THE AGB NEWSLETTER

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

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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is our pleasure to present you the 128$^{\rm th}$ issue of the AGB Newsletter, with an amazing number and variety of topics.

Congratulations to Pieter Deroo, who obtained his Ph.D. for very nice work on IR interferometric data and models.

We wish to draw your attention to IAU Symposium 256 on the Magellanic Clouds (see the announcement at the end of this newsletter); the SOC is looking forward to see your original and exciting proposals for contributions on the topic of AGB stars!

Looking for a job? Why not apply for the postdoctoral research position at the IAC on Tenerife?

We haven't received much more correspondence about the terminology with regard to mixing processes. However, a related question was put forward with regard to the term "envelope". This term is sometimes used for the stellar convective region below the photosphere, but at other times the circumstellar medium is meant.

The next issue will be distributed on the 1$^{\rm st}$ of March; the deadline for contributions is the 29$^{\rm th}$ of February.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

To avoid confusion, the term "envelope" should be used to mean the circumstellar medium, "mantle" the convective part of the star below the stellar photosphere, and "atmosphere" the region in between.

Reactions to this statement or suggestions for next month's statement can be e-mailed to agbnews@astro.keele.ac.uk (please state whether you wish to remain anonymous)

Refereed Journal Papers

Defining the Termination of the Asymptotic Giant Branch

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I suggest a theoretical quantitative definition for the termination of the asymptotic giant branch (AGB) phase and the beginning of the post-AGB phase. I suggest that the transition will be taken to occur when the ratio of the dynamical time scale to the the envelope thermal time scale, Q, reaches its maximum value. Time average values are used for the different quantities, as the criterion does not refer to the short time-scale variations occurring on the AGB and post-AGB, e.g., thermal pulses (helium shell flashes) and magnetic activity. Along the entire AGB the value of Q increases, even when the star starts to contract. Only when a rapid contraction starts does the value of Q start to decrease. This criterion captures the essence of the transition from the AGB to the post AGB phase, because Q is connected to the stellar effective temperature, reaching its maximum value at $T \sim 4000 - 6000$ K, it is related to the mass loss properties, and it reaches its maximum value when rapid contraction starts and envelope mass is very low.

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Light element abundances in two chemically peculiar stars: HD 104340 & HD 206983

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We derive carbon, nitrogen, oxygen and lithium abundances as well as $^{12}C/^{13}C$ isotopic ratios in two chemically peculiar red giant stars, HD 104340 and HD 206983. The abundances were determined via spectrum synthesis of optical high-resolution spectra containing C_2, CH, CN, [O I] and Li I lines. Our results indicate that HD 206983 is a barium star, while HD 104340, although showing enhancements of s-process elements, should not be considered as a classical barium star: its barium star nature can be explained by internal nuclesynthesis. The low metallicity giant HD 104340 can experience deeper convective mixing and, consequently, a larger dredge-up of CNO-cycle products compared to normal red giants. Light element abundance pattern of HD 104340 resembles anomalies resulting from the appearance on the stellar surface of material enriched by triple-α and CNO cycling.

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Asymptotic Giant Branch Stars in the Phoenix Dwarf Galaxy

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JHK_s near-infrared photometry of stars in the Phoenix dwarf galaxy is presented and discussed. Combining these data with the optical photometry of Massey et al. allows a rather clean separation of field stars from Phoenix members.

The discovery of a Mira variable ($P = 425$ days), which is almost certainly a carbon star, leads to an estimate of the distance modulus of 23.10 ± 0.18 that is consistent with other estimates and indicates the existence of a significant population of age ~ 2 Gyr. The two carbon stars of Da Costa have $M_{\rm bol} = -3.8$ and are consistent with belonging to a population of similar age; some other possible members of such a population are identified. A Da Costa non-carbon star is Delta $K_{\rm s} \sim 0.3$ mag brighter than these two carbon stars. It may be an AGB star of the dominant old population. The nature of other stars lying close to it in the $K_{\rm s}$,(J-$K_{\rm s}$) diagram needs studying.

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J, H, K spectro-interferometry of the Mira variable S Orionis

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Methods: Visibility data of S Ori were obtained at phase 0.78 with the VLTI/AMBER instrument using the fringe tracker FINITO at 29 spectral channels between 1.29 and 2.32 μm. Apparent uniform disk (UD) diameters were computed for each spectral channel. In addition, the visibility data were directly compared to predictions by recent self-excited dynamic model atmospheres.
Results: S Ori shows significant variations in the visibility values as a function of spectral channel that can only be described by a clear variation in the apparent angular size with wavelength. The closure phase values are close to zero at all spectral channels, indicating the absence of asymmetric intensity features. The apparent UD angular diameter is smallest at about 1.3 and 1.7 μm and increases by a factor of ~ 1.4 around 2.0 μm. The minimum UD angular diameter at near-continuum wavelengths is 8.1 ± 0.5 mas, corresponding to ~ 420 $R_\odot$. The S Ori visibility data and the apparent UD variations can be explained reasonably well by a dynamic atmosphere model that includes molecular layers, particularly water vapor and CO. The best-fitting photospheric angular diameter of the model atmosphere is 8.3 ± 0.2 mas, consistent with the UD diameter measured at near-continuum wavelengths.
Conclusions: The measured visibility and UD diameter variations with wavelength resemble and generally confirm the predictions by recent dynamic model atmospheres. These size variations with wavelength can be understood as the effects from water vapor and CO layers lying above the continuum-forming photosphere. The major remaining differences between observations and model prediction are very likely due to an imperfect match of the phase and cycle combination between observation and available models.

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Kinematics and H_2 morphology of the multipolar Post-AGB star IRAS 16594−4656

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Context: The spectrum of IRAS 16594−4656 shows shock excited H_2 emission and collisionally excited emission lines such as [O I], [C I], and [Fe II].

Aim: The goal is to determine the location of the H_2 and [Fe II] shock emission, to determine the shock velocities,and constrain the physical properties in the shock.
Methods: High resolution spectra of the H_2 1-0 S(1), H_2 2-1 S(1), [Fe II], and Paβ emission lines were obtained with the near infrared spectrograph Phoenix on Gemini South.
Results: The position-velocity diagrams of H_2 1-0 S(1), H_2 2-1 S(1), and [Fe II] are presented. The H_2 and [Fe II] emission is spatially extended. The collisionally excited [O I] and [C I] optical emission lines have a similar double peaked profile compared to the extracted H_2 profile and appear to be produced in the same shock. They all indicate an expansion velocity of ~ 8 km s^{-1} and the presence of a neutral, very high density region with n_e about 3×10^6 to 5×10^7 cm^{-3}. The [Fe II] emission however is single peaked. It has a gaussian FWHM of 30 km s^{-1} and a total width of 62 km s^{-1} at 1% of the peak. The Paβ profile is even wider with a gaussian FWHM of 48 km s^{-1} and a total width of 75 km s^{-1} at 1% of the peak.
Conclusions: The H_2 emission is excited in a slow 5 to 20 km s^{-1} shock into dense material at the edge of the lobes, caused by the interaction of the AGB ejecta and the post-AGB wind. The 3D representation of the H_2 data shows a hollow structure with less H_2 emission in the equatorial region. The [Fe II] emission is not present in the lobes, but originates close to the central star in fast shocks in the post-AGB wind or in a disk. The Paβ emission also appears to originate close to the star.

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The planetary nebula NGC 1360, a test case of magnetic collimation and evolution after the fast wind

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The central star of this nebula has an observed intense magnetic field and the fast wind is no longer present, indicating that a back flow process has probably developed. Long-slit, spatially resolved echelle spectra have been obtained across the main body of NGC 1360 and over its system of bipolar jets. Deep images of the knotty structures of the jets have also been obtained. The data allow a detailed study of the structure and kinematics of this object and the results are modeled considering the effects of a magnetic collimation process in the development of the nebula and then switching off the fast stellar wind to follow its evolution to its current state. The model is able to successfully reproduce many of the key features of NGC 1360 under these premises.

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A Spitzer Space Telescope Atlas of ω Centauri: The Stellar Population, Mass Loss, and the Intracluster Medium

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We present a Spitzer Space Telescope imaging survey of the most massive Galactic globular cluster, omega Centauri, and investigate stellar mass loss at low metallicity and the intracluster medium (ICM). The survey covers approximately 3.2× the cluster half-mass radius at 3.6, 4.5, 5.8, 8, and 24 μm, resulting in a catalog of over 40,000 point-sources in

the cluster. Approximately 140 cluster members ranging 1.5 dex in metallicity show a red excess at 24 μm, indicative of circumstellar dust. If all of the dusty sources are experiencing mass loss, the cumulative rate of loss is estimated at $2.9 - 4.2 \times 10^{-7}$ $M_\odot$ yr^{-1}, 63% – 66% of which is supplied by three asymptotic giant branch stars at the tip of the Red Giant Branch (RGB). There is little evidence for strong mass loss lower on the RGB. If this material had remained in the cluster center, its dust component ($> 1 \times 10^{-4}$ $M_\odot$) would be detectable in our 24 and 70 μm images. While no dust cloud located at the center of ω Cen is apparent, we do see four regions of very faint, diffuse emission beyond two half-mass radii at 24 μm. It is unclear whether these dust clouds are foreground emission or are associated with ω Cen. In the latter case, these clouds may be the ICM in the process of escaping from the cluster.

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Independent Emission and Absorption Abundances for Planetary Nebulae

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Emission-line abundances have been uncertain for more than a decade due to unexplained discrepancies in the relative intensities of the forbidden lines and weak permitted recombination lines in planetary nebulae (PNe) and H II regions. The observed intensities of forbidden and recombination lines originating from the same parent ion differ from their theoretical values by factors of more than an order of magnitude in some of these nebulae. In this study we observe UV resonance line absorption in the central stars of PNe produced by the nebular gas, and from the same ions that emit optical forbidden lines. We then compare the derived absorption column densities with the emission measures determined from ground-based observations of the nebular forbidden lines. We find for our sample of PNe that the collisionally excited forbidden lines yield column densities that are in basic agreement with the column densities derived for the same ions from the UV absorption lines. A similar comparison involving recombination line column densities produces poorer agreement, although near the limits of the formal uncertainties of the analyses. An additional sample of objects with larger abundance discrepancy factors will need to be studied before a stronger statement can be made that recombination line abundances are not correct.

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BF Eridani: a cataclysmic variable with a massive white dwarf and an evolved secondary

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We present high- and medium-resolution spectroscopic observations of the cataclysmic variable BF Eri during its low and bright states. The orbital period of this system was found to be 0.270881(3) days. The secondary star is clearly visible in the spectra through absorption lines of the neutral metals Mg I, Fe I and Fe I. Its spectral type was found to

be K3±0.5. A radial velocity study of the secondary yielded a semi-amplitude of $K_2 = 182.5 \pm 0.9$ km s^{-1}. The radial velocity semiamplitude of the white dwarf was found to be $K_1 = 74 \pm 3$ km s^{-1} from the motion of the wings of the Hα and Hβ emission lines. From these parameters we have obtained that the secondary in BF Eri is an evolved star with a mass of 0.50–0.59 M$_\odot$, whose size is about 30 per cent larger than a zero-age main-sequence single-star of the same mass. We also show that BF Eri contains a massive white dwarf ($M_1 \geq 1.23$ M$_\odot$), allowing us to consider the system as a SN Ia progenitor. BF Eri also shows a high γ-velocity ($\gamma = -94$ km s^{-1}) and substantial proper motion. With our estimation of the distance to the system ($d \approx 700 \pm 200$ pc), this corresponds to a space velocity of ∼350 km s^{-1} with respect to the dynamical local standard of rest. The cumulative effect of repeated nova eruptions with asymmetric envelope ejection might explain the high space velocity of the system. We analyze the outburst behaviour of BF Eri and question the current classification of the system as a dwarf nova. We propose that BF Eri might be an old nova exhibiting "stunted" outbursts.

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R Coronae Borealis stars in the Galactic Bulge discovered by EROS-2

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Rare types of variable star may give unique insight into short-lived stages of stellar evolution. The systematic monitoring of millions of stars and advanced light curve analysis techniques of microlensing surveys make them ideal for discovering also such rare variable stars. One example is the R Coronae Borealis (RCB) stars, a rare type of evolved carbon-rich supergiant. We have conducted a systematic search of the EROS-2 database for the Galactic catalogue Bulge and spiral arms to find Galactic RCB stars. The light curves of ∼100 million stars, monitored for 6.7 years (from July 1996 to February 2003), have been analysed to search for the main signature of RCB stars, large and rapid drops in luminosity. Follow-up spectroscopy has been used to confirm the photometric candidates. We have discovered 14 new RCB stars, all in the direction of the Galactic Bulge, bringing the total number of confirmed Galactic RCB stars to about 51. After reddening correction, the colours and absolute magnitudes of at least 9 of the stars are similar to those of Magellanic RCB stars. This suggests that these stars are in fact located in the Galactic Bulge, making them the first RCB stars discovered in the Bulge. The localisation of the 5 remaining RCBs is more uncertain: 4 are either located behind the Bulge at an estimated maximum distance of 14 kpc or have an unusual thick circumstellar shell; the other is a DY Per RCB which may be located in the Bulge, even if it is fainter than the known Magellanic DY Per. From the small scale height found using the 9 new Bulge RCBs, $61 < h^{\rm RCB}_{\rm Bulge} < 246$ pc (95% C.L.), we conclude that the RCB stars follow a disk-like distribution inside the Bulge.

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and from http://eros.in2p3.fr/Variables/RCB/

Infrared Spectroscopic Study of a Selection of AGB and Post-AGB Stars

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We present here near-infrared spectroscopy in the H and K bands of a selection of nearly 80 stars that belong to various AGB types, namely S type, M type and SR type. This sample also includes 16 Post-AGB (PAGB) stars.

From these spectra, we seek correlations between the equivalent widths of some important spectral signatures and the infrared colors that are indicative of mass loss. Repeated spectroscopic observations were made on some PAGB stars to look for spectral variations. We also analyse archival SPITZER mid-infrared spectra on a few PAGB stars to identify spectral features due to PAH molecules providing confirmation of the advanced stage of their evolution. Further, we model the SEDs of the stars (compiled from archival data) and compare circumstellar dust parameters and mass loss rates in different types.
Our near-infrared spectra show that in the case of M and S type stars, the equivalent widths of the CO(3-0) band are moderately correlated with infrared colors, suggesting a possible relationship with mass loss processes. A few PAGB stars revealed short term variability in their spectra, indicating episodic mass loss: the cooler stars showed in CO first overtone bands and the hotter ones showed in H I Brackett lines. Our spectra on IRAS 19399+2312 suggest that it is a transition object. From the SPITZER spectra, there seems to be a dependence between the spectral type of the PAGB stars and the strength of the PAH features. Modelling of SEDs showed among the M and PAGB stars that the higher the mass loss rates, the higher the [K−12] colour in our sample.

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Circumstellar water vapour in M-type AGB stars: Radiative transfer models, abundances and predictions for HIFI

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Context: Surprisingly high amounts of H_2O have recently been reported in the circumstellar envelope around the M-type asymptotic giant branch star W Hya. This has lead to the speculation that evaporation of icy cometary or planetary bodies might be an effective ongoing mechanism in such systems. However, substantial uncertainties remain, as the required radiative transfer modelling is difficult due to high optical depths, sub-thermal excitation and the sensitivity to the combined radiation field from the central star and dust grains.
Aims: By performing a detailed radiative transfer analysis, we determine fractional abundances of circumstellar H_2O in the envelopes around six M-type asymptotic giant branch stars. The models are also used to predict H_2O spectral line emission for the upcoming Herschel/HIFI mission.
Methods: We use Infrared Space Observatory Long Wavelength Spectrometer spectra to constrain the circumstellar fractional abundance distribution of ortho-H_2O, using a non-local thermal equilibrium, and non-local, radiative transfer code based on the accelerated lambda iteration formalism. The mass-loss rates and kinetic temperature structures for the sample stars are determined through radiative transfer modelling of CO line emission based on the Monte-Carlo method. The density and temperature profiles of the circumstellar dust grains are determined through spectral energy distribution modelling using the publicly available code Dusty.
Results: The determined ortho-H_2O abundances lie between 2×10^{-4} and 1.5×10^{-3} relative to H_2, with the exception of WX Psc, which has a much lower estimated ortho-H_2O abundance of only 2×10^{-6}, possibly indicating H_2O adsorption onto dust grains or recent mass-loss-rate modulations. The estimated abundances are uncertain by, at best, a factor of a few.
Conclusions: The high water abundance found for the majority of the sources suggests that either the 'normal' chemical processes are very effective in producing H_2O, or else non-local thermal equilibrium atmospheric chemistry, grain surface reactions, or a release of H_2O (e.g. from icy bodies like Kuiper belt objects) play a role. However, more detailed information on the physical structure and the velocity field of the region where the water vapour lines are formed is required to improve abundance estimates. We provide predictions for ortho-H_2O lines in the spectral window of Herschel/HIFI. These spectrally resolved lines cover a wide range of excitation conditions and will provide valuable additional information on the physical and chemical properties of the inner stellar wind where H_2O is abundant.

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Detection of 'parent' molecules from the inner wind of AGB stars as tracers of non-equilibrium chemistry

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Context: Asymptotic Giant Branch (AGB) stars are typified by strong dust-driven, molecular outflows. For long, it was believed that the molecular content of the circumstellar envelope of AGB stars is primarily determined by the atmospheric C/O ratio. However, recent observations of molecules such as HCN, SiO, and SO reveal gas-phase abundances higher than predicted by thermodynamic equilibrium (TE) models. UV-photon initiated dissociation in the outer envelope or non-equilibrium formation by the effect of shocks in the inner envelope may be the origin of the anomolous abundances.

Aims: We aim to detect (i) a group of 'parent' molecules (CO, SiO, HCN, CS), predicted by non-equilibrium studies to form with almost constant abundances independent of the C/O ratio and the stellar evolutionary stage on the Asymptotic Giant Branch (AGB), and (ii) the few molecules, such as SiS and SO, that are sensitive to the O- or C-rich nature of the star.

Methods: Several low and high excitation rotational transitions of key molecules are observed at mm and sub-mm wavelengths with JCMT and APEX in four AGB stars: the oxygen-rich Mira WX Psc, the S star W Aql, and the two carbon stars V Cyg and II Lup. A critical density analysis is performed to determine the formation region of the high-excitation molecular lines.

Results: We detect the four 'parent' molecules in all four objects, implying that, indeed, these chemical species form whatever the stage of evolution on the AGB. High-excitation lines of SiS are also detected in three stars with APEX, whereas SO is only detected in the oxygen-rich star WX Psc.

Conclusions: This is the first multi-molecular observational proof that periodically shocked layers above the photosphere of AGB stars show some chemical homogeneity, whatever the photospheric C/O ratio and stage of evolution of the star.

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The impact of the ^{18}F(α,p)^{21}Ne reaction on asymptotic giant branch nucleosynthesis

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We present detailed models of low and intermediate-mass asymptotic giant branch (AGB) stars with and without the ^{18}F(α,p)^{21}Ne reaction included in the nuclear network, where the rate for this reaction has been recently experimentally evaluated for the first time. The lower and recommended measured rates for this reaction produce negligible changes to the stellar yields, whereas the upper limit of the rate effects the production of ^{19}F and ^{21}Ne. The stellar yields increase by $\sim$ 50% to up to a factor of 4.5 for ^{19}F, and by factors of $\sim$ 2 to 9.6 for ^{21}Ne. While the ^{18}F(α,p)^{21}Ne reaction competes with ^{18}O production, the extra protons released are captured by ^{18}O to facilitate the ^{18}O$(p,\alpha)^{15}$N$(\alpha,\gamma)^{19}$F

chain. The higher abundances of ^{19}F obtained using the upper limit of the rate helps to match the [F/O] ratios observed in AGB stars, but only for large C/O ratios. Extra-mixing processes are proposed to help to solve this problem. Some evidence that the ^{18}F(α,p)^{21}Ne rate might be closer to its upper limit is provided by the fact that the higher calculated ^{21}Ne/^{22}Ne ratios in the He intershell provide an explanation for the Ne isotopic composition of SiC grains from AGB stars. This needs to be confirmed by future experiments of the ^{18}F(α,p)^{21}Ne reaction rate. The availability of accurate fluorine yields from AGB stars will be fundamental for interpreting observations of this element in carbon-enhanced metal poor stars.

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Abundances of Planetary Nebula NGC 2392

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The spectra of the planetary nebula NGC 2392 is reanalysed using spectral measurements made in the mid-infrared with the Spitzer Space Telescope. The aim is to determine the chemical composition of this object. We also make use of IUE and ground based spectra. Abundances determined from the mid-infrared lines, which are insensitive to electron temperature, are used as the basis for the determination of the composition, which are found to differ somewhat from earlier results. The abundances found, especially the low value of helium and oxygen, indicate that the central star was originally of rather low mass. Abundances of phosphorus, iron, silicon and chlorine have been determined for the first time in this nebula. The variation of electron temperature in this nebula is very clear reaching quite high values close to the center. The temperature of the central star is discussed in the light of the high observed stages of ionization. The nebular information indicates the spectrum of the star deviates considerably from a blackbody.

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In Search of Possible Associations between Planetary Nebulae and Open Clusters

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We consider the possibility of cluster membership for 13 planetary nebulae that are located in close proximity to open clusters lying in their lines of sight. The short lifetimes and low sample size of intermediate-mass planetary nebulae with respect to nearby open clusters conspire to reduce the probability of observing a true association. Not surprisingly, line of sight coincidences almost certainly exist for 7 of the 13 cases considered. Additional studies are advocated, however, for 6 planetary nebula/open cluster coincidences in which a physical association is not excluded by the available evidence, namely M 1-80/Berkeley 57, NGC 2438/NGC 2437, NGC 2452/NGC 2453, VBRC 2 & NGC 2899/IC 2488, and HeFa 1/NGC 6067. A number of additional potential associations between planetary nebulae and open clusters is tabulated for reference purposes. It is noteworthy that the strongest cases involve planetary nebulae lying in cluster coronae, a feature also found for short-period cluster Cepheids, which are themselves potential progenitors of planetary nebulae.

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First Images of R Aquarii and its Asymmetric Water Shell

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We report imaging observations of the symbotic long-period Mira variable R Aquarii (R Aqr) at near-infrared and radio wavelengths. The near-infrared observations were made with the IOTA imaging interferometer in three narrow-band filters centered at 1.51, 1.64, and 1.78 μm, which sample mainly water, continuum, and water features, respectively. Our near-infrared fringe visibility and closure phase data are analyzed using three models. (a) A uniform disk model with wavelength-dependent sizes fails to fit the visibility data, and is inconsistent with the closure phase data. (b) A three-component model, comprising a Mira star, water shell, and an off-axis point source, provide a good fit to all data. (c) A model generated by a constrained image reconstruction analysis provides more insight, suggesting that the water shell is highly non-uniform, i.e., clumpy. The VLBA observations of SiO masers in the outer molecular envelope show evidence of turbulence, with jet-like features containing velocity gradients.

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A phenomenological model for the extended zone above AGB stars

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I suggest the existence of an extended zone above the surface of asymptotic giant branch (AGB), as well as similar stars experiencing high mass loss rates. In addition to the escaping wind, in this zone there are parcels of gas that do not reach the escape velocity. These parcels of dense gas rise slowly and then fall back. The wind and bound gas exist simultaneously to distances of ~ 100 AU. I term this region the effervescent zone. In this phenomenological study I find that the density of the unbound material in the effervescent zone falls as $\sim r^{-5/2}$, not much faster than the wind density. The main motivation to propose the effervescent model is to allow wide binary companions to influence the morphology of the descendant planetary nebulae (PN) by accreting mass from the effervescent zone. Accretion from the effervescent zone is more efficient than accretion from the wind in forming an accretion disk around the companion. The companion might then blow two jets that will shape the descendant PN.

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The Evolution of NGC 7027 at Radio Frequencies: A New Determination of the Distance and Core Mass

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We present the results of a 25-year program to monitor the radio flux evolution of the planetary nebula NGC 7027. We find significant evolution of the spectral flux densities. The flux density at 1465 MHz, where the nebula is optically thick, is increasing at a rate of $0.251 \pm 0.015\%$ yr^{-1}, caused by the expansion of the ionized nebula. At frequencies where the emission is optically thin, the spectral flux density is changing at a rate of $-0.145 \pm 0.005\%$ yr^{-1}, caused by a decrease in the number of ionizing photons coming from the central star. A distance of 980 ± 100 pc is derived. By fitting interpolated models of post-AGB evolution to the observed changes, we find that over the 25-yr monitoring period, the stellar temperature has increased by 3900 ± 900 K and the stellar bolometric luminosity has decreased by $1.75 \pm 0.38\%$. We derive a distance-independent stellar mass of 0.655 ± 0.01 M$_\odot$ adopting the Blöcker stellar evolution models, or about 0.04 M$_\odot$ higher when using models of Vassiliadis & Wood which may provide a better fit. A Cloudy photoionization model is used to fit all epochs at all frequencies simultaneously. The differences between the radio flux density predictions and the observed values show some time-independent residuals of typically 1%. A possible explanation is inaccuracies in the radio flux scale of Baars et al. We propose an adjustment to the flux density scale of the primary radio flux calibrator 3C 286, based on the Cloudy model of NGC 7027. We also calculate precise flux densities for NGC 7027 for all standard continuum bands used at the VLA, as well as for some new 30 GHz experiments.

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Carbon-Enhanced Metal-Poor Stars. III. Main-Sequence Turn-Off Stars from the SDSS/SEGUE Sample

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The chemical compositions of seven Carbon-Enhanced Metal-Poor (CEMP) turn-off stars are determined from high-resolution spectroscopy. Five of them are selected from the SDSS/SEGUE sample of metal-poor stars. Another star, also chosen from the SDSS/SEGUE sample, has only a weak upper limit on its carbon abundance obtained from the high-resolution spectrum. The effective temperatures of these objects are all higher than 6000 K, while their metallicities, parametrized by [Fe/H], are all below -2; the star with the lowest iron abundance in this study has [Fe/H] $= -3.1$. Six of our program objects exhibit high abundance ratios of barium ([Ba/H] $> +1$), suggesting large contributions of the products of former AGB companions via mass transfer across binary systems. One star in our study (SDSS 1707+58) exhibits a rapid variation in its radial velocity, which is a strong signature that this star belongs to a close binary. Combining our results with previous studies provides a total of 20 CEMP main-sequence turn-off stars for which the abundances of carbon and at least some neutron-capture elements are determined. Inspection of the [C/H] ratios for this sample of CEMP turn-off stars show that they are generally higher than those of CEMP giants; their dispersion in this ratio is also smaller. We take these results to indicate that the carbon-enhanced material provided from the companion AGB star is preserved at the surface of turn-off stars with no significant dilution, which appears counter to expectations if processes such as thermohaline mixing have operated in unevolved CEMP stars. In contrast to the behavior of [C/H], a large dispersion in the observed [Ba/H] is found for the sample of CEMP turn-off

stars, suggesting that the efficiency of the s-process in very metal-poor AGB stars may differ greatly from star to star. Four of the six stars from the SDSS/SEGUE sample exhibit kinematics that are associated with membership in the outer-halo population, a remarkably high fraction.

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Effects of metallicity on the chemical composition of carbon stars

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We present Spitzer IRS data on 19 asymptotic giant branch (AGB) stars in the Large Magellanic Cloud, complementing existing published data sets of carbon stars in both Magellanic Clouds and the Milky Way, to investigate the effects of metallicity on dust and molecular spectral features arising from the circumstellar envelope. We find that the C_2H_2 P and R branches at 7.5 μm are affected by dust dilution at higher mass-loss rates — albeit to a lesser extent for sources in the Magellanic Clouds, compared to the Milky Way — while the narrow 13.7 μm C_2H_2 Q branch only shows the effect of dust dilution at low mass-loss rates. A strong metallicity dependence is not observed for the Q branch. Independent of metallicity, we also provide an explanation for the observed shifts in the central wavelength of the SiC emission feature, as we show that these are largely caused by molecular band absorption on either side of the dust emission feature, dominating over shifts in the central wavelength caused by self-absorption. We have devised a method to study the dust condensation history in carbon-rich AGB stars in different metallicity environments, by measuring the strength of the 11.3 μm SiC and 30 μm MgS features with respect to the continuum, as a function of mass-loss rate. With this method, it is possible to distinguish in what order SiC and graphite condense, which is believed to be sensitive to the metallicity, prior to the eventual deposit of the MgS layer.

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HST Snapshot Survey of Post-AGB Objects

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The results from a *Hubble Space Telescope* (*HST*) snapshot survey of post-AGB objects are shown. The aim of the survey is to complement existing *HST* images of PPN and to connect various types of nebulosities with physical and chemical properties of their central stars. Nebulosities are detected in 15 of 33 sources. Images and photometric and geometric measurements are presented. For sources with nebulosities we see a morphological bifurcation into two groups, DUPLEX and SOLE, as previous studies have found. We find further support to the previous results suggesting that this dichotomy is caused by a difference in optical thickness of the dust shell. The remaining 18 sources are classified as stellar post-AGB objects, because our observations indicate a lack of nebulosity. We show that some stellar sources may in fact be DUPLEX or SOLE based on their infrared colors. The cause of the differences among the groups are investigated. We discuss some evidence suggesting that high progenitor-mass AGB stars tend to become DUPLEX post-AGB objects. Intermediate progenitor-mass AGB stars tend to be SOLE post-AGB objects. Most of

the stellar sources probably have low mass progenitors and do not seem to develop nebulosities during the post-AGB phase and therefore do not become planetary nebulae.

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Self-enrichment by AGB stars in Globular Clusters: comparison between intermediate and high metallicities

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We present theoretical evolutionary sequences of intermediate mass stars ($M = 3-6.5$ M$_\odot$) with metallicity $Z = 0.004$. Our goal is to test whether the self-enrichment scenario by massive Asymptotic Giant Branch stars may work for the high metallicity Globular Clusters, after previous works by the same group showed that the theoretical yields by this class of objects can reproduce the observed trends among the abundances of some elements, namely the O-Al and O-Na anticorrelations, at intermediate metallicities, i.e. [Fe/H]$= -1.3$. We find that the increase in the metallicity favours only a modest decrease of the luminosity and the temperature at the bottom of the envelope for the same core mass, and also the efficiency of the third dredge-up is scarcely altered. On the contrary, differences are found in the yields, due to the different impact that processes with the same efficiency have on the overall abundance of envelopes with different metallicities. We expect the same qualitative patterns as in the intermediate metallicity case, but the slopes of some of the relationships among the abundances of some elements are different. We compare the sodium–oxygen anticorrelation for clusters of intermediate metallicity ($Z \sim 0.001$) and clusters of metallicity large as in these new models. Although the observational data are still too scarce, the models are consistent with the observed trends, provided that only stars of $M > 5$ M$_\odot$ contribute to self-enrichment.

Accepted for publication in MNRAS

AGB Variables and the Mira Period-Luminosity Relation

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Published data for large amplitude asymptotic giant branch variables in the Large Magellanic Cloud are re-analysed to establish the constants for an infrared (K) period-luminosity relation of the form: $M_{\rm K} = \rho[\log P - 2.38] + \delta$. A slope of $\rho = -3.51 \pm 0.20$ and a zero point of $\delta = -7.15 \pm 0.06$ are found for oxygen-rich Miras (if a distance modulus of 18.39 ± 0.05 is used for the LMC). Assuming this slope is applicable to Galactic Miras we discuss the zero-point for these stars using the revised *Hipparcos* parallaxes together with published VLBI parallaxes for OH Masers and Miras in Globular Clusters. These result in a mean zero-point of $\delta = -7.25 \pm 0.07$ for O-rich Galactic Miras. The zero-point for Miras in the Galactic Bulge is not significantly different from this value.
Carbon-rich stars are also discussed and provide results that are consistent with the above numbers, but with higher uncertainties. Within the uncertainties there is no evidence for a significant difference between the period-luminosity relation zero-points for systems with different metallicity.

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Available from arXiv:0801.4465

The physical structure of the point-symmetric and quadrupolar planetary nebula NGC 6309

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We analyse the point-symmetric planetary nebula NGC 6309 in terms of its three-dimensional structure and of internal variations of the physical conditions to deduce the physical processes involved in its formation. We used VLA-D 3.6-cm continuum, ground-based, and HST-archive imaging as well as long slit high- and low-dispersion spectroscopy. The low-dispersion spectra indicate a high excitation nebula, with low to medium variations of its internal physical conditions. In the optical images, the point-symmetric knots show a lack of [N II] emission as compared with similar features previously known in other PNe. A rich internal structure of the central region is seen in the HST images, resembling a deformed torus. Long slit high-dispersion spectra reveal a complex kinematics in the central region. The spectral line profiles from the external regions of NGC 6309 indicate expanding lobes (~ 40 km s^{-1}) as those generally found in bipolar nebulae. Finally, we have found evidence for the presence of a faint halo, possibly related to the envelope of the AGB-star progenitor. Our data indicate that NGC 6309 is a quadrupolar nebula with two pairs of bipolar lobes whose axes are oriented $PA = 40$ and $PA = 76$. Equatorial and polar velocities for these two pairs of lobes are 29 and 86 km s^{-1} for the bipolar system at $PA = 40$ and 25 and 75 km s^{-1} for the bipolar system at $PA = 76$. There is also a central torus that is expanding at 25 km s^{-1}. Kinematical age for all these structures is around 3700 to 4000 yr. We conclude that NGC 6309 was formed by a set of well-collimated bipolar outflows (jets), which were ejected in the initial stages of its formation as a planetary nebula. These jets carved the bipolar lobes in the previous AGB wind and their remnants are now observed as the point-symmetric knots tracing the edges of the lobes.

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Available from arXiv:0801.4601

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.

Submitted to The Astrophysical Journal
Available from http://isc.astro.cornell.edu/∼sloan/library/2008/mc_dust/

Conference Papers

The connection between mass loss and nucleosynthesis

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I discuss the relationship between mass loss and nucleosynthesis on the Asymptotic Giant Branch (AGB). Because of thermal pulses and possibly other mixing processes, products of nucleosynthesis can be brought to the surface of AGB stars, increasingly so as the star becomes more luminous, cooler, and unstable against pulsation of its tenuous mantle. As a result, mass loss is at its most extreme when dredge-up is too. As the high rate of mass loss truncates AGB evolution, it determines the enrichment of interstellar space with the AGB nucleosynthesis products. The changing composition of the stellar atmosphere also affects the mass-loss process, most obviously in the formation of dust grains — which play an important rôle in driving the wind of AGB stars.

Oral contribution, published in "The IX$^{\rm th}$ Torino Workshop on Evolution and Nucleosynthesis of AGB Stars", AIP Proceedings
Available from arXiv:0801.0557
and from http://www.astro.keele.ac.uk/∼jacco/research/ecology.html

Evolution of Alfvén wave-driven solar winds to red giants

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In this talk we introduce our recent results of global 1D MHD simulations for the acceleration of solar and stellar winds. We impose transverse photospheric motions corresponding to the granulations, which generate outgoing Alfvén waves. The Alfvén waves effectively dissipate by 3-wave coupling and direct mode conversion to compressive waves in density-stratified atmosphere. We show that the coronal heating and the solar wind acceleration in the open magnetic field regions are natural consequence of the footpoint fluctuations of the magnetic fields at the surface (photosphere). We also discuss winds from red giant stars driven by Alfvén waves, focusing on different aspects from the solar wind. We show that red giants wind are highly structured with intermittent magnetized hot bubbles embedded in cool chromospheric material.

Oral contribution, published in IAUS 247 " Waves & Oscillations in The Solar Atmosphere: Heating and Magneto-Seismology"
Available from arXiv:0801.0050

The Physical Properties of Red Supergiants: Comparing Theory and Observations

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Red supergiants (RSGs) are an evolved stage in the life of intermediate massive stars (< 25 M$_\odot$). For many years, their location in the H-R diagram was at variance with the evolutionary models. Using the MARCS stellar atmospheres, we have determined new effective temperatures and bolometric luminosities for RSGs in the Milky Way, LMC, and SMC, and our work has resulted in much better agreement with the evolutionary models. We have also found evidence of significant visual extinction due to circumstellar dust. Although in the Milky Way the RSGs contribute only a small fraction ($< 1\%$) of the dust to the interstellar medium (ISM), in starburst galaxies or galaxies at large look-back times, we expect that RSGs may be the main dust source. We are in the process of extending this work now to RSGs of higher and lower metallicities using the galaxies M31 and WLM.

Oral contribution, published in "Massive Stars as Cosmic Engines", IAUS 250, eds. F. Bresolin, P.A. Crowther & J. Puls

Available from arXiv:0801.1806

and from http://www.lowell.edu/users/massey/IAU250RSG.pdf

Review Paper

Post-Red Supergiants

René Oudmaijer[1], *Ben Davies*[2], *Willem-Jan de Wit*[1] *and Mitesh Patel*[3]

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The yellow hypergiants are found in a stage between the massive Red Supergiants and the Wolf-Rayet stars. This review addresses current issues concerning the evolution of massive stars, concentrating on the transitional post-Red Supergiant phase. Few yellow hypergiants are known and even fewer show direct evidence for having evolved off the Red Supergiant branch. Indeed, only two such rare objects with clear evidence for having gone through of a previous mass losing phase are known, IRC +10420 and HD 179821. We will review their properties and present recent results employing near-infrared interferometry, integral field spectroscopy and polarimetry. Finally, their real-time evolution is discussed.

Published in "Biggest, Baddest, Coolest Stars" (ASP Conf Series) eds. D. Luttermoser, B. Smith & R. Stencel (Keynote Talk)

Available from arXiv:0801.2315

Thesis

High spatial resolution study of the circumstellar environment of AGB and post-AGB stars

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In recent years it became clear that post-AGB stars in binary systems are quite common. Most binaries seem to display a distinct observational characteristic in the broad-band SED: the dust excess starts already in the near-IR (typically at K) which is mostly interpreted as coming from a circumstellar disc.

In our thesis we used the newly available interferometric instrumentation at ESO operating in the near-IR (the AMBER instrument) and in the N-band (the MIDI instrument), to investigate the circumstellar structures at very high spatial resolution.

We resolved 9/11 objects and proved that the circumstellar material around all objects must be very compact indeed. Moreover, for several objects we found interferometric evidence for a strongly asymmetric structure on milli-arcsecond scale. The typical diameter of the N-band emission was found to be 40 AU.

We confronted the high spatial resolution data with our self-consistent disc models based on 2D radiative transfer. We found that both the interferometric observables as well as the broad band SED, are reproduced very well by a passive dusty circumbinary disc in which the scale height is determined by the hydrostatic equilibrium equation. A prominent feature is that at sublimation temperature, the dust receives the unattenuated radiation of the central object and a puffed-up inner rim is created. The opacity of this rim is a major structure-element of the disc and the associated SED. We found that for all objects, the dust excess starts near sublimation temperature, which is well beyond the orbit. Our analysis showed that the circumbinary discs must be very stable.

The stability of such structures was investigated further in a pilot study of the circumstellar dust of a silicate J-type carbon star. We concluded that the interferometric observables are also in this object consistent with a similar, highly processed disc which is likely of circumbinary origin.

We conclude that binary post-AGB stars are surrounded by stable passive circumbinary discs. Understanding the formation, detailed structure and evolution of these discs is of prime importance since the discs must play a lead role in the evolution of a significant fraction of binary stars.

Defended on December 21st 2007 at the University of Leuven
Available from http://www.ster.kuleuven.be/pub/deroo_phd/

Job Advert

Instituto de Astrofísica de Canarias — Post-doctoral position

The Instituto de Astrofísica de Canarias (IAC, Tenerife, Spain; http://www.iac.es) invites applicants for ONE post-doctoral research position within the framework of the project "The population of planetary nebulae and symbiotic stars of the Galaxy" (AYA2007-66804), financed by the Spanish National Program for Astronomy and Astrophysics. The successful candidate is expected to be integrated in the IAC research group led by Dr. Romano Corradi and Dr. Antonio Mampaso working on planetary nebulae and symbiotic stars. The group presently also counts on three PhD students, several undergraduate students, and numerous collaborations worldwide.

Tasks:
Specifically, the candidate is expected to spend at least 50% of his/her time working on the analysis of the data from the INT Photometric H-α Survey of the Northern Galactic Plane (IPHAS),whose observations are about to be completed on La Palma. IPHAS is providing a complete census of the H-α emission in the Northern Galactic Plane, detecting a large number of new planetary nebulae, symbiotic stars, and all other classes of H-α emitting stars. Further details on the survey can be found at http://www.iphas.org. A major goal to be pursued by the successful candidate is to estimate the total population of planetary nebulae and symbiotic stars in the Milky Way making use of

IPHAS and all other existing data in the literature. Another target is to make detailed studies of the most remarkable objects discovered by IPHAS. Involvement in the extension of IPHAS to the Southern hemisphere (VPHAS+) is also foreseen. On the remaining time, the candidate is welcome to join the other research projects of the group, which include the study of the dynamics of planetary nebulae and nebulae around symbiotic stars, and the search and study of extragalactic planetary nebulae with special emphasis on the determination of their global population size and chemical properties.

Highly considered:
Both theoretical and observational expertise will be positively considered, and in particular any previous experience with the analysis of optical and near-IR observations and the ability of dealing with large astronomical databases.

Doctorate:
Applicants must have a PhD in Astrophysics or Physics and the doctoral certificate at the moment of starting their appointment to take place during the first semester of 2008 and cannot have received the PhD degree more than seven years prior to the date of application.

NOTE: Applicants who prepared their thesis at the IAC must present written evidence of having spent one continuous year, or 18 accumulated months, in other research institutes.

Remuneration:
The gross annual salary is 32.405,56 euros per annum, subject to up to 20% tax and Social Security deductions. Medical insurance under the Spanish National Health Service will be provided, and will also cover your accompanying partner and children (if relevant).

Duration:
The contract will start during the first semester of 2008, be in force two years and three months and will conclude, in any case, before 30$^{\text{th}}$ September 2010.

Non-UE citizens: If you are citizen of a country not belonging to the European Union, you are not allowed to sign any contract with the IAC until you obtain the compulsory documentation required to live and work in Spain (Visa, Residence Permit, Work Permit Waiver). Please contact the Spanish consulate in your country for details.

Compulsory documentation to submit:
⋆ The Application Form: WORD, PDF
⋆ Curriculum Vitae, bibliography, brief statement of research interests, and a covering letter telling us about the skills you can bring to the job.
⋆ A photocopy of your PhD degree or certificate.
⋆ A photocopy of your passport.
⋆ At least two letters of recommendation must be sent (electronic submission preferred) directly by researchers or professionals familiar with your work, to the Secretariat of the IAC's Research Division secinv@iac.es.

Applications must be sent, electronic submission preferred, to the Secretariat of the Research Division, secinv@iac.es. Applications may also be sent by post, however, applications received after the deadline cannot be accepted, unless they are post-stamped, on the application form, by the postal office, before the deadline. Please note that the stamp on the envelope is not valid. Postal address: Instituto de Astrofísica de Canarias, C/ Via Láctea s/n, E-38205 La Laguna, Tenerife, Spain.

Questions about the position are encouraged and can be addressed to Dr. Romano Corradi at rcorradi@ing.iac.es, or Dr. Antonio Mampaso at amr@iac.es.
Details of the evaluation and selection process for this position can be found in the official announcement (Spanish version only).

THE RECEPTION OF APPLICATIONS WILL CLOSE ON 15$^{\text{th}}$ FEBRUARY 2008

See also http://www.iac.es/folleto/research/postdocs2008/nebulosas_eng_2008.html

Announcement

IAU Symposium 256
The Magellanic System: Stars, Gas, and Galaxies

First Announcement, 1 February 2008

The beautiful, green campus of the University of Keele cordially invites you to attend IAU Symposium 256 on "The Magellanic System: Stars, Gas, and Galaxies", from Monday 28 July to Friday 1 August 2008.

All details and forms can be found on the conference website http://www.astro.keele.ac.uk/iaus256

The last IAU Symposium dedicated to the Magellanic System took place ten years ago, in Victoria (Canada). Since then, there has been enormous progress in observing and understanding the physics and dynamics of the stars and the interstellar medium within these nearby gas-rich galaxies, as well as their global structure and mutual interaction.

Programme

IAU Symposium 256 is dedicated to all aspects of Magellanic Cloud research (including the Magellanic Bridge, Stream and Leading Arms) — see the programme for more details. We have invited a number of speakers to present key talks in certain areas, but we have ensured plenty of opportunity for contributed talks. We expect strong competition for these slots, however, and we therefore encourage anyone interested in presenting a talk to submit a convincing abstract by the 31 March 2008 deadline.

Registration

The fee for early (deadline 30 April 2008) is £120. This covers local administration costs, and includes a copy of the proceedings and conference stationary. The fee for registrations after this deadline is £150. Registration closes on 18 July 2008. The registration and payment form will go live in March 2008. Pre-registered delegates will be notified by e-mail when this happens.

Accommodation

We have booked accommodation on campus for about 200 participants. The packages include all meals, assuming arrival on Sunday afternoon and departure on Saturday morning (except dinner on the day of the conference dinner). Most rooms have en-suite facilities (£418 total). Some rooms with shared facilities are available at a cheaper rate (£351 total). A (very) limited number of double occupancy rooms have been booked as well (£429 total per delegate, but much cheaper for guests). All accommodation is allocated on a first come, first served basis upon registration. If you do not wish to take advantage of the accommodation packages you will still need to purchase a day delegate package (£137 total) in addition to the registration fee in order to be able to attend the symposium.

Financial assistance

We have limited funds available to assist delegates whose attendence is made difficult by a lack of financial resources at their home institutions. These funds are allocated on a competitive basis, with priority given to students and delegates from countries with a weak currency or under-represented groups of the astronomical community. The deadline for applications for financial assistance is 29 February 2008. Note that your chances are greatly increased if you also submit a proposed contribution accompanied by a strong abstract by that (early) deadline. Students are requested to ask their thesis director to e-mail a letter of support to us.

Travel

Keele is located in the United Kingdom between Manchester and Birmingham, in a rural setting on a hilltop a few kilometers outside the towns of Newcastle-under-Lyme and Stoke-on-Trent (famous for its Potteries, such as Wedgwood, Doulton and Spode). There are good rail connections from Manchester and Birmingham to Stoke-on-Trent

(Crewe is somewhat further). Manchester Airport is the nearest to Keele and has many intercontinental connections (directly or via London or other European airports). Liverpool Airport and the London airports are progressively less convenient alternatives.

Proceedings

All registered attendees receive a complementary copy of the conference proceedings. These will be published by Cambridge University Press.

Style files and macros, as well as information about the page allocations will be made available before the start of the symposium.

The deadline for submitting manuscripts is 30 September 2008. We must adhere strictly to this deadline, to ensure a timely publication.

Cultural events

To relax after the scientific sessions, why not enjoy the programme of cultural events we have put together?

On Sunday evening, you are cordially invited to a complementary welcome cocktail at the historical Keele Hall, which is situated in beautifully landscaped gardens on the university campus.

On Monday evening, we host an open air performance of one of Shakespeare's greatest works, 'Othello', in the gardens of Keele Hall, by Anvil Productions. This is bound to be exceedingly good theatre, and a lot of fun. Tickets can be purchased upon registration for the conference at £12.50, which includes a guaranteed seat if purchased by 30 April 2008 (thereafter, a seat cannot be guaranteed and you may need to lounge on the lawn instead).

On Tuesday evening, there will be a public lecture on Archaeoastronomy, by Professor Clive Ruggles. Although free of charge, this promises to be an exciting presentation drawing a large audience from the general public, and we therefore urge you to reserve a ticket in advance (using the registration form).

On Wednesday evening, we host a classical concert to be performed in the University Chapel by the acclaimed ensemble London Concertante. The programme is put together exclusively for the symposium, and will include pieces by Herschel, Bach, Mozart and Vivaldi. This event is open to the public, and we therefore recommend you purchase your ticket(s) upon registration for the conference. Tickets are £12.50.

On Thursday evening will be the conference dinner, hosted in a beautiful 16th century country manor house in south Cheshire, Wrenbury Hall. The costs for this three-course dinner are £40 per person and include a welcome cocktail and transport.

Important dates

29 February 2008	Submission deadline for financial assistance requests
March 2008	Registration and payment form goes live
31 March 2008	Submission deadline for proposed contributions
30 April 2008	Deadline for early registration
18 July 2008	Final deadline for registration
28 July - 1 August 2008	IAU Symposium 256 takes place at Keele
30 September 2008	Deadline for submission of proceedings manuscripts

We look forward to meeting you at Keele this Summer!

Jacco van Loon and Nye Evans, on behalf of the SOC and LOC

See also http://www.astro.keele.ac.uk/iaus256