THE AGB NEWSLETTER

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

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

No. 134 — 3 August 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 134$^{\rm th}$ issue of the AGB Newsletter. It is also our pleasure to announce that the AGB Newsletter is now an official publication of the IAU Working Group on Abundances in Red Giants, which is chaired by John Lattanzio. You will see items relevant to the working group and its objectives appear in the newsletter.

On a much sadder note, Bengt Westerlund passed away in June. Bengt has of course left a tremendous legacy in the field of AGB stars in the Magellanic Clouds, amongst many other important works. An obituary is published in the Magellanic Clouds Newsletter, and IAU Symposium 256 has been dedicated to his memory.

This month's issue features many interesting articles of which we can only highlight some: the detection of CO in a water fountain star (He et al.) and fluorine in a Halo PN (Otsuka et al.), resolving the envelopes of AGB stars in the Galactic Centre (Richichi et al.) and of a silicate carbon star showing an accretion disk around a companion (Ohnaka et al.), but also the impressive simulations of wind interaction in the red/blue supergiant phase (Chiţă et al.) from which we can certainly learn a lot about the post-AGB phase; also don't miss the review by Lionel Siess on Super-AGB stars.

Please bring well-motivated and skillful undergraduate students to the attention of our colleagues in Leuven, who are seeking a Ph.D. candidate; for the slightly more advanced students and postdocs the advertisement by the University of Manchester may be of interest. If you are just looking for a holiday in the Sun in a country draped with history, then perhaps you'd like to take up the challenge posed by Noam Soker.

The next issue will be distributed on the 1$^{\rm st}$ of October; the deadline for contributions is the 30$^{\rm th}$ of September. This is a longer interval than usual, due to one of the editors going for some (badly-needed) holidays in Peru.

Editorially Yours,

Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

What kind of Planetary Nebula will a silicate carbon star produce?

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 X-Ray Spectrum of a Planetary Nebula at High Resolution:Chandra Gratings Spectroscopy of BD+30°3639

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We present the results of the first X-ray gratings spectroscopy observations of a planetary nebula (PN), the X-ray-bright, young BD+30°3639. We observed BD+30°3639 for a total of 300 ks with the Chandra X-ray Observatory's Low Energy Transmission Gratings in combination with its Advanced CCD Imaging Spectrometer (LETG/ACIS-S). The LETG/ACIS-S spectrum of BD+30°3639 is dominated by H-like resonance lines of O VIII and C VI and the He-like triplet line complexes of Ne IX and O VII. Other H-like resonance lines, such as N VII, as well as lines of highly ionized Fe, are weak or absent. Continuum emission is evident over the range 6–18 Å. Spectral modeling indicates the presence of a range of plasma temperatures from $T_{\rm x} \sim 1.7 \times 10^6$ K to 2.9×10^6 K and an intervening absorbing column $N_{\rm H} \sim 2.4 \times 10^{21}$ cm^{-2}. The same modeling conclusively demonstrates that C and Ne are highly enhanced, with abundance ratios of C/O ∼15–45 and Ne/O ∼3.3–5.0 (90% confidence ranges, relative to the solar ratios), while N and Fe are depleted, N/O ∼0.0–1.0 and Fe/O ∼0.1–0.4. The intrinsic luminosity of the X-ray source determined from the modeling and the measured flux ($F_{\rm X} = 4.1 \times 10^{-13}$ ergs cm^{-2} s^{-1}) is $L_{\rm X} \sim 8.6 \times 10^{32}$ erg s^{-1} (assuming $D = 1.2$ kpc).

These gratings spectroscopy results are generally consistent with earlier results obtained from X-ray CCD imaging spectroscopy of BD+30°3639, but are far more precise. Hence the Chandra/LETGS results for BD+30°3639 place severe new constraints on models of PN wind-wind interactions in which X-ray emitting gas within PNs is generated via shocks and the plasma temperature is moderated by effects such as heat conduction or rapid evolution of the fast wind. The tight constraints placed on the (nonsolar) abundances directly implicate the present-day central star — hence, ultimately, the intershell region of the progenitor asymptotic giant branch star — as the origin of the shocked plasma now emitting in X-rays.

Submitted to ApJ

Available from arXiv:0806.2281

The Magellanic Cloud Calibration of the Galactic Planetary Nebula Distance Scale

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Galactic planetary nebula (PN) distances are derived, except in a small number of cases, through the calibration of statistical properties of PNe. Such calibrations are limited by the accuracy of individual PN distances which are obtained with several non-homogeneous methods, each carrying its own set of liabilities. In this paper we use the physical properties of the PNe in the Magellanic Clouds, and their accurately known distances, to recalibrate the Shklovsky/Daub distance technique. Our new calibration is very similar (within 1%) of the commonly used distance scale by Cahn et al. (1992), although there are important differences. We find that neither distance scale works well for PNe with classic ("butterfly") bipolar morphology, and while the radiation bounded PN sequences in both the Galactic and the Magellanic Cloud calibration have similar slopes, the transition from optically thick to optically thin

appears to occur at higher surface brightness and smaller size than that adopted by Cahn et al. The dispersion in the determination of the scale factor suggests that PN distances derived by this method are uncertain by at least 30%, and that this dispersion cannot be reduced significantly by using better calibrators. We present a catalog of Galactic PN distances using our re-calibration which can be used for future applications, and compare the best individual Galactic PN distances to our new and several other distance scales, both in the literature and newly recalibrated by us, finding that our scale is the most reliable to date.

Accepted for publication in The Astrophysical Journal
Available from arXiv:0807.1129

Discovery of a [WO] central star in the planetary nebula Th 2-A

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About 2500 planetary nebulae are known in our Galaxy but only 224 have central stars with reported spectral types in the Strasbourg-ESO Catalogue of Galactic Planetary Nebulae (Acker et al. 1992; Acker et al. 1996).
We have started an observational program aiming to increase the number of PN central stars with spectral classification. By means of spectroscopy and high resolution imaging, we identify the position and true nature of the central star. We carried out low resolution spectroscopic observations at CASLEO telescope, complemented with medium resolution spectroscopy performed at Gemini South and Magellan telescopes.
As a first outcome of this survey, we present for the first time the spectra of the central star of the PN Th 2-A. These spectra show emission lines of ionized C and O, typical in Wolf-Rayet stars.
We identify the position of that central star, which is not the brightest one of the visual central pair. We classify it as of type [WO 3]pec, which is consistent with the high excitation and dynamical age of the nebula.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0806.4968

SDSS J142625.71+575218.3: The First Pulsating White Dwarf with a Large Detectable Magnetic Field

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We report the discovery of a strong magnetic field in the unique pulsating carbon-atmosphere white dwarf SDSS J142625.71+575218.3. From spectra gathered at the MMT and Keck telescopes, we infer a surface field of $B_{\rm s} \simeq 1.2$ MG, based on obvious Zeeman components seen in several carbon lines. We also detect the presence of a Zeeman-splitted He I 4471 line, which is an indicator of the presence of a non-negligible amount of helium in the atmosphere of this Hot DQ star. This is important for understanding its pulsations, as nonadabatic theory reveals that some helium must be present in the envelope mixture for pulsation modes to be excited in the range of effective temperature where the target star is found. Out of nearly 200 pulsating white dwarfs known today, this is the first example of a star with

a large detectable magnetic field. We suggest that SDSS J142625.71+575218.3 is the white dwarf equivalent of a roAp star.

Accepted for publication in The Astrophysical Journal Letters
Available from arXiv:0807.1112

A point source survey of M 31 with the Spitzer Space Telescope

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We explore the stellar population of M 31 in a Spitzer Space Telescope survey utilizing IRAC and MIPS observations. Red supergiants are the brightest objects seen in the infrared; they are a prominent evolutionary phase. Due to their circumstellar envelopes, many of these radiate the bulk of their luminosity at IRAC wavelengths and do not stand out in the near infrared or optically. Going fainter, we see large numbers of asymptotic giant branch stars, many of which are known long period variables. Relative to M 33 the AGB carbon star population of M 31 appears sparse, but this needs to be spectroscopically confirmed.

Accepted for publication in The astrophysical Journal
Available from arXiv:0807.0941

The symbiotic star CH Cygni. I. An analysis of the shocked nebulae at different epochs

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Context. We analyse the line and continuum spectra of the symbiotic system CH Cygni.
Aims. To show that the colliding-wind model is valid to explain this symbiotic star at different phases.
Methods. Peculiar observed features such as flickering, radio variation, X-ray emission, as well as the distribution of the nebulae and shells throughout the system are investigated by modelling the spectra at different epochs. The models account consistently for shock and photoionization and are constrained by absolute fluxes.
Results. We find that the reverse shock between the stars leads to the broad lines observed during the active phases, as well as to radio and hard X-ray emission, while the expanding shock is invoked to explain the data during the transition phases.

Submitted to Astronomy & Astrophysics
Available from arXiv:0807.1480

The symbiotic star CH Cygni. II. The broad Lyα emission line explained by shocks

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Context. In 1985, at the end of the active phase 1977–1986, a broad (4000 km s^{-1}) Lyα line appeared in the symbiotic system CH Cygni that had never been observed previously.
Aims. In this work we investigate the origin of this anomalous broad Lyα line.
Methods. We suggest a new interpretation of the broad Lyα based on the theory of charge transfer reactions between ambient hydrogen atoms and post-shock protons at a strong shock front.
Results. We have found that the broad Lyα line originated from the blast wave created by the outburst, while the contemporary optical and UV lines arose from the nebula downstream of the expanding shock in the colliding wind scenario.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0807.1473

Active Cool Stars and He I 10830 Å: the Coronal Connection

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The mechanism of formation of the He I 10830 Å triplet in cool stars has been subject of debate for the last 30 years. A relation between the X-ray luminosity and the He I 10830 Å flux was found in cool stars, but the dominant mechanism of formation in these stars (photoionization by coronal radiation followed by recombination and cascade, or collisional excitation in the chromosphere), has not yet been established. We use modern instrumentation (NOT/SOFIN) and a direct measurement of the EUV flux, which photoionizes He I, to investigate the formation mechanism of the line for the most active stars which are frequently excluded from analysis. We have observed with an unprecedented resolution ($R \sim 170,000$) the He I 10830 Å triplet in a set of 15 stars that were also observed with the Extreme Ultraviolet Explorer (EUVE) in order to compare the line strengths with their EUV and X-ray fluxes. Active dwarf and subgiant stars do not exhibit a relation between the EUV flux and the equivalent width of the He I 10830 Å line. Giant stars however, show a positive correlation between the strength of the He I 10830 Å absorption and the EUV and X-ray fluxes. The strength of the C IV 1550 Å emission does not correlate with coronal fluxes in this sample of 15 stars. Active dwarf stars may have high chromospheric densities thus allowing collisional excitation to dominate photoionization/recombination processes in forming the He I 10830 Å line. Active giant stars possess lower gravities, and lower chromospheric densities than dwarfs, allowing for photoexcitation processes to become important. Moreover, their extended chromospheres allowfor scattering of infrared continuum radiation, producing strong absorption in He I and tracing wind dynamics.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0807.0175

Thermohaline mixing and gravitational settling in carbon-enhanced metal-poor stars

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We investigate the formation of carbon-enhanced metal-poor (CEMP) stars via the scenario of mass transfer from a

carbon-rich asymptotic giant branch (AGB) primary to a low-mass companion in a binary system. We explore the extent to which material accreted from a companion star becomes mixed with that of the recipient, focusing on the effects of thermohaline mixing and gravitational settling. We have created a new set of asymptotic giant branch models in order to determine what the composition of material being accreted in these systems will be. We then model a range of CEMP systems by evolving a grid of models of low-mass stars, varying the amount of material accreted by the star (to mimic systems with different separations) and also the composition of the accreted material (to mimic accretion from primaries of different mass). We find that with thermohaline mixing alone, the accreted material can become mixed with between 16 and 88 per cent of the pristine stellar material of the accretor, depending on the mass accreted and the composition of the material. If we include the effects of gravitational settling, we find that thermohaline mixing can be inhibited and, in the case that only a small quantity of material is accreted, can be suppressed almost completely.

Accepted for publication in MNRAS
Available from arXiv:0807.1758

High Spatial Resolution Mid-IR Imaging of V838 Monocerotis: Evidence of New Circumstellar Dust Creation

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We report high spatial resolution 11.2 and 18.1 μm imaging of V838 Monocerotis obtained with Gemini Observatory's Michelle instrument in 2007 March. Strong emission is observed from the unresolved stellar core of V838 Mon in our Gemini imagery, and is confirmed by Spitzer MIPS 24 μm imaging obtained in 2007 April. The 2007 flux density of the unresolved mid-infrared emission component is $\sim$2 times brighter than that observed in 2004. No clear change in the net amount of 24 μm extended emission is observed between the 2004 and 2007 epoch Spitzer imagery. We interpret these data as evidence that V838 Mon has experienced a new circumstellar dust creation event.
We suggest that this newly created dust has condensed from the expanding ejecta produced from V838 Mon's 2002 outburst events, and is most likely clumpy. We speculate that one (or more) of these clumps might have passed through the line-of-sight in late 2006, producing the brief multi-wavelength photometric event reported by Bond (2006) and Munari et al. (2007). We detect no evidence of extended emission above a level of $\sim$1 mJy at 11.2 μm and $\sim$7 mJy at 18.1 μm over radial distances of 1860–93000 AU ($0.3 - 15.0''$) from the central source. Using the simple assumption that ejecta material expands at a constant velocity of 300–500 km s^{-1}, this gap of thermal emission suggests that no significant prior circumstellar dust production events have occurred within the past $\sim$900–1500 years.

Accepted for publication in ApJL
Available from arXiv:0807.1763

Binarity in Cool Asymptotic Giant Branch Stars: A Galex Search for Ultraviolet Excesses

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The search for binarity in AGB stars is of critical importance for our understanding of how planetary nebulae acquire the dazzling variety of aspherical shapes which characterises this class. However, detecting binary companions in

such stars has been severely hampered due to their extreme luminosities and pulsations. We have carried out a small imaging survey of AGB stars in ultraviolet light (using GALEX) where these cool objects are very faint, in order to search for hotter companions. We report the discovery of significant far-ultraviolet excesses towards nine of these stars. The far-ultraviolet excess most likely results either directly from the presence of a hot binary companion, or indirectly from a hot accretion disk around the companion.

Submitted to Astrophysical Journal
Available from arXiv:0807.1944

Detection of the spectral binary (SB2) nature of BD $-6°1178$ = IRAS 05238−0626

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BD $-6°1178$ identified with the infrared source IRAS 05238−0626 is shown for the first time to be a spectroscopic binary (SB2) by analyzing the high-resolution spectra taken with the NES echelle spectrograph of the 6-m telescope. The components of the binary have close spectral types and luminosity classes: F5 IV–III and F3 V. The heliocentric radial velocities are measured for both components at four observing moments in 2004–2005. Both stars have close rotation velocities, which are equal to 24 and 19 km s^{-1}. We do not confirm the classification of BD $-6°1178$ as a supergiant in the transition stage of becoming a planetary nebula. BD $-6°1178$ probably is a young pre-MS stars. It is possibly a member of the 1c subgroup of the Ori OB1 association.

Accepted for publication in Astrophysical Bulletin
Available from arXiv:0807.2499

First detection of CO lines in a water fountain star

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Context: Water fountain stars are very young post-AGB stars with high velocity water maser jets. They are the best objects to study the onset of bipolar jets from evolved stars due to their young dynamical ages. However, none of them have been observed in any thermal lines.
Aims: Search for CO lines in the water fountain star IRAS 16342−3814 and investigate the properties of its thermal gas.
Methods: The proximity, peculiar stellar velocity and high Galactic latitude of IRAS 16342−3814 make a single dish observation possible. We use the Arizona Radio Observatory 10m telescope to observe the CO $J = 2 - 1$ line and compare the line parameters with that of masers.
Results: We report the detection of ^{12}CO and ^{13}CO $J = 2 - 1$ lines from IRAS 16342−3814. The inferred ^{12}CO mass-loss rate is an order of magnitude lower than the infrared and OH mass-loss rates, indicating a very cold and thick O-rich circumstellar envelope around the star. We also find a ^{12}CO expansion velocity of $v_{\rm exp} = 46 \pm 1$ km s^{-1} that is too high for an AGB wind and confirm the systemic velocity of 44 ± 1 km s^{-1}. In addition we measure a very low ^{12}CO/^{13}CO line ratio of 1.7.
Conclusions: The first detection of CO lines has provided a new way to investigate the water fountain stars. Given

the high expansion velocity of the CO gas and its relation to maser velocities, we infer that the CO emission region is co-located with the OH mainline masers in the warm base of the optical bipolar lobes, while the high velocity OH 1612 MHz and H_2O masers are located in the side walls and at the farthest ends of the bipolar lobes, respectively. Further observations are highly desired to understand the very low $^{12}CO/^{13}CO$ line ratio.

Accepted for publication in A&A Letters
Available from arXiv:0807.2899

A $H^{13}CN/HN^{13}C$ linelist, model atmospheres and synthetic spectra for carbon stars.

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A line list of vibration-rotation transitions for ^{13}C substituted HCN is presented. The line list is constructed using known experimental levels where available, calculated levels and *ab initio* line intensities originally calculated for the major isotopologue. Synthetic spectra are generated and compared with observations for cool carbon star WZ Cas. It is suggested that high resolution HCN spectra recorded near 14 μm should be particularly sensitive to the ^{13}C to ^{12}C ratio.

Accepted for publication in NMRAS
Available from arXiv:0807.0717

Detection of Fluorine in the Halo Planetary Nebula BoBn 1: Evidence for a Binary Progenitor Star

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We have found the fluorine lines [F IV]$\lambda\lambda$3996.92,4059.90 in the extremely metal-poor ([Ar/H] $= -2.10 \pm 0.21$) halo planetary nebula (PN) BoBn 1 in high-dispersion spectra from the 8.2 m VLT UVES archive. Chemical abundance analysis shows that the fluorine abundance is [F/H] $= +1.06 \pm 0.08$, making BoBn 1 the most fluorine-enhanced and metal-poor PN among fluorine-detected PNe and providing new evidence that fluorine is enhanced by nucleosynthesis in low-mass metal-poor stars. A comparison with the abundances of carbon-enhanced metal-poor (CEMP) stars suggests that BoBn 1 shares their origin and evolution with CEMP stars such as HE 1305+0132. BoBn 1 might have evolved from a binary consisting of 2 $M_\odot$ primary and 0.8 $M_\odot$ secondary stars.

Published in The Astrophysical Journal Letters
Available from http://www.journals.uchicago.edu/doi/full/10.1086/591147

Multiple ring nebulae around blue supergiants

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In the course of the life of a massive star, wind-wind interaction can give rise to the formation of circumstellar nebulae which are both predicted and observed in nature. We present generic model calculations to predict the properties of such nebulae for blue supergiants. From stellar evolution calculations including rotation, we obtain the time dependence of the stellar wind properties and of the stellar radiation field. These are used as input for hydro-calculations of the circumstellar medium throughout the star's life. Here, we present the results for a rapidly rotating 12 $M_\odot$ single star. This star forms a blue loop during its post main sequence evolution, at the onset of which its contraction spins it up close to critical rotation. Due to the consequent anisotropic mass loss, the blue supergiant wind sweeps up the preceding slow wind into an hourglass structure. Its collision with the previously formed spherical red supergiant wind shell forms a short-lived luminous nebula consisting of two polar caps and a central inner ring. With time, the polar caps evolve into mid-latitude rings which gradually move toward the equatorial plane while the central ring fades. These structures are reminiscent of the observed nebulae around the blue supergiant Sher 25 and the progenitor of SN 1987A. The simple model of an hourglass colliding with a spherical shell reproduces most of the intriguing nebula geometries discovered around blue supergiants, and suggests that they form an evolutionary sequence. Our results indicate that a binary system is not required to obtain them.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0807.3049

The evolution of planetary nebulae. V. The diffuse X-ray emission

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Observations with space-borne X-ray telescopes revealed the existence of soft, diffuse X-ray emission from the inner regions of planetary nebulae. Although the existing images support the idea that this emission arises from the hot shocked central-star wind which fills the inner cavity of a planetary nebula, existing models have difficulties to explain the observations consistently. We investigate how the inclusion of thermal conduction changes the physical parameters of the hot shocked wind gas and the amount of X-ray emission predicted by time-dependent hydrodynamical models of planetary nebulae with central stars of normal, hydrogen-rich surface composition. The radiation hydrodynamical models show that heat conduction leads to lower temperatures and higher densities within a bubble and brings the physical properties of the X-ray emitting domain into close agreement with the values derived from observations. Depending on the central-star mass and the evolutionary phase, our models predict X-ray [0.45–2.5 keV] luminosities between 10^{-8} and 10^{-4} of the stellar bolometric luminosities, in good agreement with the observations. Less than 1% of the wind power is radiated away in this X-ray band. Although temperature, density, and also the mass of the hot bubble is significantly altered by heat conduction, the dynamics of the whole system remains practically the same. Heat conduction allows the construction of nebular models which predict the correct amount of X-ray emission and at the same time are fully consistent with the observed mass-loss rate and wind speed. Thermal conduction must be considered as a viable physical process for explaining the diffuse X-ray emission from planetary nebulae with closed inner cavities. Magnetic fields must then be absent or extremely weak.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:0807.3290

Milliarcsecond angular resolution of reddened stellar sources in the vicinity of the Galactic Center

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For the first time, the lunar occultation technique has been employed on a very large telescope in the near-IR with the aim of achieving systematically milliarcsecond resolution on stellar sources.
We have demonstrated the burst mode of the ISAAC instrument, using a fast read-out on a small area of the detector to record many tens of seconds of data at a time on fields of few squared arcseconds. We have used the opportunity to record a large number of LO events during a passage of the Moon close to the Galactic Center in March 2006. We have developed and employed for the first time a data pipeline for the treatment of LO data, including the automated estimation of the main data analysis parameters using a wavelet-based method, and the preliminary fitting and plotting of all light curves.
We recorded 51 LO events over about four hours. Of these, 30 resulted of sufficient quality to enable a detailed fitting. We detected two binaries with subarcsecond projected separation and three stars with a marginally resolved angular diameter of about 2 milliarcseconds. Two more stars, which are cross-identified with SiO maser, were found to be resolved and in one case we could recover the brightness profile of the extended emission, which is well consistent with an optically thin shell. The remaining unresolved stars were used to characterize the performance of the method.
The LO technique at a very large telescope is a powerful and efficient method to achieve angular resolution, sensitivity, and dynamic range that are among the best possible today with any technique. The selection of targets is naturally limited and LOs are fixed-time events, however each observation requires only a few minutes including overheads. As such, LOs are ideally suited to fill small gaps of idle time between standard observations.

Accepted for publication in A&A
Available from arXiv:0807.2646

Milliarcsecond angular resolution of reddened stellar sources in the vicinity of the Galactic Center II. Additional observations

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We present lunar occultation (LO) observations obtained in August 2006 with the recently demonstrated burst mode of the ISAAC instrument at the ESO VLT. The results presented here follow the previously reported observations carried out in March 2006 on a similar but unrelated set of sources.
Interstellar extinction in the inner regions of the galactic bulge amounts to tens of magnitudes at visual wavelengths. As a consequence, the majority of sources in that area are poorly studied and large numbers of potentially interesting sources such as late-type giants with circumstellar shells, stellar masers, infrared stars, remain excluded from the typical investigations which are carried out in less problematic regions. Also undetected are a large numbers of binaries. By observing LO events in this region, we gain the means to investigate at least a selected number of sources with an unprecedented combination of sensitivity and angular resolution.
The LO technique permits to achieve milliarcsecond resolution with a sensitivity of $K \approx 12$ mag at a very large telescope. We have used the opportunity of a favorable passage of the Moon over a crowded region in the general direction of the Galactic Center to observe 78 LO events of heavily reddened stellar sources.
We have detected six new binary and one triple star, with typical projected separation of $\approx 0.01''$. We have also detected

the compact circumstellar emission around one maser and one central star of a planetary nebula. Additionally we have measured the diameter and/or circumstellar shell of two carbon stars and other IR sources.
We have used the upper limits on the size of about 60 unresolved or marginally resolved sources to establish the performance of the method. In agreement with our previous result, we conclude that lunar occultations in fast read-out mode on a detector subwindow at an 8 m-class telescope can achieve an angular resolution close to $0.001''$ with a sensitivity $K \approx 12$ mag.

Accepted for publication in A&A
Available from arXiv:0807.2650

Stellar Evolution and Variability in the Pre-ZAHB Phase

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One of the most dramatic events in the life of a low-mass star is the He flash, which takes place at the tip of the red giant branch and is followed by a series of secondary flashes before the star settles on the zero-age horizontal branch (ZAHB). Yet, no stars have ever been positively identified in this key phase in the life of a low-mass star (hereafter the "pre-ZAHB" phase). In this paper, we investigate the possibility that at least some pre-ZAHB stars may cross the instability strip, thus becoming variable stars whose properties might eventually lead to positive identifications. In particular, it has been suggested that some of the RR Lyrae stars with high period change rates ($\dot{\mathrm{P}}$) may in fact be pre-ZAHB stars. Here we present the first theoretical effort devoted to interpreting at least some of the high-$\dot{\mathrm{P}}$ stars as pre-ZAHB pulsators. We constructed an extensive grid of evolutionary tracks using the Garching Stellar Evolution Code (GARSTEC) for a chemical composition appropriate to the case of the globular cluster M 3 (NGC 5272), where a number of stars with high $\dot{\mathrm{P}}$ values are found. We follow each star's pre-ZAHB evolution in detail, and compute the periods and period change rates for the stars lying inside the instability strip, also producing pre-ZAHB Monte Carlo simulations that are appropriate for the case of M 3. Our results indicate that one should expect of order 1 pre-ZAHB star for every 60 or so bona-fide HB stars in M 3. Among the pre-ZAHB stars, approximately 22% are expected to fall within the boundaries of the instability strip, presenting RR Lyrae-like pulsations. On average, these pre-ZAHB pulsators are expected to have longer periods than the bona-fide HB pulsators, and 76% of them are predicted to show negative $\dot{\mathrm{P}}$ values. While the most likely $\dot{\mathrm{P}}$ value for the pre-ZAHB variables is ≈ -0.3 d Myr^{-1}, more extreme $\dot{\mathrm{P}}$ values are also possible: 38% of the variables are predicted to have $\dot{P} < -0.8$ d Myr^{-1}. It appears likely, therefore, that some — but certainly not all — of the RR Lyrae stars in M 3 with high (absolute) $\dot{\mathrm{P}}$ values are in fact pre-ZAHB pulsators in disguise.

Accepted for publication in Astronomy and Astrophysics
Available from arXiv:0807.3017

The trigger of the AGB superwind: the importance of carbon

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The driving mechanism of the AGB superwind has become controversial in recent years. The efficacy of dust-driven mass loss has been queried. Spitzer observation of AGB stars in Local Group Galaxies show the surprising result that at low metallicity, AGB mass loss occurs at low luminosity, possibly lower than in the Galaxy, but only for carbon-rich stars. Oxygen-rich stars in the Galaxy and in lower metallicity galaxies have similar mass-loss rates only at high luminosities. To explain this dichotomy, we propose that the superwind has a dual trigger. The superwind starts either when sufficient excess carbon builds up for efficient formation of carbonaceous dust (which we propose occurs when $X_{\mathrm{CO}} = (\mathrm{C}-\mathrm{O})/\mathrm{O}_{\odot} = 0.1$), or when the luminosity reaches a value sufficient for a silicate-dust-driven wind (proposed at $L = 10^4 Z^{-4/3}$ L$_{\odot}$). We show that this dual trigger fits the current observational constraints:

the luminosity at which the superwind begins, and the predominance of carbon superwind star at low metallicity. We use stellar evolution models to check the consistency of our explanations and present detailed predictions of the luminosities at which the superwind is triggered for different metallicities and initial stellar masses.

Accepted for publication in MNRAS Letters
Available from arXiv:0807.3730

Production of ^{26}Al by super-AGB stars

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Super AGB (SAGB) stars have initial masses ranging between $\sim 7-11$ M$_\odot$ and develop efficient hydrogen burning at the base of their convective envelope during their AGB evolution, leading to a substantial production of ^{26}Al$_g$.
We present the first discussion of the contribution of the SAGB stars to the galactic ^{26}Al$_g$ production, and we estimate the main uncertainties that affect the determination of the ^{26}Al$_g$ yields.
The results of full stellar evolution computations are presented, with special emphasis on the ^{26}Al$_g$ yields from SAGB stars. We also use a postprocessing nucleosynthesis code to quantify the uncertainties associated with the nuclear reaction rates and with the treatment of convection that modifies the thermodynamical conditions at the base of the convective envelope.
Hot bottom burning leads to individual SAGB ^{26}Al$_g$ yields that are larger than those from intermediate mass stars, amounting to typical values as high as 5×10^{-5} M$_\odot$. The overall SAGB contribution remains modest, however, not exceeding ~ 0.3 M$_\odot$ of the estimated galactic content of 2.8 $M_\odot$. On the other hand, the SAGB ^{26}Al/^{27}Al ratios always exceed 0.01, which is commensurable with the values measured in some SiC grains considered to originate in C-rich AGB stars. However, the isotopic composition of some other elements, particularly nitrogen, is clearly at variance with the observations. We find that the ^{26}Al$_g$ yields are not affected by the pollution induced by the third dredge-ups, but that they strongly depend on the evolution of the temperature at the base of the convective envelope, the determination of which remains highly dependent on the specific convection model used in the stellar computations. Modifications of T$_{\rm env}$ by $\pm10\%$ leads to variations in the ^{26}Al$_g$ yields by a factor of 0.2 to 6. In comparison, the nuclear reaction rate uncertainties have less of an impact, altering the yields by less than a factor of 2.

Accepted for publication in A&A
Available from http://www-astro.ulb.ac.be/∼siess/news.html

The Carbon Abundance and ^{12}C/^{13}C Isotopic Ratio in the Atmosphere of Arcturus from 2.3 μm CO Bands

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Absorption lines of the ^{12}CO and ^{13}CO molecular bands ($\Delta v = 2$) at 2.29 – 2.45 μm are modelled in spectrum of Arcturus (K2 III). We compute a grid of model atmospheres and synthetic spectra for giant of $T_{\rm eff} = 4300$, $\log g = 1.5$, and the elemental abundances of Peterson et al. (1993), but abundances of carbon, oxygen and the carbon isotopic ratio ^{12}C/^{13}C are varied in our computations. The computed spectra are fitted to the observed spectrum of Arcturus from the atlas of Hinkle et al. (1995). The best fit to observed spectrum is achieved for $\log N({\rm C}) = -3.78 \pm 0.1$, $^{12}{\rm C}/^{13}{\rm C} = 8 \pm 1$. A dependence of the determined ^{12}C/^{13}C vs. log N(C) and log N(O) in atmospheres of red giants is discussed.

Accepted for publication in Astronomy Reports, 2008, vol. 52, No. 9, 749–759. C. Pleiades Publishing Ltd.
Available from arXiv:0807.3667

Asymmetric silicate dust distribution toward the silicate carbon star BM Gem

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Silicate carbon stars show the 10 μm silicate emission, despite their carbon-rich photospheres. They are considered to have circumbinary or circum-companion disks, which serve as a reservoir of oxygen-rich material shed by mass loss in the past. We present N-band spectro-interferometric observations of the silicate carbon star BM Gem using MIDI at the Very Large Telescope Interferometer (VLTI). Our aim is to probe the spatial distribution of oxygen-rich dust with high spatial resolution. BM Gem was observed with VLTI/MIDI at 44–62 m baselines using the UT2-UT3 and UT3-UT4 baseline configurations. The N-band visibilities observed for BM Gem show a steep decrease from 8 to $\sim$10 μm and a gradual increase longward of $\sim$10 μm, reflecting the optically thin silicate emission feature emanating from sub-micron-sized amorphous silicate grains. The differential phases obtained at baselines of $\sim$44–46 m show significant non-zero values ($\sim -70^\circ$) in the central part of the silicate emission feature between $\sim$9 and 11 μm, revealing a photocenter shift and the asymmetric nature of the silicate emitting region. The observed N-band visibilities and differential phases can be fairly explained by a simple geometrical model in which the unresolved star is surrounded by a ring with azimuthal brightness modulation. The best-fit model is characterized by a broad ring ($\sim$70 mas across at 10 μm) with a bright region which is offset from the unresolved star by $\sim$20 mas at a position angle of $\sim 280^\circ$. This model can be interpreted as a system with a circum-companion disk and is consistent with the spectroscopic signatures of an accretion disk around an unseen companion recently discovered in the violet spectrum of BM Gem.

Accepted for publication in Astronomy & Astrophysics
Available from arXiv:0807.3342

Radio continuum properties of young planetary nebulae

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We have selected a small sample of post-AGB stars in transition towards the planetary nebula and present new Very Large Array multi-frequency high-angular resolution radio observations of them. The multi-frequency data are used to create and model the targets' radio continuum spectra, proving that these stars started their evolution as very young planetary nebulae. In the optically thin range, the slopes are compatible with the expected spectral index (-0.1). Two targets (IRAS 18062+2410 and 17423−1755) seem to be optically thick even at high frequency, as observed in a handful of other post-AGB stars in the literature, while a third one (IRAS 20462+3416) shows a possible contribution from cold dust. In IRAS 18062+2410, where we have three observations spanning a period of four years, we detect an increase in its flux density, similar to that observed in CRL 618. High-angular resolution imaging shows bipolar structures that may be due to circumstellar tori, although a different hypothesis (i.e., jets) could also explain the observations. Further observations and monitoring of these sources will enable us to test the current evolutionary models of planetary nebulae.

Accepted for publication in Monthly Notices of the Royal Astronomical Society
Available from arXiv:0807.3684

Cool luminous stars: the hybrid nature of their infrared spectra

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We identified a possible origin of the difficulty in abundance analysis of cool luminous stars. We found purely empirically that there is a limit of $\log W/\nu = -4.75$ (W: equivalent width, ν: wavenumber) above which the observed lines do not follow the line formation theory based on the classical micro-turbulent model and that the abundance analysis can be done only with the lines of $\log W/\nu < -4.75$. The C, O, and their isotopic abundances determined from such weak lines of CO and OH in 23 K – M giant stars are roughly consistent with the predictions of evolutionary models. However, the stronger lines of $\log W/\nu > -4.75$ cannot be analyzed at all by the classical line formation theory. From the behavior of these lines and considering other observations such as the detections of H_2O lines, not only in the late M giants but also in the early M and K giant stars, we found that these lines are badly disturbed by the contamination from an extra molecular layers. We already know that the very strong lines of $\log W/\nu > -4.4$ are contaminated by the contribution from the extra warm molecular layers, but we now show that such contamination should be prevailing not only in the strong low excitation lines but also in the intermediate-strength lines ($-4.75 < \log W/\nu < -4.4$) including those with LEP as high as 2 eV. The reason why these lines cannot be used for determining photospheric abundances is simply because they include the contamination of the non-photospheric origin. Instead they can be new proves of the warm molecular envelope for which little is known yet. An important conclusion is that the infrared spectra of K – M giant stars are a hybrid of at least two components originating in the photosphere and the warm molecular envelope. In the interpretation and analysis of the infrared spectra of cool luminous stars, it is essential to keep their hybrid nature in mind. A more serious problem, however, is how to understand the atmospheric structure responsible to the formation of such a hybrid spectrum.

Accepted for publication in A&A
Available from arXiv:0807.4387

The delayed contribution of low and intermediate mass stars to chemical galactic enrichment: An analytical approach

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We find a new analytical solution for the chemical evolution equations, taking into account the delayed contribution of all low and intermediate mass stars (LIMS) as one representative star that enriches the interstellar medium. This solution is built only for a star formation rate proportional to the gas mass in a closed box model. We obtain increasing C/O and N/O ratios with increasing O/H, behavior impossible to match with the Instantaneous Recycling Approximation (IRA). Our results, obtained by two analytical equations, are very similar to those found by numerical models that consider the lifetimes of each star. This delayed model reproduces successfully the evolution of C/O-O/H and Y-O relations in the solar vicinity. This analytical approximation is a useful tool to study the chemical evolution of elements produced by LIMS when a galactic chemical evolutionary code is not available.

Accepted for publication in Revista Mexicana de Astronomía y Astrofísica
Available from arXiv:0807.0971

The Magellanic zoo: Mid-infrared Spitzer spectroscopy of evolved stars and circumstellar dust in the Magellanic Clouds

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We observed a sample of evolved stars in the Large and Small Magellanic Clouds (LMC and SMC) with the Infrared Spectrograph on the Spitzer Space Telescope. Comparing samples from the SMC, LMC, and the Galaxy reveals that the dust-production rate depends on metallicity for oxygen-rich stars, but carbon stars with similar pulsation properties produce similar quantities of dust, regardless of their initial metallicity. Other properties of the oxygen-rich stars also depend on metallicity. As the metallicity decreases, the fraction of naked (i.e. dust-free) stars increases, and among the naked stars, the strength of the 8 μm absorption band from SiO decreases. Our sample includes several massive stars in the LMC with long pulsation periods which produce significant amounts of dust, probably because they are young and relatively metal rich. Little alumina dust is seen in circumstellar shells in the SMC and LMC, unlike in Galactic samples. Three oxygen-rich sources also show emission from magnesium-rich crystalline silicates. Many also show an emission feature at 14 μm. The one S star in our sample shows a newly detected emission feature centered at 13.5 μm. At lower metallicity, carbon stars with similar amounts of amorphous carbon in their shells have stronger absorption from molecular acetylene (C_2H_2) and weaker emission from SiC and MgS dust, as discovered in previous studies.

Accepted for publication in ApJ
Available from arXiv:0807.2998
and from http://isc.astro.cornell.edu/∼sloan/library/2008/mc_dust/

Conference Papers

Chemical abundances of planetary nebulae in the disk-bulge connection

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We report the spectrophotometric investigation of a planetary nebula sample located at the disk-bulge interface of the Milky Way. The main goal of this work was to determine the galactocentric distance where, according to the intermediate mass population, bulge and disk properties separate. In order to derive such distance, new abundances were derived for a sample of PN located at this region, and the results were combined with additional data from the literature. The abundance analysis indicates a chemical abundance distribution similar to that derived from bulge stars, as already pointed out by other authors.
Statistical distance scales were then used to study the distribution of chemical abundances across the disk-bulge connection. A Kolmogorov-Smirnov test was used to find the distance in which the chemical properties of these regions better separate, resulting in a best value of 2.9 kpc to define the inner limit of the disk.

Poster contribution, published in IAU Symposium 254
Available from arXiv:0807.0017

Non-LTE Spectral Analysis of Extremely Hot Post-AGB Stars: Constraints for Evolutionary Theory

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Spectral analysis by means of Non-LTE model-atmosphere techniques has arrived at a high level of sophistication: fully line-blanketed model atmospheres which consider opacities of all elements from H to Ni allow the reliable determination of photospheric parameters of hot, compact stars. Such models provide a crucial test of stellar evolutionary theory: recent abundance determinations of trace elements like, e.g., F, Ne, Mg, P, S, Ar, Fe, and Ni are suited to investigate on AGB nucleosynthesis. E.g., the strong Fe depletion found in hydrogen-deficient post-AGB stars is a clear indication of an efficient s-process on the AGB where Fe is transformed into Ni or even heavier trans iron-group elements.
We present results of recent spectral analyses based on high-resolution UV observations of hot stars.

Oral contribution, published in IAU Symp. 252, Sanya, China
Available from arXiv:0806.1432

Dust in Interstellar Clouds, Evolved Stars and Supernovae

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Outflows of pre-main-sequence stars drive shocks into molecular material within 0.01–1 pc of the young stars. The shock-heated gas emits infrared lines of H_2 and H_2O and millimeter and submillimeter lines of many species including CO, SiO, H_2S and HCO^+. Dust grains are important charge carriers and play a large role in coupling the magnetic field and flow of neutral gas. Some understanding of the effects of the dust on the dynamics of oblique shocks began to emerge in the 1990s. However, detailed models of these shocks are required for the calculation of the grain sputtering contribution to gas phase abundances of species producing observed emissions. We are developing such models.
Some of the molecular species introduced into the gas phase by sputtering in shocks or by thermally driven desorption in radiatively heated hot cores form on grain surfaces. Recently laboratory studies have begun to contribute to the understanding of surface reactions and thermally driven desorption important for the chemistry of star forming clouds.
Dusty plasmas are prevalent in many evolved stars just as well as in star forming regions. Radiation pressure on dust plays a significant role in mass loss from some post-main-sequence stars. The mechanisms leading to the formation of carbonaceous dust in the stellar outflows are similar to those important for soot formation in flames. However, nucleation in oxygen-rich outflows is less well understood and remains a challenging research area.
Dust is observed in supernova ejecta that have not passed through the reverse shocks that develop in the interaction of ejecta with ambient media. Dust is detected in high redshift galaxies that are sufficiently young that the only stars that could have produced the dust were so massive that they became supernovae. Consequently, the issue of the survival of dust in strong supernova shocks is of considerable interest.

Oral contribution, published in 5^{th} International Conference on Physics of Dusty Plasmas
Available from arXiv:0807.1465

Review Paper

The most massive AGB stars

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The general properties of stars in the mass range 7–12 $M_{\odot}$, also referred to as super-AGB stars, are reviewed and special attention is paid to determine how their mass range depends on the initial metallicity and what fraction of these stars end their life as Oxygen-neon white dwarfs or explode as electron-capture supernova.

Published in IAU Symposium No. 252, 2008, "The Art of Modelling Stars in the 21st Century"
Available from http://www-astro.ulb.ac.be/∼siess/news.html

Job Adverts

Institute of Astronomy, KULeuven, Belgium PhD position: From Spitzer to Herschel: The final evolutionary stages of solar-type stars

This PhD project is embedded into the scientific exploitation of the HERSHEL mission of ESA and will focus on the theme of the Guaranteed Time Key Program entitled: The circumstellar environment in post-main-sequence objects.

The project will start with the preparatory program based on the infrared spectra of evolved stars already obtained with the NASA-SPITZER infrared satellite. Early 2009, the ESA infrared satellite HERSHEL will be launched and the research group is Leuven was (and is) heavily involved in the instrument development program of this mission. The aim of this PhD project is to harvest the rich potential of the satellite in the study of the badly understood phenomena associated with the mass loss and dust formation processes. With its improved spatial resolution, its better sensitivity and the extension to longer and unexplored wavelength regions, the HERSHEL mission is ideally suited to investigate quantitatively the circumstellar shells of evolved stars.

The project is embedded in a larger theoretical and observational effort to study in detail the mass-loss processes in evolved stars. The project will concentrate on a very detailed study of outflow sources from the early Asymptotic Giant Branch (AGB) up to the Planetary Nebula (PN) evolutionary stages. It involves, as starting point, the Spectral Energy Distribution (SED) determination of all individual sources including UV and optical data coming from MERCATOR and other ground-based telescopes. Detailed radiative transfer outflow models will be built including photon, gas and dust interactions. The goal of this extensive study is to investigate the changes of spectral signatures due to the hardening of the radiation field during the AGB-PN transition as well as a reconstruction of the mass-loss history of these objects.

More information can be obtained from
Hans.VanWinckel@ster.kuleuven.be;
Joris.Blommaert@ster.kuleuven.be or
Leen.Decin@ster.kuleuven.be

See also http://phd.kuleuven.be/set/

Jodrel Bank Centre for Astrophysics, University of Manchester, UK
STFC postdoctoral and advanced fellowships

The Jodrell Bank Centre for Astrophysics invites applications from candidates wishing to be considered for an STFC Advanced or Postdoctoral Fellowship to be based in the School of Physics and Astronomy at the University of Manchester.

STFC expects to award a number of 3 and 5-years fellowships, to be held at UK institutions. These are at postdoctoral level; the avdanced fellowships are expected to lead to a permanent position.

Candidates can only apply on behalf of one UK institution, and need to first apply to the proposed host, to obtain support, before applying to STFC. Each prospective host may only support a limited a number of applicants.

The JBCA is one of the largest astronomy groups in the UK, with 26 permanent academic staff. It operates the Jodrell Bank Observatory and MERLIN, and hosts the international headquarters for the SKA project. e-MERLIN will become operational during 2009. The UK ALMA regional centre is expected to be hosted in Manchester. Active research areas in Manchester range from cosmology to planets, with particular strengths in pulsars, gravitational lensing, CMB (Planck, CLOVER), dust and astrochemistry, star formation, and solar astronomy. There is also an active instrumentation group spanning the wavelength range from sub-mm to centimeter. Observational interests further include the JCMT, the VLT and the VLTI.

Applications are welcomed within any of the research activities of the JBCA. We are especially interested in people wishing to make use of e-Merlin, ALMA and/or SCUBA-2. Science areas of particular interest are star formation at high redshift, and planet building.

Deadlines
1 September 2008: Receipt of application
8 September 2008: Decisions on endorsement by the School
15 October 2008: Receipt of full application at the STFC

Informal enquiries for astronomy and astrophysics may be made to Prof. Albert Zijlstra,
email: a.zijlstra@manchester.ac.uk, Tel: 0161-3063925, after Aug 15.

Applications should include a full curriculum vitae a brief description of your proposed research project (max 2 sides A4), and names of three referees, and may be sent before 1st September 2008 to

lisa.mcdermott@manchester.ac.uk, with a cc: to
sabina.a.hawthornthwaite@manchester.ac.uk,

or by post to the address below

Lisa McDermott
Jodrell Bank Center for Astrophysics
Alan Turing Building
School of Physics & Astronomy
The University of Manchester
Oxford Road
Manchester M13 9PL
UK

You will be contacted by 8th September 2008 as to whether your application will be endorsed by the School. If you are succesful, we will work with you on the proposed research plan.

See also http://www.jb.man.ac.uk/fellowships.html

A Prize Announcement

The planetary nebula (PN) community is increasingly becoming convinced that single stars cannot readily make nebulae with strong axi-symmetry and that binarity might be a key ingredient to explain a majority of all PNe. A consortium of observers (and some theorists) are currently designing tests to test this hypothesis.

η Carinae is a massive binary system with a bipolar nebula around it, which we call the Homunculus. The Homunculus was formed in the 1837–1856 Great Eruption. My efforts to convince the η Carinae community that this bipolar structure is due to the binary interaction have failed. I challenge the wider stellar community to write a paper offering arguments more compelling than those I have listed in my own papers, and that can convince the Eta Carinae community that its secular properties and its nebula are due to the companion.

I will consider as evidence 10 positive citations to that paper from papers that refer to the Homunculus (not including papers with me on authors' list or selfcitation). For anyone who succeed, I offer a prize: A round-trip ticket to Israel for up to 1300 Dollars, one week lodging and food, and two guided tours to the north of Israel.

Noam Soker
Dept. Of Physics
Technion, Israel