyata, Takashi (Univ. of Tokyo, Japan)
Tanabé, Toshihiko (Univ. of Tokyo, Japan)
Mito, Hiroyuki (Kiso Obs., Univ. of Tokyo, Japan)
Izumiura, Hideyuki (Okayama Obs., NAOJ, Japan)
Ita, Yoshifusa (NAOJ, Japan)
Yamamura, Issei (JAXA/ISAS, Japan)
Ueta, Toshiya (Univ. of Denver, USA)
Matsunaga, Noriyuki (Kyoto Univ., Japan)

——— Registration Form ———— send the Form to matsunaga@kusastro.kyoto-u.ac.jp
1) Name –

2) Affiliation –

3) Are you going to attend for the entire schedule between 12 and 14? – YES or OR Specify otherwise [ ]

4) Presentation: Are you giving a presentation — YES(Talk/Poster) or NO
Author list —
Title —
Abstract (200 words or less) —

5) Are you going to attend the banquet on Thursday 13^{th}. YES or NO

6) Your e-mail and postal address:

Message, if any: