THE AGB NEWSLETTER

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

No. 131 — 30 April 2008

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

Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 131st issue of the AGB Newsletter. We have now about 600 registered users, a number which continues to grow.

Many congratulations to Jason Nordhaus for his very interesting Ph.D. thesis. He will be moving to Princeton soon, and we are looking forward to hear more from him in the future.

For those looking for a postdoctoral position in an exciting group, there is one advertised at Monash University, in beautiful cosmopolitan Melbourne.

Besides all the other very interesting abstracts that were submitted for this issue, we would like to draw your attention to the hugely impressive result obtained by Ohnaka et al., who spatially resolved the dust envelope surrounding the extreme red supergiant WOH G64 — which is situated in the Large Magellanic cloud! Also, new work is presented on mass loss from Cepheids (Neilson & Lester), and a much-welcomed refereed publication appeared presenting some theoretical predictions for the mass loss from metal-poor carbon stars (Mattsson et al.).

The next issue will be distributed on the 1st of June; the deadline for contributions is the 31st of May.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Does meteoritic evidence challenge or confirm our understanding of stellar structure and evolution?

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)

The limb-darkened Arcturus; Imaging with the IOTA/IONIC interferometer

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This paper is an H band interferometric examination of Arcturus, a star frequently used as a spatial and spectral calibrator. Using the IOTA 3 telescope interferometer, we performed spectro-interferometric observation ($R \sim 35$) of Arcturus. Atmospheric models and prescriptions were fitted to the data to derive the brightness distribution of the photosphere. Image reconstruction was also obtained using two software algorithms: Wisard and Mira. An achromatic power law proved to be a good model of the brightness distribution, with a limb darkening compatible with the one derived from atmospheric model simulations using our Marcs model. A Rosseland diameter of 21.05 ± 0.21 was derived, corresponding to an effective temperature of $T_{\rm eff} = 4295 \pm 26$ K. No companion was detected from the closure phases, with an upper limit on the brightness ratio of 8×10^{-4} at 1AU. Dynamic range at such distance from the photosphere was established at 1.5×10^{-4} (1σ rms). An upper limit of 1.7×10^{-3} was also derived for the level of brightness asymmetries present on the photosphere.

Accepted for publication in A&A
Available from arXiv:0804.0192

A Three-Dimensional Magnetohydrodynamic Model of Planetary Nebula Jets, Knots, and Filaments

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The morphologies of planetary nebulae are believed to be self-organized configurations. These configurations are modeled by three-dimensional temporally self-similar magnetohydrodynamic solutions with radial flow, under the gravitational field of a central star of mass M. These solutions reproduce basic features, such as jets, point-symmetric knots, and filaments, through plasma pressure, mass density, and magnetic field lines. The time evolution function of the radial velocity starts as a slow wind and terminates as a fast wind.

Submitted to Astronomy and Astrophysics
Available from arXiv:0803.4518

On the Enhancement of Mass Loss in Cepheids Due to Radial Pulsation

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An analytical derivation is presented for computing mass-loss rates of Cepheids by using the method of Castor, Abbott, & Klein (1975) modified to include a term for momentum input from pulsation and shocks generated in the atmosphere. Using this derivation, mass-loss rates of Cepheids are determined as a function of stellar parameters. When applied to a set of known Cepheids, the calculated mass-loss rates range from 10^{-10} to 10^{-7} $M_\odot$ yr^{-1}, larger than if the winds were driven by radiation alone. Infrared excesses based on the predicted mass-loss rates are compared to observations from optical interferometry and IRAS, and predictions are made for Spitzer observations. The mass-loss rates are consistent with the observations, within the uncertainties of each. The rate of period change of Cepheids is discussed and shown to relate to mass loss, albeit the dependence is very weak. There is also a correlation between the large mass-loss rates and the Cepheids with slowest absolute rate of period change due to evolution through the instability strip. The enhanced mass loss helps illuminate the issue of infrared excess and the mass discrepancy found in Cepheids.

Accepted for publication in Astrophysical Journal
Available from arXiv:0803.4198

The Unusual Distributions of Ionized Material and Molecular Hydrogen in NGC 6881: Signposts of Multiple Events of Bipolar Ejection in a Planetary Nebula

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The planetary nebula NGC 6881 displays in the optical a quadrupolar morphology consisting of two pairs of highly collimated bipolar lobes aligned along different directions. An additional bipolar ejection is revealed by the hydrogen molecular emission, but its wide hourglass morphology is very different from that of the ionized material. To investigate in detail the spatial distribution of molecular hydrogen and ionized material within NGC 6881, and to determine the prevalent excitation mechanism of the H_2 emission, we have obtained new near-IR Brγ and H_2 and optical Hα and [N II] images, as well as intermediate resolution JHK spectra. These observations confirm the association of the H_2 bipolar lobes to NGC 6881 and find that the prevalent excitation mechanism is collisional. The detailed morphology and very different collimation degree of the H_2 and ionized bipolar lobes of NGC 6881 not only imply that multiple bipolar ejections have occurred in this nebula, but also that the dominant shaping agent is different for each bipolar ejection: a bipolar stellar wind most likely produced the H_2 lobes, while highly collimated outflows are carving out the ionized lobes into the thick circumstellar envelope. The asymmetry between the southeast and northwest H_2 bipolar lobes suggests the interaction of the nebula with an inhomogeneous interstellar medium. We find evidence that places NGC 6881 in the H II region Sh 2-109 along the Orion local spiral arm.

Published in The Astronomical Journal, Volume 135, Issue 4, pp. 1441-1449 (2008)
Available from arXiv:0804.0598

Feedback from galactic stellar bulges and hot gaseous haloes of galaxies

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We demonstrate that the feedback from stellar bulges can play an essential role in shaping the halo gas of galaxies

with substantial bulge components by conducting 1-D hydrodynamical simulations. The feedback model we consider consists of two distinct phases: 1) an early starburst during the bulge formation and 2) a subsequent longlasting mass and energy injection from stellar winds of low-mass stars and Type Ia SNe. An energetic outward blastwave is initiated by the starburst and is maintained and enhanced by the long-lasting stellar feedback. For a Milky Way-like galactic bulge, this blastwave sweeps up the halo gas in the proto-galaxy and heats up the surrounding medium to a scale much beyond the virial radius of the halo, thus the accretion of the halo hot gas can be completely stopped. In addition to that, the long-lasting feedback in the later phase powers a galactic bulge wind that is reverse-shocked at a large radius in the presence of surrounding intergalactic medium and hence maintains a hot gaseous halo. As the mass and energy injection decreases with time, the feedback evolves to a subsonic and quasi-stable outflow, which is enough to prevent halo gas from cooling. The two phases of the feedback thus re-enforce each-other's impact on the gas dynamics. The simulation results demonstrate that the stellar bulge feedback may provide a plausible solution to the long-standing problems in understanding the Milky-Way type galaxies, such as the "missing stellar feedback" problem and the "over-cooling" problem. The central point of the present model is that the conspiracy of the two-phase feedback keeps a low density and a high temperature for the halo gas so that the X-ray emission from the diffuse gas is significantly lowered and the radiative cooling is largely suppressed. The simulations also show that the properties of the hot gas in the subsonic outflow state depend sensitively on the environment and the formation history of the bulge. This dependence and variance may explain the large dispersion in the X-ray to B-band luminosity ratio of the low $L_{\rm X}/L_{\rm B}$ elliptical galaxies.

Submitted to MNRAS
Available from arXiv:0803.4215

Line ratios from shocked cloudlets in planetary nebulae

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Context. Some PNe and PPNe show compact knots, travelling at high velocities away from the central sources.
Aims. In this paper, we compute a number of models from which we obtain predictions of the emission line spectrum, which can be compared with the spectra of the observed knots.
Methods. We carry out a series of 11 axisymmetric simulations of an initially spherical cloudlet, travelling away from a photoionizing source, into a uniform medium. The simulations include a multi-frequency transfer of the ionizing radiation, and a 33 species nonequilibrium ionization network.
Results. From our simulations, we have computed emission maps and spatially integrated emission line spectra. The predictions show a transition from spectra similar to the ones of shock wave models (for the simulations with lower photoionization rates) to spectra similar to the ones of photoionized regions (for the simulations with higher photoionization rates).
Conclusions. The spectra from our photoionized cloudlet models have a range of line ratios that approximately agrees with the observed spectra when shown in two-line ratio diagnostic diagrams. The predicted and observed spatial distributions of the emission (with high ionization lines extending more towards the source than lower ionization lines) also agree in a qualitative way.

Accepted for publication in Astronomy & Astrophysics
Available from angels.riera@upc.edu

Intense Mass Loss from C-rich AGB Stars at low Metallicity?

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In this letter we argue that the energy injection by the pulsations may be of greater importance for the mass-loss rate of AGB stars than the metallicity and that the trend with metallicity is not as simple as it is sometimes assumed to be. Using our detailed radiation hydrodynamical models including dust formation, we demonstrate the effects of pulsation energy on the wind properties. We find that the mass-loss rate scales with the kinetic energy input by pulsations as long as the dust-saturated wind regime is not reached and all other stellar parameters are kept constant — including the absolute abundance of condensible carbon (not bound in CO), which is more relevant than keeping the C/O-ratio constant when comparing stars of different metallicity. The pressure and temperature gradients in the atmospheres of stars become steeper and flatter, respectively, when the metallicity is reduced, while the radius where the atmosphere becomes opaque is typically associated with a higher gas pressure. This effect has to be compensated for by adjusting the velocity amplitude of the variable inner boundary (piston), which is used to simulate the effects of pulsation, in order to obtain models with comparable kinetic energy input. Hence, it is more relevant to compare models with similar energy-injections rather than the same velocity amplitude. Thus, as there is no evidence for weaker pulsations in low-metallicity AGB stars, we conclude that it is actually unlikely that low-metallicity C-stars have a lower mass-loss rate, than their more metal-rich counterparts with similar stellar parameters, as long as they have a comparable amount of condensible carbon.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:0804.2482

Binary central stars of PN discovered through photometric variability. I. What we know and what we would like to find out

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Shaping axi-symmetric planetary nebulae is easier if a companion interacts with a primary at the top of the asymptotic giant branch. To determine the impact of binarity on planetary nebula formation and shaping, we need to determine the central star of planetary nebula binary fraction and period distribution. The short-period binary fraction has been known to be 10-15% from a survey of ∼100 central stars for photometric variability indicative of irradiation effects, ellipsoidal variability or eclipses. This survey technique is known to be biased against binaries with long periods and this fact is used to explain why the periods of all the binaries discovered by this survey are smaller than 3 days. In this paper we assess the status of knowledge of binary central stars discovered because of irradiation effects. We determine that, for average parameters, this technique should be biased against periods longer than 1-2 weeks, so it is surprising that no binaries were found with periods longer than 3 days. Even more puzzling is the fact that 9 out of 12 of the irradiated binaries, have periods smaller than *one day*, a fact that is starkly at odds with post-common envelope predictions. We suggest that either all common envelope models tend to overestimate post-common envelope periods or that this binary survey might have suffered from additional, unquantified biases. If the latter hypothesis is true, the currently-known short-period binary fraction is put in serious doubt. We also introduce a new survey for binary-related variability, which will enable us to better quantify biases and determine an independent value for the short period binary fraction.

Accepted for publication in Astronomical Journal
Available from arXiv:0804.2436
and from http://www.noao.edu/wiyn/planb/Publications.html

Multiple and Precessing Collimated Outflows in the Planetary Nebula IC 4634

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With its remarkable double-S shape, IC 4634 is an archetype of point-symmetric planetary nebulae (PN). In this paper, we present a detailed study of this PN using archival *HST* WFPC2 and ground-based narrow-band images to investigate its morphology, and long-slit spectroscopic observations to determine its kinematics and to derive its physical conditions and excitation. The data reveal new structural components, including a distant string of knots distributed along an arc-like feature 40″–60″ from the center of the nebula, a skin of enhanced [O III]/Hα ratio enveloping the inner shell and the double-S feature, and a triple-shell structure. The spatio-kinematical study also finds an equatorial component of the main nebula that is kinematically independent from the bright inner S-shaped arc. We have investigated in detail the bow shock-like features in IC 4634 and found that their morphological, kinematical and emission properties are consistent with the interaction of a collimated outflow with surrounding material. Indeed, the morphology and kinematics of some of these features can be interpreted using a 3D numerical simulation of a collimated outflow precessing at a moderate, time-dependent velocity. Apparently, IC 4634 has experienced several episodes of point-symmetric ejections oriented at different directions with the outer S-shaped feature being related to an earlier point-symmetric ejection and the outermost arc-like string of knots being the relic of an even much earlier point-symmetric ejection. There is tantalizing evidence that the action of these collimated outflows has also taken part in the shaping of the innermost shell and inner S-shaped arc of IC 4634.

Accepted for publication in The Astrophysical Journal
Available from arXiv:0804.1812

Kinematical Analysis of a Sample of Bipolar Planetary Nebulae

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We present the kinematics of a sample of bipolar planetary nebulae (PNe) which cover a wide range of observed morphologies and collimation degrees, from bipolar PNe with a marked equatorial ring and wide lobes to highly collimated objects. We use an empirical model in order to derive the expansion velocity, collimation degree, and inclination angle of the PN with respect to the plane of the sky. The equatorial expansion velocities measured in the objects in our sample are always in the low to medium range (3–16 km s^{-1}),while their polar expansion velocities range from low to very high (18–100 km s^{-1}). None of the objects in our sample, even those that show an extreme collimation degree, seem to be (kinematically) younger than $\sim$1000 yr. We compare our results with the state-of-the-art theoretical models for the formation of bipolar PNe. We find good agreement between the observed expansion velocities and numerical models that use magnetic fields with stellar rotation as collimation mechanism.

Accepted for publication in The Astronomical Journal
Available from arXiv:0804.1467

Aluminum-, Calcium- And Titanium-Rich Oxide Stardust In Ordinary Chondrite Meteorites

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We report O-, Al-Mg, K, Ca, and Ti isotopic data for a total of 96 presolar oxide grains found in residues of several unequilibrated ordinary chondrite meteorites. Identified grain types include Al_2O_3, $MgAl_2O_4$, hibonite ($CaAl_{12}O_{19}$) and Ti oxide. This work greatly increases the presolar hibonite database, and is the first report of presolar Ti oxide. O-isotopic compositions of the grains span previously observed ranges and indicate an origin in red giant and asymptotic giant branch (AGB) stars of low mass (<2.5 $M_\odot$) for most grains. Cool bottom processing in the parent AGB stars is required to explain isotopic compositions of many grains. Potassium-41 enrichments in hibonite grains are attributable to in situ decay of now-extinct ^{41}Ca. Inferred initial $^{41}Ca/^{40}Ca$ ratios are in good agreement with model predictions for low-mass AGB star envelopes, provided that ionization suppresses ^{41}Ca decay. Stable Mg and Ca isotopic ratios of most of the hibonite grains reflect primarily the initial compositions of the parent stars and are generally consistent with expectations for Galactic chemical evolution, but require some local interstellar chemical inhomogeneity. Very high $^{17}O/^{16}O$ or $^{25}Mg/^{24}Mg$ ratios suggest an origin for some grains in binary star systems where mass transfer from an evolved companion has altered the parent star compositions. A supernova origin for the hitherto enigmatic ^{18}O-rich Group 4 grains is strongly supported by multi-element isotopic data for two grains. The Group 4 data are consistent with an origin in a single supernova in which variable amounts of material from the deep ^{16}O-rich interior mixed with a unique end-member mixture of the outer layers. The Ti oxide grains primarily formed in low-mass AGB stars. They are smaller and rarer than presolar Al_2O_3, reflecting the lower abundance of Ti than Al in AGB envelopes.

Accepted for publication in Astrophysical Journal
Available from arXiv:0804.2866
and from http://www.dtm.ciw.edu/lrn/preprints/nittler-oxides2008.pdf

V2324 Cyg — an F-type star with fast wind

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For the first time high-resolution optical spectroscopy of the variable star V2324 Cyg associated with the IR-source IRAS 20572+4919 is performed. More than 200 absorption features (mostly Fe II, Ti II, Cr II, Y II, Ba II, and Y II) are identified within the wavelength interval 4549–7880 Å. The spectral type and rotation velocity of the star are found to be F0 III and $V \sin i$=69 km s^{-1}, respectively. H I and Na I D lines have complex P Cyg-type profiles with an emission component. Neither systematic trend of radial velocity V_r with line depth R_o nor temporal variability of V_r have been found. We determined the average heliocentric radial velocity $V_r = -16.8 \pm 0.6$ km s^{-1}. The radial velocities inferred from the cores of the absorption components of the Hβ and Na I wind lines vary from −140 to −225 km s^{-1} (and the expansion velocities of the corresponding layers, from about 120 to 210 km s^{-1}). The maximum expansion velocity is found for the blue component of the split Hα absorption: 450 km s^{-1} for December 12, 1995. The model atmospheres method is used to determine the star's parameters: $T_{\rm eff} = 7500$ K, $\log g = 2.0$, $\xi_t = 6.0$ km s^{-1}, and metallicity, which is equal to the solar value. The main peculiarity of the chemical abundances pattern is the overabundance of lithium and sodium. The results cast some doubt on the classification of V2324 Cyg as a post-AGB star.

Accepted for publication in Astrophysical Bulletin
Available from arXiv:0804.3295

Toward better simulations of planetary nebulae luminosity functions

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We describe a procedure for the numerical simulation of the planetary nebulae luminosity function (PNLF), improving on previous work (Méndez & Soffner 1997). Earlier PNLF simulations were based on an imitation of the observed distribution of the intensities of [O III] 5007 relative to Hβ, generated predominantly using random numbers. We are now able to replace this by a distribution derived from the predictions of hydrodynamical PN models (Schönberner et al. 2007), which are made to evolve as the central star moves across the HR diagram, using proper initial and boundary conditions. In this way we move one step closer to a physically consistent procedure for the generation of a PNLF. As an example of these new simulations, we have been able to reproduce the observed PNLF in the Small Magellanic Cloud.

Accepted for publication in ApJ
Available from arXiv:0804.0826

Fe and Al Abundances for 180 Red Giants in the Globular Cluster Omega Centauri (NGC 5139)

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We present radial velocities, Fe, and Al abundances for 180 red giant branch (RGB) stars in the Galactic globular cluster Omega Centauri (ω Cen). The majority of our data lie in the range $11.0< V <13.5$, which covers the RGB from about 1 mag. above the horizontal branch to the RGB tip. The selection procedures are biased towards preferentially observing the more metal-poor and luminous stars of ω Cen. Abundances were determined using equivalent width measurements and spectrum synthesis analyses of moderate resolution spectra ($R \approx$13,000) obtained with the Blanco 4m telescope and Hydra multifiber spectrograph. Our results are in agreement with previous studies as we find at least four different metallicity populations with [Fe/H]= -1.75, -1.45, -1.05, and -0.75, with a full range of $-2.20 \lesssim$[Fe/H]$\lesssim -0.70$. [Al/Fe] ratios exhibit large star-to-star scatter for all populations, with the more than 1.0 dex range of [Al/Fe] decreasing for stars more metal-rich than [Fe/H]~ -1.4. The minimum [Al/Fe] abundance observed for all metallicity populations is [Al/Fe]$\sim +0.15$. The maximum abundance of log ϵ(Al) is reached for stars with [Fe/H]~ -1.4 and does not increase further with stellar metallicity. We interpret these results as evidence for type II SNe providing the minimum [Al/Fe] ratio and a mass spectrum of intermediate mass asymptotic giant branch stars causing the majority of the [Al/Fe] scatter. These results seem to fit in the adopted scheme that star formation occurred in ω Cen over >1 Gyr.

Accepted for publication in ApJ
Available from arXiv:0804.2607

Evidence for a companion to BM Gem, a silicate carbon star

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Balmer and Paschen continuum emission as well as Balmer series lines of P Cygni-type profile from H_γ through H_{23} are revealed in the violet spectra of BM Gem, a carbon star associated with an oxygen-rich circumstellar shell ("silicate carbon star") observed with the high dispersion spectrograph (HDS) on the Subaru telescope. The blue-shifted absorption in the Balmer lines indicates the presence of an outflow, the line of sight velocity of which is at least 400 km s^{-1}, which is the highest outflow velocity observed to date in a carbon star. The Balmer lines showed a significant change in profile over a period of 75 days. Strong Ca II K emission was also detected, while Ca II H emission, where H_ϵ overlapped, was absent on both observation occasions. Violet spectra of the other two silicate carbon stars, V778 Cyg and EU And, and of the prototypical J-type carbon star, Y CVn, were also observed, but none of these were detected in either continuum emission below 4000 Å or Balmer lines. We argue that the observed unusual features in BM Gem are strong evidence for the presence of a companion, which should form an accretion disk that gives rise to both an ionized gas region and a high velocity, variable outflow. The estimated luminosity of ∼0.2 (0.03–0.6) $L_\odot$ for the ionized gas can be maintained by a mass accretion rate to a dwarf companion of $\sim 10^{-8}$ $M_\odot$ yr^{-1}, while $\sim 10^{-10}$ $M_\odot$ yr^{-1} is sufficient for accretion to a white dwarf companion. These accretion rates are feasible for some detached binary configurations on the basis of the Bond-Hoyle type accretion process. Therefore, we concluded that the carbon star BM Gem is in a detached binary system with a companion of low mass and low luminosity. However, we are unable to determine whether this companion object is a dwarf or a white dwarf, although the gas outflow velocity of 400 km s^{-1} as well as the non-detection in the X-ray survey favor its identity as a dwarf star. The upper limits for binary separation are 210 AU and 930 AU for a dwarf and a white dwarf, respectively, in the case of circular orbit. We also note that the observed features of BM Gem mimic those of Mira (*o* Cet), which may suggest actual similarities in their binary configurations and circumstellar structures.

Accepted for publication in ApJ
Available from arXiv:0804.4040

The fluorine abundance in a Galactic Bulge AGB star measured from CRIRES spectra

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We present measurements of the fluorine abundance in a Galactic Bulge Asymptotic Giant Branch (AGB) star. The measurements were performed using high resolution K-band spectra obtained with the CRIRES spectrograph, which has been recently installed at ESO's VLT, together with state-of-the-art model atmospheres and synthetic spectra. This represents the first fluorine abundance measurement in a Galactic Bulge star, and one of few measurements of this kind in a third dredge-up oxygen-rich AGB star. The F abundance is found to be close to the solar value scaled down to the metallicity of the star, and in agreement with Disk giants that are comparable to the Bulge giant studied

here. The measurement is of astrophysical interest also because the star's mass can be estimated rather accurately ($1.4 \leq M/\mathrm{M}_{\odot} \leq 2.0$). AGB nucleosynthesis models predict only a very mild enrichment of F in such low mass AGB stars. Thus, we suggest that the fluorine abundance found in the studied star is representative for the star's natal cloud, and that fluorine must have been produced at a similar level in the Bulge and in the Disk.

Accepted for publication in Astrophysical Journal
Available from arXiv:0804.4057

Spatially resolved dusty torus toward the red supergiant WOH G64 in the Large Magellanic Cloud

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We present N-band spectro-interferometric observations of the red supergiant WOH G64 in the Large Magellanic Cloud (LMC) using MIDI at the Very Large Telescope Interferometer (VLTI). While the very high luminosity ($\sim 5 \times 10^5$ $\mathrm{L}_{\odot}$) previously estimated for WOH G64 suggests that it is a very massive star with an initial mass of $\sim$40 $\mathrm{M}_{\odot}$, its low effective temperature ($\sim$3200 K) is in serious disagreement with the current stellar evolution theory.
WOH G64 was observed with VLTI/MIDI using the UT2-UT3 and UT3-UT4 baseline configurations. The dust envelope around WOH G64 has been spatially resolved with a baseline of $\sim$60 m — the first MIDI observations to resolve an individual stellar source in an extragalactic system. The observed N-band visibilities show a slight decrease from 8 to $\sim$10 μm and a gradual increase longward of $\sim$10 μm, reflecting the 10 μm silicate feature in self-absorption. This translates into a steep increase of the uniform-disk diameter from 8 to 10 μm (from 18 to 26 mas) and a roughly constant diameter above 10 μm. The visibilities measured at four position angles differing by $\sim 60^{\circ}$ but at approximately the same baseline length ($\sim$60 m) do not show a noticeable difference, suggesting that the object appears nearly centrosymmetric. The observed N-band visibilities and spectral energy distribution can be reproduced by an optically and geometrically thick silicate torus model viewed close to pole-on. The luminosity of the central star is derived to be $\sim 2.8 \times 10^5$ $\mathrm{L}_{\odot}$, which is by a factor of 2 lower than the previous estimates based on spherical models. We also identify the H_2O absorption features at 2.7 and 6 μm in the spectra obtained with the Infrared Space Observatory and the Spitzer Space Telescope. The 2.7 μm feature originates in the photosphere and/or the extended molecular layers, while the 6 μm feature is likely to be of circumstellar origin.
The lower luminosity newly derived from our MIDI observations and two-dimensional modeling brings the location of WOH G64 on the H-R diagram in much better agreement with theoretical evolutionary tracks for a 25 $\mathrm{M}_{\odot}$ star. However, the effective temperature is still somewhat too cool for the theory. The low effective temperature of WOH G64 places it very close to or even beyond the Hayashi limit, which implies that this object may be experiencing unstable, violent mass loss.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0803.3823

Conference Papers

The Place of Recurrent Novae among the Symbiotic Stars

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The observational properties of recurrent novae indicate that they can be divided into two subclasses:systems with a dwarf and a red giant secondary, respectively. The second type — which includes RS Oph — bears many similarities

to symbiotic stars.

Oral contribution, published in Proceedings of the Meeting: RS Ophiuchi (2006), eds. Nye Evans, Mike Bode & Tim O'Brien, Astronomical Society of the Pacific Conference Series
Available from arXiv:0803.3685

Lithium-rich giants in the Sagittarius dSph Tidal Streams

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The nature and origin of Lithium rich giant stars is still matter of debate. In the contest of our spectroscopic survey of giants in the tidal streams of the Sagittarius dwarf spheroidal (dSph) galaxy, we present the serendipitous discovery of 2 super Li-rich stars ($A(\mathrm{Li}) > 3.5 - 4.0$). Besides D 461 in Draco, these are the only Li-rich stars known in a Local Group dSph galaxy. The high Li abundance and the low mass of these stars support their origin as due to fresh Li production in the stars associated with some kind of extra-mixing process.

Oral contribution, published in "XXI Century challenges for stellar evolution", held in Cefalú (Sicily, Italy), August 29 - September 2, 2007; eds. S. Cassisi & M. Salaris, Mem. SAIt Vol. 79 No. 2
Available from arXiv:0803:4359

Polarization and SEDs from Microlensing of Circumstellar Envelopes

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Microlensing surveys have proven to be tremendously fruitful in providing valuable data products for many fields of astrophysics, from eclipse lightcurves for substellar candidates to limb darkening in stellar atmospheres. We report on a program of modeling observables from microlensing of circumstellar envelopes, particularly those of red giant stars that are the most likely to show finite source effects. We will summarize work for how polarization light curves can be used to infer envelope properties and will describe recent modeling of the time dependent spectral energy distributions (SEDs) for microlensing of dusty winds. One of the most exciting developments is the possibility of measuring variable polarization from microlensing in a suitable source using the RINGO polarimeter at La Palma. Also quite interesting is the possibility of probing a dusty wind using IRAC data for a suitable source in the event that Spitzer has a "warm" cycle.

Oral contribution, published in The Manchester Microlensing Conference: "The 12^{th} International Conference and ANGLES Microlensing Workshop"
Available from arXiv:0804.2176

O(He) Stars

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Spectral analyses of H-deficient post-AGB stars have shown that a small group of four extremely hot objects exists

which have almost pure He absorption-line spectra in the optical. These are classified as O(He) stars. For their evolution there are two scenarios: They could be the long-sought hot successors of RCrB stars, which have not been identified up to now. If this turns out to be true, then a third post-AGB evolutionary sequence is revealed, which is probably the result of a double-degenerate merging process. An alternative explanation might be that O(He) stars are post early-AGB stars. These depart from the AGB just before they experience their first thermal pulse (TP) which will then occur as a late thermal pulse (LTP). This would be a link to the low-mass He-enriched sdO stars and low-mass, particularly He-rich PG 1159 stars.

Oral contribution, published in "Hydrogen-Deficient Stars", Sept. 17-21, 2008, Tübingen, Germany
Available from arXiv:0804.2366

UV and FUV spectroscopy of the hybrid PG 1159-type central star NGC 7094

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Previous studies aiming at the iron-abundance determination in three PG 1159 stars (K 1−16, PG 1159−035, NGC 7094) and a [WC]-PG 1159 transition star (Abell 78) have revealed that no object shows any iron line in the UV spectrum. The stars are iron-deficient by at least 1 dex, typically. A possible explanation is that iron nuclei were transformed by neutron captures into heavier elements (s-process), however, the extent of the iron-destruction would be much stronger than predicted by AGB star models. But if n-captures are the right explanation, then we should observe an enrichment of trans-iron elements. In this paper we report on our search for a possible nickel overabundance in one of the four Fe deficient PG 1159 stars, namely the central star NGC 7094. We are unable to identify any nickel line in HST and FUSE spectra and conclude that Ni is not overabundant. It is conceivable that iron was transformed into even heavier elements, but their identification suffers from the lack of atomic data.

Oral contribution, published in "Hydrogen-Deficient Stars", Sept. 17-21, 200, Tübingen, Germany
Available from arXiv:0804.2372

Review Paper

Atomic Processes in Planetary Nebulae and H II Regions

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Spectroscopic studies of Planetary Nebulae (PNe) and H II regions have driven much development in atomic physics. In the last few years the combination of a generation of powerful observatories, the development of ever more sophisticated spectral modeling codes, and large efforts on mass production of high quality atomic data have led to important progress in our understanding of the atomic spectra of such astronomical objects. In this paper I review such progress, including evaluations of atomic data by comparisons with nebular spectra, detection of spectral lines from most iron-peak elements and n-capture elements, observations of hyperfine emission lines and analysis of isotopic abundances, fluorescent processes, and new techniques for diagnosing physical conditions based on recombination spectra. The review is directed toward atomic physicists and spectroscopists trying to establish the current status of the atomic data and models and to know the main standing issues.

Published in Physica Scripta T series
Available from arXiv:0803.3457

Thesis

From Binaries to Asymmetric Outflows: The Influence of Low-mass Companions Around AGB Stars

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The study of intermediate mass, evolved stars is undergoing renewed interest due to recent observational and theoretical results suggesting that binarity is fundamental for shaping post-Asymptotic Giant Branch and Planetary Nebula outflows. Despite extensive research, the physical mechanism responsible for transitioning from a spherical Asymptotic Giant Branch (AGB) star to an asymmetric post-AGB object is poorly understood. In an effort to understand how binaries may produce asymmetries, this thesis presents several theoretical studies which explore the effect of low-mass companions on evolved star outflows. This thesis consists of four separate projects:

(1.) Close companions may become engulfed by the evolved star and in-spiral during a common envelope phase. Common envelope evolution can lead to three different consequences: (i.) equatorial ejection of material (ii.) spin-up of the envelope resulting in an explosive dynamo-driven jet and (iii.) tidal shredding of the companion into an accretion disk which ejects a poloidal wind.

(2.) In addition, we study a dynamical, large-scale $\alpha - \Omega$ interface dynamo operating in an AGB star in both an isolated setting and a setting in which a low-mass companion is embedded inside the envelope. The back reaction of the fields on the shear is included and differential rotation and rotation deplete via turbulent dissipation and Poynting flux. For the isolated star, the shear must be resupplied in order to sufficiently sustain the dynamo. Furthermore, we investigate the energy requirements that convection must satisfy to accomplish this by analogy to the Sun. For the common envelope case, a robust dynamo results, unbinding the envelope under a range of conditions.

(3.) Wide binaries can interact with the wind of the evolved primary. The gravitational influence of the secondary focuses material in the equatorial plane. The companion induces spiral shocks which may anneal amorphous grains into crystalline dust. This work presents a physical mechanism to produce crystalline dust in AGB star binaries.

(4.) We present a spectral modeling technique which constrains the geometry of evolved star nebulae. We apply our technique to HD 179821 which exhibits a dou- ble peaked spectral energy distribution (SED) with a sharp rise from $\sim 8 - 20$ μm. Such features have been associated with dust shells or inwardly truncated circumstellar disks. In order to compare SEDs from both systems, we employ a spherically symmetric radiative transfer code and compare it to a radiative, inwardly truncated disc code. As a case study, we model the broad-band SED of HD 179821 using both codes. Shortward of 40 μm, we find that both models produce equivalent fits to the data. However, longward of 40 μm, the radial density distribution and corresponding broad range of disc temperatures produce excess emission above our spherically symmetric solutions and the observations. For HD 179821, our best fit consists of a $T_{\rm eff} = 7000$ K central source characterized by $\tau_{\rm V} \sim 1.95$ and surrounded by a radiatively driven, spherically symmetric dust shell. The extinction of the central source reddens the broad-band colours so that they resemble a $T_{\rm eff} = 5750$ K photosphere. We believe that HD 179821 contains a hotter central star than previously thought. Our results provide an initial step towards a technique to distinguish geometric differences from spectral modeling.

Available from http://www.pas.rochester.edu/∼nordhaus

Postdoctoral Fellow in Stellar Astrophysics

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

A position exists for a Postdoctoral Fellow within the SINS group at Monash University's Centre for Stellar and Planetary Astrophysics. We are seeking someone with expertise in modeling advanced stages of stellar evolution, with applications to Super-AGB stars, nucleosynthesis and electron-capture supernovae. The successful applicant will work directly with a team working on SAGB stars, consisting of John Lattanzio, Pilar Gil Pons and Lionel Siess.

The position is available now and is for 2 years initially, with the possibility of extension to a third year. Salary will be in the range $61,820 - $66,360 (Australian Dollars). A generous superannuation payment is included. The Fellow will be part of the SINS group, a very active and growing group consisting of Prof John Lattanzio, Dr Maria Lugaro, Dr Ross Church and Dr Richard Stancliffe, as well as postgraduate students and other members of CSPA.

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

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

Applications, including three letters of reference, should arrive by 1 June at the following address:

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Further information is available from

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http://www.melbourne.com.au/
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See also http://www.maths.monash.edu.au/∼johnl/sins/