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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 165$^{\rm th}$ issue of the AGB Newsletter. Lots of nucleosynthesis work, pulsating stars, binaries, and AGB stars in stellar systems from globulars and the Bulge to Local Group galaxies and farther afield.

Congratulations to Valério Ribeiro, who has just obtained his Philospher's Degree. It's great then to see that there are opportunitites for postdoctoral research, such as the one advertised by the group in Uppsala.

Don't miss the announcement of the very interesting workshop in wonderful Warsaw this Summer.

Stefan Uttenthaler, back in Vienna, offered the following reaction to last month's Food for Thought:
"Certainly, the PN population will not be fully representative of the underlying AGB population. Most likely not every AGB star will evolve into a PN, and also the binarity properties (incl. planets) of the population will have an impact on the evolution from the AGB to the PN phase. In fact, just in the previous issue of the Newsletter, De Marco & Soker note that the presence of a companion will alter the PN life time, and that only one quarter of all AGB stars will make a PN.
Now concerning the Bulge my opinion is that in the absence of evidence that the PNe are *not* representative for the underlying AGB population (i.e. they do not originate in the same population), it is safer to assume that at least some of today's PNe originate from the same population as the current AGB stars do. Gaia will most certainly tell us whether or not there are two populations within the Bulge AGB and PN populations, as is found among the K giants (Babusiaux et al. 2010) or the red clump stars (Nataf et al. 2010; McWilliam & Zoccali 2010)."

The next issue is planned to be distributed early in May 2011.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Which elemental yields from AGB stars are reliably computed, and how unreliable are the others?

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

Convective-reactive proton-^{12}C combustion in Sakurai's object (V4334 Sagittarii) and implications for the evolution and yields from the first generations of stars

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Depending on mass and metallicity as well as evolutionary phase, stars occasionally experience convective-reactive nucleosynthesis episodes. We specifically investigate the situation when nucleosynthetically unprocessed, H-rich material is convectively mixed with a He-burning zone, for example in convectively unstable shell on top of electron-degenerate cores in AGB stars, young white dwarfs or X-ray bursting neutron stars. Such episodes are frequently encountered in stellar evolution models of stars of extremely low or zero metal content [...] We focus on the convective-reactive episode in the very-late thermal pulse star Sakurai's object (V4334 Sagittarii). Asplund et al. (1999) determined the abundances of 28 elements, many of which are highly non-solar, ranging from H, He and Li all the way to Ba and La, plus the C isotopic ratio. Our simulations show that the mixing evolution according to standard, one-dimensional stellar evolution models implies neutron densities in the He that are too low to obtain a significant neutron capture nucleosynthesis on the heavy elements. We have carried out 3D hydrodynamic He-shell flash convection [...] we assume that the ingestion process of H into the He-shell convection zone leads only after some delay time to a sufficient entropy barrier that splits the convection zone [...] we obtain significantly higher neutron densities (∼few 10^{15} cm^{-3}) and reproduce the key observed abundance trends found in Sakurai's object. These include an overproduction of Rb, Sr and Y by about 2 orders of magnitude higher than the overproduction of Ba and La. Such a peculiar nucleosynthesis signature is impossible to obtain with the mixing predictions in our one-dimensional stellar evolution models. [...] We determine how our results depend on uncertainties of nuclear reaction rates, for example for the ^{13}C(α, n)^{16}O reaction.

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and from http://iopscience.iop.org/0004-637X/727/2/89/

The basal chromospheric Mg II h+k flux of evolved stars: Probing the energy dissipation of giant chromospheres

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Of a total of 177 cool G, K, and M giants and supergiants, we measured the Mg II h+k line emission of extended chromospheres in high-resolution (LWR) IUE spectra by using the IUE final data archive at STScI, and derived the respective stellar surface fluxes. They represent the chromospheric radiative energy losses presumably related to basal heating by the dissipation of acoustic waves, plus a highly variable contribution due to magnetic activity.
Thanks to the large sample size, we find a very well-defined lower limit, the basal chromospheric Mg II h+k line flux of cool giant chromospheres, as a function of $T_{\rm eff}$. A total of 16 giants were observed several times, over a period of up to 20 years. Their respective minimal Mg II h+k line fluxes confirm the basal flux limit very well because none of their emissions dip beneath the empirically deduced basal flux line representative for the overall sample. Based on a

total of 15 to 22 objects with very low Mg II h+k emission, we find as limit: $\log F_{\rm MgII} = 7.33 \log T_{\rm eff} - 21.75$ (cgs units; based on the B–V relation). Within its uncertainties, this is almost the same relation as has been found in the past for the geometrically much thinner chromospheres of main sequence stars. But any residual dependence of the basal flux on the surface gravity is difficult to determine, since especially among the G-type giants there is a large spread of the individual chromospheric Mg II fluxes, apparently due to revived magnetic activity. However, it can be stated that over a gravity range of more than four orders of magnitude (main-sequence stars to supergiants), the basal flux does not appear to vary by more than a factor of 2.
These findings are in good agreement with the predictions by previous hydrodynamic models of acoustic wave propagation and energy dissipation, as well as with earlier empirical determinations. Finally, we also discuss the idea that the ample energy flux of the chromospheric acoustic waves in a cool giant may yield, as a by-product, the energy flux required by its cool wind (i.e., non-dust-driven, "Reimers-type" mass-loss), provided a dissipation mechanism of a sufficiently long range is operating.

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The evolution of isotope ratios in the Milky Way galaxy

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Isotope ratios have opened a new window into the study of the details of stellar evolution, supernovae, and galactic chemical evolution. We present the evolution of the isotope ratios of elemental abundances (from C to Zn) in the solar neighbourhood, bulge, halo, and thick disk, using chemical evolution models with updated yields of Asymptotic Giant Branch (AGB) stars and core-collapse supernovae. The evolutionary history of each element is different owing to the effects of the initial progenitor mass and metallicity on element production. In the bulge and thick disk the star formation timescale is shorter than in the solar neighbourhood, leading to higher [α/Fe] ratios. Likewise, the smaller contribution from Type Ia supernovae in these regions leads to lower [Mn/Fe] ratios. Also in the bulge, the abundances of [(Na, Al, P, Cl, K, Sc, Cu, Zn)/Fe] are higher because of the effect of metallicity on element production from core-collapse supernovae. According to our predictions, it is possible to find metal-rich stars ([Fe/H] $\gtrsim -1$) that formed in the early Universe as a result of rapid star formation. The chemical enrichment timescale of the halo is longer than in the solar neighbourhood, and consequently the ratios of [(C, F)/Fe] and ^{12}C/^{13}C are higher owing to a significant contribution from low-mass AGB stars. While the [α/Fe] and [Mn/Fe] ratios are the same as in the solar neighbourhood, the [(Na, Al, P, Cl, K, Sc, Cu, Zn)/Fe] ratios are predicted to be lower. Furthermore, we predict that isotope ratios such as ^{24}Mg/^{25,26}Mg are larger because of the contribution from low-metallicity supernovae. Using isotopic ratios it is possible to select stars that formed in a system with a low chemical enrichment efficiency such as the satellite galaxies that were accreted onto our own Milky Way Galaxy.

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Radial stellar pulsation and three-dimensional convection. I. Numerical methods and adiabatic test cases

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We are developing a three-dimensional radiation hydrodynamics code to simulate the interaction of convection and pulsation in classical variable stars. One key goal is the ability to carry these simulations to full amplitude in order

to compare them with observed light and velocity curves. Previous two-dimensional calculations were prevented from doing this because of drift in the radial coordinate system, due to the algorithm defining radial movement of the coordinate system during the pulsation cycle. We remove this difficulty by defining our coordinate system flow algorithm to require that the mass in a spherical shell remains constant throughout the pulsation cycle. We perform adiabatic test calculations to show that large amplitude solutions repeat over more than 150 pulsation periods. We also verify that the computational method conserves the peak kinetic energy per period, as must be true for adiabatic pulsation models.

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The UK Infrared Telescope M 33 monitoring project. II. The star formation history in the central square kiloparsec (and inferences about super-AGB stars)

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We have conducted a near-infrared monitoring campaign at the UK InfraRed Telescope (UKIRT), of the Local Group spiral galaxy M 33 (Triangulum). The main aim was to identify stars in the very final stage of their evolution, and for which the luminosity is more directly related to the birth mass than the more numerous less-evolved giant stars that continue to increase in luminosity. In this second paper of the series, we construct the birth mass function and hence derive the star formation history. The star formation rate has varied between ~ 0.002 and 0.007 $M_\odot$ yr^{-1} kpc^{-2}. We give evidence of two epochs of a star formation rate enhanced by a factor of a few – one that happened ≥ 6 Gyr ago and produced $\geq 80\%$ of the total mass in stars, and one around 250 Myr ago that lasted ~ 200 Myr and formed $\leq 6\%$ of the mass in stars. We construct radial and azimuthal distributions in the image plane and in the galaxy plane for populations associated with old first-ascent red giant branch (RGB) stars, intermediate-age Asymptotic Giant Branch (AGB) stars and young (massive) blue and red supergiants. We find that the RGB stars follow a spheroidal distribution, while younger stars follow a flat-disc distribution. The intermediate-age population displays signs of a pseudo-bulge or possibly a bar. The inner spiral arm pattern as recorded in mid-19$^{\rm th}$-century drawings is confirmed. We interpret our findings as evidence for an old, pressure-supported component and a younger disc formed 6 Gyr ago, with an accretion event occurring 250 Myr ago giving rise to the compact nucleus in M 33. Our study provides support for recent Padova stellar evolution models except that super-AGB stars likely reach low temperatures and thus high mass-loss rates, supporting the super-AGB nature of the progenitors of dust-enshrouded supernovae such as SN 2008S.

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High-resolution near-IR spectra of NGC 6624 and NGC 6569

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We present the first abundances analysis based on high-resolution infrared (IR) echelle spectra of NGC 6569 and NGC 6624, two moderately reddened globular clusters located in the outer bulge of the Galaxy. We find [Fe/H] $= -0.79 \pm 0.02$ dex and [Fe/H] $= -0.69 \pm 0.02$ dex for NGC 6569 and NGC 6624, respectively and an average α-elements enhancement of $\approx +0.43 \pm 0.02$ dex and $+0.39 \pm 0.02$ dex, consistent with previous measurements on other

metal-rich Bulge clusters. We measure accurate radial velocities of $\langle v_{\rm r} \rangle = -47 \pm 4$ km s^{-1} and $\langle v_{\rm r} \rangle = +51 \pm 3$ km s^{-1} and velocity dispersions of ≈ 8 km s^{-1} and ≈ 6 km s^{-1} for NGC 6569 and NGC 6624, respectively. Finally, we find very low ^{12}C/^{13}C isotopic ratio (≤ 7 in NGC 6624 and ≈ 5 in NGC 6569), confirming the presence extra-mixing mechanisms during the red giant branch evolution phase.

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Characterisation of red-giant stars in the public *Kepler* data

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The first public release of long-cadence stellar photometric data collected by the NASA *Kepler* mission has now been made available. In this paper we characterise the red-giant (G–K) stars in this large sample in terms of their solar-like oscillations. We use published methods and well-known scaling relations in the analysis. Just over 70% of the red giants in the sample show detectable solar-like oscillations, and from these oscillations we are able to estimate the fundamental properties of the stars. This asteroseismic analysis reveals different populations: low-luminosity H-shell burning red-giant branch stars, cool high-luminosity red giants on the red-giant branch and He-core burning clump and secondary-clump giants.

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Improved prospects for the detection of new Large Magellanic Cloud planetary nebulae

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The Large Magellanic Cloud (LMC) contains the nearest large extragalactic population of planetary nebulae (PNe). A shallow viewing angle and low interstellar reddening towards the LMC potentially means a larger, more complete flux-limited population can be assembled than for any other galaxy. These advantages appear to be reflected by the small gap between the catalogued (~ 700 PNe) and estimated (1000 ± 250 PNe) population size. With more detailed multi-wavelength studies the catalogued number of LMC PNe may fall, potentially widening this gap. We demonstrate here that the gap can be further bridged with improved optical and near-infrared imaging surveys. We present three [O III]-selected PNe discovered from ESO WFI observations of the 30 Doradus region and one serendipitous discovery from near-infrared Vista Magellanic Cloud (VMC) survey observations. The WFI PNe have resolved [O III] and Hα nebulae that verify their PN nature and their [O III] fluxes place them 6–7 mag ($m_{5007} = 20$–21 mag) fainter than the

bright-end of the planetary nebula luminosity function (PNLF). Their faintness, small angular size and surrounding complex emission-line background explains why previous Hα surveys of the region did not select them. We estimate there may be as many as 50–75 similar PNe awaiting discovery in the central $5^\circ \times 5^\circ$ of the LMC. The VMC survey routinely detects PNe as red resolved nebulae that may allow some of this expected population to be recovered without traditional narrow-band imaging surveys. We demonstrate this potential with the first new VMC-selected PN which has a rare Wolf–Rayet [WC9]–[WC11] central star.

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Binaries discovered by the SPY survey VI. Discovery of a low mass companion to the hot subluminous planetary nebula central star EGB 5 – A recently ejected common envelope?

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Hot subdwarf B stars (sdBs) in close binary systems are assumed to be formed via common envelope ejection. According to theoretical models, the amount of energy and angular momentum deposited in the common envelope scales with the mass of the companion. That low mass companions near or below the core hydrogen-burning limit are able to trigger the ejection of this envelope is well known. The currently known systems have very short periods $\simeq 0.1$–0.3 d. Here we report the discovery of a low mass companion ($M_2 > 0.14$ M$_\odot$) orbiting the sdB star and central star of a planetary nebula EGB 5 with an orbital period of 16.5 d at a minimum separation of 23 R$_\odot$. Its long period is only just consistent with the energy balance prescription of the common envelope. The marked difference between the short and long period systems will provide strong constraints on the common envelope phase, in particular if the masses of the sdB stars can be measured accurately. Due to selection effects, the fraction of sdBs with low mass companions and similar or longer periods may be quite high. Low mass stellar and substellar companions may therefore play a significant role for the still unclear formation of hot subdwarf stars. Furthermore, the nebula around EGB 5 may be the remnant of the ejected common envelope making this binary a unique system to study this short und poorly understood phase of binary evolution.

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Binaries discovered by the MUCHFUSS project: SDSS J08205+0008 – An eclipsing subdwarf B binary with brown dwarf companion

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Hot subdwarf B stars (sdBs) are extreme horizontal branch stars believed to originate from close binary evolution. Indeed about half of the known sdB stars are found in close binaries with periods ranging from a few hours to a few

days. The enormous mass loss required to remove the hydrogen envelope of the red-giant progenitor almost entirely can be explained by common envelope ejection. A rare subclass of these binaries are the eclipsing HW Vir binaries where the sdB is orbited by a dwarf M star. Here we report the discovery of an HW Vir system in the course of the MUCHFUSS project. A most likely substellar object ($\simeq 0.068$ $M_\odot$) was found to orbit the hot subdwarf J08205+0008 with a period of 0.096 days. Since the eclipses are total, the system parameters are very well constrained. J08205+0008 has the lowest unambiguously measured companion mass yet found in a subdwarf B binary. This implies that the most likely substellar companion has not only survived the engulfment by the red-giant envelope, but also triggered its ejection and enabled the sdB star to form. The system provides evidence that brown dwarfs may indeed be able to significantly affect late stellar evolution.

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Very deep spectroscopy of the bright Saturn Nebula NGC 7009 – I. Observations and plasma diagnostics

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We present very deep CCD spectrum of the bright, medium-excitation planetary nebula NGC 7009, with a wavelength coverage from 3040 to 11,000 Å. Traditional emission line identification is carried out to identify all the emission features in the spectra, based on the available laboratory atomic transition data. Since the spectra are of medium resolution, we use multi-Gaussian line profile fitting to deblend faint blended lines, most of which are optical recombination lines (ORLs) emitted by singly ionized ions of abundant second-row elements such as C, N, O and Ne. Computer-aided emission-line identification, using the code EMILI developed by Sharpee et al., is then employed to further identify all the emission lines thus obtained. In total about 1200 emission features are identified, with the faintest ones down to fluxes 10^{-4} of Hβ. The flux errors for all emission lines, estimated from multi-Gaussian fitting, are presented. Plots of the whole optical spectrum, identified emission lines labeled, are presented along with the results of multi-Gaussian fits.

Of all the properly identified emission lines, permitted lines contribute 81 per cent to the total line number. More than 200 O II permitted lines are presented, as well as many others from N II and Ne II. Due to its relatively simple atomic structure, C II presents few lines. Within the flux range 10^{-2}–10^{-4} Hβ where most permitted lines of C II, N II, O II and Ne II fall, the average flux measurement uncertainties are about 10 to 20 per cent. Comparison is also made of the number of emission lines identified in the current work of NGC 7009 and those of several other planetary nebulae (PNe) that have been extensively studied in the recent literature, and it shows that our line-deblending procedure increases the total line number significantly, especially for emission lines with fluxes lower than 10^{-3} of Hβ. Higher resolution is still needed to obtain more reliable fluxes for those extremely faint emission lines, lines of fluxes of the order of 10^{-5}–10^{-6} of Hβ.

Plasma diagnostics using optical forbidden line ratios give an average electron temperature of 10,020 K, which agrees well with previous results of the same object. The average electron density of NGC 7009 derived from optical forbidden line ratios is 4290 cm^{-3}. The [O III] λ4959/λ4363 nebular-to-auroral line ratio yields an electron temperature of 9800 K. The ratio of the nebular continuum Balmer discontinuity at 3646 Å to H11 reveals an electron temperature of 6500 K, about 600 K lower than the measurements published in the literature. The Balmer decrement reveals a density of about 3000 cm^{-3}. Also derived are electron temperatures from the He I line ratios, and a value of 5100 K from the λ7281/λ6678 ratio is adopted. Utilizing the effective recombination coefficients newly available, we find an electron temperature around 1000 K from O II ORL spectrum. Thus general pattern of electron temperatures, T_e([O III]) $\gtrsim T_e$(H I BJ) $\gtrsim T_e$(He I) $\gtrsim T_e$(O II), which is seen in many PNe, is repeated in NGC 7009. Far-IR fine-structure lines, with observed fluxes adopted from the literature, are also used to derive T_e and N_e. The [O III] (52μm + 88μm)/λ4959 line ratio gives an electron temperature of 9260 K, and the 52μm/88μm ratio yields an electron density of 1260 cm^{-3}.

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Lithium-rich giants in the Galactic thick disk

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Context: Lithium is a fragile element, which is easily destroyed in the stellar interior. The existence of lithium-rich giants still represents a challenge for stellar evolution models. Aims: We have collected a large database of high-resolution stellar spectra of 824 candidate thick-disk giants having 2MASS photometry and proper motions measured by the Southern Proper-Motion Program (SPM). In order to investigate the nature of Li-rich giants, we searched this database for giants presenting a strong Li I resonance line. Methods: We performed a chemical abundance analysis on the selected stars with the MOOG code along with proper ATLAS-9 model atmospheres. The iron content and atmospheric parameters were fixed by using the equivalent width of a sample of Fe lines. We also derive abundances for C, N, and O and measure or derive lower limits on the $^{12}C/^{13}C$ isotopic ratios, which is a sensible diagnostic of the stars evolutionary status. Results: We detected five stars with a lithium abundance higher than 1.5, i.e. Li-rich according to the current definition. One of them (SPM-313132) has $A(\mathrm{Li}) > 3.3$ and, because of this, belongs to the group of the rare super Li-rich giants. Its kinematics makes it a likely thin-disk member and its atmospheric parameters are compatible with it being a 4 $M_\odot$ star either on the red giant branch (RGB) or the early asymptotic giant branch. This object is the first super Li-rich giant detected at this phase. The other four are likely low-mass thick-disk stars evolved past the RGB luminosity bump, as determined from their metallicities and atmospheric parameters. The most evolved of them lies close to the RGB-tip. It has $A(\mathrm{Li}) > 2.7$ and a low $^{12}C/^{13}C$ isotopic ratio, close to the cool bottom processing predictions.

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Enrichment of heavy elements in the red giant S 15-19 in the Sextans dwarf spheroidal galaxy

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We determined the chemical abundances of the extremely metal-poor (EMP) star S 15-19 ([Fe/H] = −3.0) in the Sextans dwarf galaxy. While heavy neutron-capture elements (e.g., Ba) are generally deficient in dwarf galaxies, this object was shown to have an exceptional over-abundance of Ba ([Ba/Fe] ∼ +0.5) by a previous study, which is similar to those of r-process-enhanced stars found in the field halo. Our new high-resolution spectroscopy for this object for the blue region, however, reveals that no clear excess of r-process elements, like Eu, appears in this object. Moreover, a significant excess of carbon ([C/Fe] = +1.0) and a deficiency of Sr ([Sr/Fe] = −1.4) are found for this object. Taking the variation of the radial velocities measured at the two different epochs into consideration, the origin of the excesses of heavy neutron-capture elements in S 15-19 is not the r-process, but is the s-process in an asymptotic giant branch (AGB) star that was the binary companion (primary) of this object. Carbon- and s-processenhanced material should have been transferred to the surface of S 15-19 across the binary system. These results are compared with carbon-enhanced metal-poor stars in the field halo.

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A distance estimate based on angular expansion for the planetary nebula NGC 6881

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In this paper, we report on high angular resolution radio observations of the planetary nebula NGC 6881 obtained with the Very Large Array at a wavelength of 6 cm. The emission appears to be the superposition of a roundish core and a point-symmetric bipolar structure elongated along a position angle of about 145°. This is strongly reminiscent of the morphology seen in Hα and [N II] images. A comparison between VLA observations obtained in 1984 and 1994 clearly reveals the expansion of the core of the nebula, at a rate of 2.1 ± 0.7 mas yr^{-1}. Assuming that the expansion velocity in the plane of the sky (determined from these measurements) and the expansion velocity along the line of sight (estimated from optical spectroscopy available in the literature) are equal, we find a distance to NGC 6881 of 1.6 ± 0.5 kpc ± 0.3 kpc, where the first error reflects the uncertainty on the expansion, and the second error comes from the potential difference between pattern and material speeds. This distance is compatible with (but does not necessarily imply) an association of NGC 6881 with the nearby H II region Sh 2-109 and, more generally, the Cygnus star-forming region.

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A temporal study of oxygen-rich pulsating variable AGB star, T Cep: Investigation on dust formation and dust properties

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Pulsation is believed to be the leading cause of dusty mass loss from Asymptotic Giant Branch (AGB) stars. We present a temporal study of T Cep, a long-period Mira variable, using seven ISO SWS spectra, covering a 16-month period over a single pulsation cycle. The observed spectral dust features change over the pulsation cycle of this Mira. In general, the overall apparent changes in spectral features can be attributed to changes in the dust temperature, resulting from the intrinsic pulsation cycle of the central star. However, not all feature changes are so easily explained. Based on direct comparison with laboratory spectra of several potential minerals, the dust is best explained by crystalline iron-rich silicates. These findings contradict the currently favored dust formation hypotheses.

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Synthetic photometry for carbon-rich giants II. The effects of pulsation and circumstellar dust

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Red giant stars approaching the end of the evolutionary phase of the Asymptotic Giant Branch (AGB) are, inter

alia, characterised by (i) pulsations of the stellar interiors, and (ii) the development of dusty stellar winds. Therefore, such very evolved objects cannot be adequately described with hydrostatic dust-free model atmospheres. By using self-consistent dynamic model atmospheres which simulate pulsation-enhanced dust-driven winds we studied in detail the influence of the above mentioned two effects on the spectral appearance of long period variables with carbon-rich atmospheric chemistry. While the pulsations lead to large-amplitude photometric variability, the dusty envelopes (resulting from the outflows which contain dust particles composed of amorphous carbon) cause pronounced circumstellar reddening. Based on one selected dynamical model which is representative of C-type Mira variables with intermediate mass loss rates, we calculated synthetic spectra and photometry for standard broad-band filters (Johnson–Cousins–Glass system) from the visual to the near-infrared. The synthetic photometry was subsequently compared with observational results. Our modelling allows to investigate in detail the substantial effect of circumstellar dust on the resultant photometry. The pronounced absorption of amorphous carbon dust grains (increasing towards shorter wavelengths; $Q_{\rm abs}/a \propto \lambda^{-\beta}$ with $\beta \approx 1$), leads to colour indices which are significantly redder than the corresponding ones based on hydrostatic dust-free models. Only if we account for this circumstellar reddening we get synthetic colours that are comparable to observations of evolved AGB stars. The photometric variations of the dynamical model were compared to observed lightcurves of the C-type Mira RU Vir which appears to be quite similar to the model (although the model is not a dedicated fit). We found good agreement concerning the principal behaviour of the $BVRIJHKL$ lightcurves and also quantitatively fitting details (e.g., magnitude ranges, the amplitude decrease from visual to NIR, absolute magnitudes). The analysed model is able to reproduce the variations of RU Vir and other Miras in $(J-H)$ vs. $(H-K)$ diagrams throughout the light cycle (ranges, loops). Contrasting the model photometry with observational data for a variety of galactic C-rich giants in such colour–colour diagrams proved that the chosen atmospheric model fits well into a sequence of objects with increasing mass loss rates, i.e. redder colour indices. The comparison of our synthetic photometry with observational results provides a further indication that the applied dynamic model atmospheres represent the outer layers of pulsating and mass-losing C-rich AGB stars reasonably well.

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Long period variables and mass loss in the globular clusters NGC 362 and NGC 2808

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The pulsation periods of long period variables (LPVs) depend on their mass and helium abundance as well as on their luminosity and metal abundance. Comparison of the observed periods of LPVs in globular clusters with models is capable of revealing the amount of mass lost on the giant branch and the helium abundance. We aim to determine the amount of mass loss that has occurred on the giant branches of the low metallicity globular clusters NGC 362 and NGC 2808. We also aim to see if the LPVs in NGC 2808 can tell us about helium abundance variations in this cluster. We have used optical monitoring of NGC 362 and NGC 2808 to determine periods for the LPVs in these clusters. We have made linear pulsation models for the pulsating stars in these clusters taking into account variations in mass and helium abundance. Reliable periods have been determined for 11 LPVs in NGC 362 and 15 LPVs in NGC 2808. Comparison of the observed variables with models in the log P–K diagram shows that mass loss of ~ 0.15–0.2 $M_\odot$ is required on the first giant branch in these clusters, in agreement with estimates from other methods. In NGC 2808, there is evidence that a high helium abundance of $Y \sim 0.4$ is required to explain the periods of several of the LPVs. It would be interesting to determine periods for LPVs in other Galactic globular clusters where a helium abundance variation is suspected to see if the completely independent test for a high helium abundance provided by the LPVs can confirm the high helium abundance estimates.

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A close look at the Centaurus A group of galaxies II. Intermediate-age populations in early-type dwarfs

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We investigate the resolved stellar content of early-type dwarf galaxies in the Centaurus A group, in order to estimate the fraction of their intermediate-age populations. We use near-infrared photometric data taken with the VLT/ISAAC instrument, together with previously analyzed archival HST/ACS data. The combination of the optical and infrared wavelength range permits us to firmly identify luminous asymptotic giant branch stars, which are indicative of an intermediate-age population in these galaxies. We consider one dwarf spheroidal (CenA-dE1) and two dwarf elliptical (SGC 1319.1−4216 and ESO 269-066) galaxies that are dominated by an old population. The most recent periods of star formation are estimated to have taken place between ~ 2 and ~ 5 Gyr ago for SGC 1319.1−4216 and ESO 269-066, and approximately 9 Gyr ago for CenA-dE1. For ESO 269-066, we find that the intermediate-age populations are significantly more centrally concentrated than the predominantly old underlying stars. The intermediate-age population fraction is found to be low in the target galaxies, consistent with fractions of up to $\sim 15\%$ of the total population. These values could be higher by a factor of two or three, if we consider the observational limitations and the recent discussion about the uncertainties in theoretical models. We suggest that there is a correlation between intermediate-age population fraction and proximity to the dominant group galaxy, with closer dwarfs having slightly smaller such fractions, although our sample is too small to draw firm conclusions. Even when considering our results as lower limits, the intermediate-age population fractions for the studied dwarfs are clearly much lower than those found in similar dwarfs around the Milky Way, but comparable to what is seen for the low-mass M 31 companions. Our results confirm previous literature work by Rejkuba et al. (2006) about early-type dwarfs in the Centaurus A group.

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Conference Papers

Multiplicity in 5 $M_\odot$ stars

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Multiwavelength opportunities have provided important new insights into the properties of binary/multiple 5 $M_\odot$ stars. The combination of cool evolved primaries and hot secondaries in Cepheids (geriatric B stars) has yielded detailed information about the distribution of mass ratios. It has also provided a surprisingly high fraction of triple systems. Ground-based radial velocity orbits combined with satellite data from *Hubble*, FUSE, IUE, and *Chandra* can provide full information about the systems, including the masses. In particular, X-ray observations can identify low mass companions which are young enough to be physical companions. These multiwavelength observations provide important tests for star formation scenarios including diffenences between high and low mass results and differences between close and wide binaries.

Poster contribution, published in Bull. of the Royal Scientific Society of Liège, 80 (2011)
Available from arXiv:1102.5316
and from http://popups.ulg.ac.be/SRSL/document.php?id=3126

Exploring the morphology of the expanding nebular remnants of novae

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We report studies of several novae which are known or suspected to be recurrent. We discuss our morpho-kinematical modelling of the evolution of the optical spectra taken early after outburst for two recent novae. In the case of the known RN RS Ophiuchi, this is also coupled with HST imaging. Results support the hypothesis that remnant shaping occurs very early in a nova outburst and we also derive the structures (including inclination) and velocity field of the remnants. Overall, these results emphasise the need for coordinated imaging and spectrometry, although not always possible, if we are to truly understand remnant shaping in these systems together with the wider implications for studies of shaping mechanisms in other astronomical objects.

Oral contribution, published in "Asymmetric Planetary Nebulae 5", held in Bowness-on-Windermere, U.K., 20–25 June 2010, eds. A.A. Zijlstra, F. Lykou, I. McDonald and E. Lagadec (2011)
Available from arXiv:1103.0989

An overabundance of oxygen in planetary nebulae of the solar neighborhood

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We study the oxygen abundance in five H II regions and seven planetary nebulae (PNe) located within 2 kpc from the Sun that have available spectra of high quality. Our analysis uses a similar procedure and the same atomic data to derive abundances in all the objects. The results calculated with collisionally excited lines for the H II regions indicate that the local interstellar medium is very homogeneous, with $12 + \log(\mathrm{O/H}) = 8.45$–$8.54$. As for the PNe, six out of seven show significantly higher abundances: $12 + \log(\mathrm{O/H}) = 8.65$–$8.80$. This overabundance of oxygen in PNe also holds when we consider the abundances implied by recombination lines.

Oral contribution, published in "XIII Latin American Regional IAU Meeting", Rev. Méx. A&A. Conf. Ser.
Available from arXiv:1103.3037

Iron depletion in ionized nebulae of the Large Magellanic Cloud

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We present here preliminary results of an analysis of the iron abundance in the ionized gas of three planetary nebulae and one H II region of the Large Magellanic Cloud (LMC). These results are compared with the ones we obtain for a sample of Galactic and extragalactic nebulae. We find that the amounts of iron depletion into dust grains in LMC nebulae are similar to those found in Galactic nebulae. Objects with lower metallicities show lower depletions, but a larger sample of objects is needed to explore the reasons behind this trend.

Oral contribution, published in "XIII Latin American Regional IAU Meeting", Rev. Méx. Astron. and Astrofis. Conf. Ser.
Available from arXiv:1103.2158

Thesis

Investigation of the nebular remnants of novae

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Classical and recurrent nova outbursts occur on the surface of a white dwarf in a close binary system. It is widely established that the outburst is due to a thermonuclear runaway. Their study provides a real-time laboratory for the understanding of a wide range of astrophysical phenomena. These include for example, mass transfer in close binary systems, nuclear powered outbursts, dust formation, mass loss from red giants, and many others. Recurrent novae have also been suggested as the progenitors of Type Ia Supernovae.

This thesis concentrates on investigating the nebular remnants of novae by studying both resolved imaging (where available) and spectroscopic evolution and combining this with detailed modelling. Such studies have wider implications for example in our understanding of the shaping of proto-Planetary Nebulae.

Here, using a morpho-kinematical code, the true 3D geometry, from which information such as the remnant's inclination angle and expansion velocity can be derived, of the recurrent nova RS Ophiuchi and classical novae V2491 Cygni, V2672 Ophiuchi and KT Eridani are established and related to other characteristics of each system. Each of the classical novae have also been suggested as a recurrent nova candidate. Furthermore, several enhancements to the modelling code were implemented prompted by the work described in this thesis.

The RS Oph work entailed detailed modelling of *Hubble Space Telescope* resolved imaging combined with ground-based spectroscopic observations. Here it was shown that the bipolar morphology of RS Oph consisted of two distinct components with an outer dumbbell and an inner hour glass overdensity, which were required to reproduce both the observed images and spectra. This morphology was suggested to arise due to the interaction between the pre-existing anisotropic red-giant wind and the ejecta. The observed asymmetry in the ACS/HRC image was shown to be due to the finite width and offset from the [O III] line's rest wavelength of the F502N filter. This in turn gave valuable information on the spatial orientation of the nebula. The inclination angle was derived to be 39^{+1}_{-10} degrees, comparable with estimates of the inclination of the central binary. Furthermore, it was also suggested, when comparing two different epochs, that there was evidence for some deceleration of the inner hour glass while the outer dumbbell expanded linearly. This linear expansion is also confirmed with X-ray observations.

In the case of V2491 Cyg, V2672 Oph and KT Eri, no resolved imaging was available primarily due to their distances versus time since outburst. The modelling here concentrated on reproducing the Hα line profile at various outburst epochs to derive their true geometry.

V2491 Cyg, was explored using the first scientific results for the Liverpool Telescope prototype spectrograph. These were best-fit using a morphology with polar blobs and an equatorial ring with an inclination angle of 80^{+3}_{-12} degrees and a maximum expansion velocity of the polar blobs of 3100^{+200}_{-100} km s^{-1} and for the equatorial ring of 2700^{+200}_{-100} km s^{-1}. Multi-epoch fitting showed that the line profile at later times consisted of a combination of Hα and [N II] emission. Furthermore, the derived inclination implies that eclipses should be observed for which a search is now underway. In addition, the amplitude versus time of decline from maximum relationship, at the inclination derived, may imply a recurrent nova nature of V2491 Cyg.

V2672 Oph's derived nebular morphology was that of polar blobs and an equatorial ring with an underlying prolate structure which seemed to reduce in relative density with time compared to the other components. The inclination of the system was suggested to be 0 ± 6 degrees and a maximum expansion velocity $V_{\rm exp} = 4800^{+900}_{-800}$ km s^{-1}. The morphology found here is incompatible with that expected for a fast nova which may again lend support for a recurrent nova nature of V2672 Oph.

In KT Eri, optical spectroscopy, using a combination of second generation spectrograph on the Liverpool Telescope and those of more established observatories, and X-ray observations were compared to determine that the emergence of the He II 4686Å line is related to the emergence of the super-soft source (SSS) phase in the X-ray. This could be a useful tool as a trigger for future X-ray observations. The SSS phase is an important phase for observations because it samples the continued extensive nuclear burning on the surface of the white dwarf following outburst. Morpho-kinematical modelling suggested that the morphology of the remnant was that of a dumbbell with a ratio between the major to minor axis of 4:1 with an inclination of 58^{+6}_{-7} degrees and the maximum expansion velocity $V_{\rm exp} = 2800 \pm 200$ km s^{-1}.

Future enhancements to the modelling code are suggested. Furthermore, the results given here present sufficient scientific motivation to justify for example a renewed program of *Hubble Space Telescope* observations of nova remnants.

January 2011
Available from http://adsabs.harvard.edu/abs/2011PhDT.....1R

Job Advert

Department of Physics and Astronomy, Uppsala University, Sweden Postdoctoral Position

Three Postdoctoral positions in physics or astronomy at the Department of Physics and Astronomy, Starting date: 1st of July 2011 or as agreed upon.

The department of Physics and Astronomy has assignments within three main areas: education, research and co-operation with society, carried out within Applied Nuclear Physics, Astronomy and Space Physics, Global Energy Systems, High Energy Physics, Ion Physics, Materials Physics, Materials Theory, Molecular and Condensed Matter Physics, Nuclear Physics, Physics Education Research and Theoretical Physics. The number of employees is 260, of which approximately 100 are doctoral students. More information about the department can be found: http://www.physics.uu.se/sv/frontpage.

Duties: The work consists of at least 80 percent of research and no more than 20 percent teaching. Recruitment Period: The period of employment is 2 years. For details and a link to the application pages, please see http://www.personalavd.uu.se/ledigaplatser/419postdoc.html

Application deadline: 16 May, 2011 (reference: UFV-PA 2011/419).

See also http://www.personalavd.uu.se/ledigaplatser/419postdoc.html

Announcement

First NCAC Symposium on "Physical and chemical aspects of late stages of stellar evolution"

Warsaw, Poland
29 August – 01 September, 2011

We are pleased to announce the 1st NCAC (Nicolaus Copernicus Astronomical Center) Symposium which will be dedicated to physical and chemical aspects of late stages of stellar evolution.

The proposed program is aimed at the most important discoveries and future prospects resulting from the recent space missions as well as ground based projects related to the late stages of stellar evolution in Milky Way and the Local Group of Galaxies, especially of low and intermediate-mass stars.

In particular, the topics we would like to discuss are:

- Circumstellar molecules and dust in evolved stars
- Chemical composition of evolved stars and their environments
- Pulsations and their effect on dust formation and mass loss
- Red giant stars in interacting binaries
- Post-AGB stars

The conference is also intended to honour Prof. Alain Omont to whom the NCAC medal will be presented in recognition of his great involvement in establishing the Polish–French collaboration in astrophysics and of his outstanding scientific achievements in many fields of astrophysics.

The conference is organized by the Nicolaus Copernicus Astronomical Center and will take place at the NCAC in Warsaw, Poland. See details on the conference webpage: http://www.ncac.torun.pl/ncac_symp

The Scientific Organising Committe (SOC): Valentin Bujarrabal (Spain), Romano Corradi (Spain), Joanna Mikołajewska (co-Chair, Poland), Philipp Podsiadlowski (UK), Igor Soszyński (Poland), Grażyna Stasińska (France), Ryszard Szczerba (co-Chair, Poland), Patricia Whitelock (South Africa), Hans van Winckel (Belgium)

The Local Organizing Committee (LOC): J. Mikołajewska, R. Szczerba, N. Siodmiak

See also http://www.ncac.torun.pl/ncac_symp/