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 the 106$^{\rm th}$ issue of the AGB Newsletter. Abstracts of 27 journal papers are included, covering topics ranging from RGB mixing to magnetic fields and born-again evolution. Examples include Wouter Vlemming's *Nature* paper on magnetically confined jets, Noam Soker's work on binary versus non-binary evolution, and Dana Balser's detection of $^3{\rm He}^+$. We would like to thank all who have submitted items.

If you are interested in a new job, there are two advertisements near the end of the Newsletter, one postdoctoral position and one permanent faculty position. And for the traveller, there is an announcement of a workshop in Croatia.

We would very much like to hear from you what you think of the AGB Newsletter and the website. This month we also start a new experiment: "Food for Thought" is a brief attempt to stimulate thought by making a controversial statement or proposing a scientific question.

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

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Only interacting binaries produce Planetary Nebulae

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

The light curve of the semiregular variable L2 Puppis - II. Evidence for solar-like excitation of the oscillations

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We analyse visual observations of the pulsations of the red giant variable L2 Pup. The data cover 77 years between 1927 and 2005, thus providing an extensive empirical base for characterizing properties of the oscillations. The power spectrum of the light curve shows a single mode resolved into multiple peaks under a narrow envelope. We argue that this results from stochastic excitation, as seen in solar oscillations. The random fluctuations in phase also support this idea. A comparison with X Cam, a true Mira star with the same pulsation period, and W Cyg, a true semiregular star, illustrates the basic differences in phase behaviours. The Mira shows very stable phase, consistent with excitation by the kappa-mechanism, whereas W Cyg shows large phase fluctuations that imply stochastic excitation. We find L2 Pup to be intermediate, implying that both mechanisms play a role in its pulsation. Finally, we also checked the presence of low-dimensional chaos and could safely exclude it.

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Available from astro-ph/0507471
and from http://www.blackwell-synergy.com/doi/abs/10.1111/j.1365-2966.2005.09281.x

Red variables in the OGLE-II data base - III. Constraints on the three-dimensional structures of the Large and Small Magellanic Clouds

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We present an analysis of the 3D structure of the Magellanic Clouds, using period-luminosity (P-L) relations of pulsating red giants in the OGLE-II sample. By interpreting deviations from the mean P-L relations as distance modulus variations, we examine the 3D distributions of the sample. The results for the Large Magellanic Cloud, based solely on stars below the tip of the Red Giant Branch (LMC), confirm previous results on the inclined and possibly warped bar of the LMC. The depth variation across the OGLE-II field is about 2.4 kpc, interpreted as the distance range of a thin but inclined structure. The inclination angle is about 29°. A comparison with OGLE-II red clump distances revealed intriguing differences that seem to be connected to the red clump reddening correction. A spatially variable red clump population in the LMC can explain the deviations, which may have a broader impact on our understanding of the LMC formation history. For the Small Magellanic Cloud, we find a complex structure showing patchy distribution scattered within 3.2 kpc of the mean. However, the larger range of the overall depth on every line-of-sight is likely to smooth out significantly the real variations.

Published in Monthly Notices of the Royal Astronomical Society: Letters, Volume 359, Issue 1, pp. L42-L46.

Revised Diagnostic Diagrams for Planetary Nebulae

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Diagnostic diagrams of electron density – excitation for a sample of 613 planetary nebulae are presented. The present extensive sample allows the definition of new statistical limits for the distribution of planetary nebulae in the log [Hα/[S II]] *vs* log [Hα/[N II]], log [Hα/[S II]] *vs* [S II] $\lambda\lambda$6717/6731 and log [Hα/[N II]] *vs* [S II] $\lambda\lambda$6717/6731 planes. The diagrams provide a good representation of the ranges of physical conditions, indicated by these emission line ratios, present in planetary nebulae during different evolutionary stages.

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Available from astro-ph/0602201

The kinematics of the large western knot in the halo of the young planetary nebula NGC 6543

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A detailed analysis is presented of the dominant ionised knot in the halo of the planetary nebula NGC 6543. Observations were made at high spectral and spatial resolution of the [OIII] 5007 line using the Manchester echelle spectrometer combined with the 2.1-m San Pedro Martir Telescope. A 20-element multislit was stepped across the field to give almost complete spatial coverage of the large western knot and surrounding halo.

The spectra reveal, for the first time, gas flows around the kinematically inert knot. The gas flows are found to have velocities comparable to the sound speed as gas is photo-evaporated off an ionised surface. No evidence is found of fast wind interaction with the knot and we find it likely that the fast wind is still contained in a pressure-driven bubble in the core of the nebula. This rules out the possibility of the knot having its origin in instabilities at the interface of the fast and AGB winds. We suggest that the knot is embedded in the slowly expanding Red Giant wind and that its surfaces are being continually photoionised by the central star.

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A single-degenerate model for the progenitor of the Type Ia supernova 2002ic

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Supernova 2002ic was an atypical Type Ia supernova (SN Ia) with evidence for substantial amounts of hydrogen associated with the system. Contrary to previous claims, we show that its unusual properties can be understood within the framework of one of the most favoured progenitor models, the so-called supersoft channel. This requires that the donor star was initially relatively massive (~ 3 M$_\odot$) and that the system experienced a delayed dynamical instability, leading to a large amount of mass loss from the system in the last few 10^4 yr before the explosion. This can produce the inferred hydrogen-rich circumstellar environment, most likely with a disc-like geometry. However, to apply

these models requires a larger accretion efficiency onto the white dwarf than is assumed in present parameterizations. If this is confirmed, it would most likely increase estimates for the frequency of the single-degenerate channel. Based on population synthesis simulations we estimate that not more than 1 in 100 SNe Ia should belong to this subgroup of SNe Ia.

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Rotational mixing in low-mass stars II Self-consistent models of Pop II RGB stars

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In this paper we study the effects of rotation in low-mass, low-metallicity RGB stars. We present the first evolutionary models taking into account self-consistently the latest prescriptions for the transport of angular momentum by meridional circulation and shear turbulence in stellar interiors as well as the associated mixing processes for chemicals computed from the ZAMS to the upper RGB. We discuss in details the uncertainties associated with the physical description of the rotational mixing and study carefully their effects on the rotation profile, diffusion coefficients, structural evolution, lifetimes and chemical signatures at the stellar surface. We focus in particular on the various assumptions concerning the rotation law in the convective envelope, the initial rotation velocity distribution, the presence of μ-gradients and the treatment of the horizontal and vertical turbulence.

This exploration leads to two main conclusions : (1) After the completion of the first dredge-up, the degree of differential rotation (and hence mixing) is maximised in the case of a differentially rotating convective envelope (i.e., j_CE(r) = cst), as anticipated in previous studies. (2) Even with this assumption, and contrary to some previous claims, the present treatment for the evolution of the rotation profile and associated meridional circulation and shear turbulence does not lead to enough mixing of chemicals to explain the abundance anomalies in low-metallicity field and globular cluster RGB stars observed around the bump luminosity. This study raises questions that need to be addressed in a near future. These include for example the interaction between rotation and convection and the trigger of additional hydrodynamical instabilities.

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On the magnetic structure and wind parameter profiles of Alfven wave driven winds in late-type supergiant stars

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Cool stars at giant and supergiant evolutionary phases present low velocity and high density winds, responsible for the observed high mass-loss rates. Although presenting high luminosities, radiation pressure on dust particles is not sufficient to explain the wind acceleration process. Among the possible solutions to this still unsolved problem, Alfven waves are, probably, the most interesting for their high efficiency in transfering energy and momentum to the wind. Typically, models of Alfven wave driven winds result in high velocity winds if they are not highly damped. In this work we determine self-consistently the magnetic field geometry and solve the momentum, energy and mass conservation equations, to demonstrate that even a low damped Alfven wave flux is able to reproduce the low velocity wind. We

show that the magnetic fluxtubes expand with a super-radial factor $S > 30$ near the stellar surface, larger than that used in previous semi-empirical models. The rapid expansion results in a strong spatial dilution of the wave flux. We obtained the wind parameter profiles for a typical supergiant star of 16 $M_\odot$. The wind is accelerated in a narrow region, coincident with the region of high divergence of the magnetic field lines, up to 100 km/s. For the temperature, we obtained a slight decrease near the surface for low damped waves, because the wave heating mechanism is less effective than the radiative losses. The peak temperature occurs at 1.5 r_0 reaching 6000 K. Propagating outwards, the wind cools down mainly due to adiabatic expansion.

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Evolution of massive AGB stars : I Carbon Burning phase

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We present new computations of the evolution of solar metallicity stars in the mass range 9-12 $M_\odot$. This first paper of a series focuses on the propagation of the carbon burning flame front and provides a detailed analysis of the structural evolution up to the formation of the neon-oxygen core. Our calculations which do not include overshooting indicate that off-center carbon ignition is restricted to a small mass range between 9.0 and 11.3 $M_\odot$. The chemical imprints of the first and second dredge-ups on the surface composition are analyzed and compared to "standard" less massive stars. It results that, aside from being more luminous and slightly bluer in the HR diagram, massive AGB stars are almost indistinguishable from their lower mass counterparts, as far as the chemical composition is concerned. During the second dredge-up, we note however that the envelope penetrates deeper into the He burning shell than lower mass stars. Our simulations indicate that above $\sim$ 11.0 $M_\odot$, the depth of the second dredge up is considerably reduced, marking the transition between low and massive stars. We also investigate the effects of the nuclear uncertainties associated with $^{12}C+^{12}C$ reactions and show that it has a little impact on the core composition. Finally we describe the nucleosynthesis and chemical structure of the newly formed neon-oxygen core.

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Available from http://www-astro.ulb.ac.be/∼siess/aa2006.ps.gz

Expansion Parallax for the Compact Planetary Nebula M2-43

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We present high quality radio continuum observations made with the Very Large Array at 3.6 cm at two epochs toward the planetary nebula M2-43. The comparison of the two epochs, obtained with a time separation of 4.07 years, clearly shows the expansion of the planetary nebula with an angular rate of 0.61±0.09 mas/year. Assuming that the expansion velocity in the plane of the sky (determined from these measurements) and the expansion velocity in the line of sight (determined from optical spectroscopy available in the literature) are equal, we find a distance to the planetary nebula of 6.9±1.5 kpc. This is the largest distance for a planetary nebula measured up to now with this technique.

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CNO in evolved intermediate mass stars

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In order to investigate the possible influence of rotation on the efficiency of the first dredge-up we determined atmospheric parameters, masses, and abundances of carbon, nitrogen, and oxygen in a sample of evolved intermediate mass stars. We used high resolution spectra and conducted a model atmosphere analysis. The abundances were calculated through spectral synthesis and compared to the predictions of rotating and non-rotating evolutionary models. Almost all those objects in our sample where carbon and nitrogen abundances could be determined show signs of internal mixing. The stars, however, seem to be mixed to different extents. Among the mixed stars we identify five in our sample with abundances in agreement with the non-rotating models, four stars that seem to be mixed beyond that, and one star that seems to be slightly less mixed than predicted for the first dredge-up. There are also five stars that seem to be slightly more mixed than expected, but their abundances are in marginal agreement with both rotating and non-rotating models. Such differences in the extent of the mixing are not predicted by the standard models and imply the action of other mixing mechanisms than solely the convective dredge-up. We also identified for the first time an important correlation between the [N/C] ratio and the stellar mass.

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A magnetically collimated jet from an evolved star

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Planetary nebulae often have asymmetric shapes, which could arise due to collimated jets from evolved stars before evolution to the planetary nebula phase. The source of jet collimation in these stars is unknown. Magnetic fields are thought to collimate outflows that are observed in many other astrophysical sources, such as active galactic nuclei and proto-stars, although hitherto there are no direct observations of both the magnetic field direction and strength in any collimated jet. Theoretical models have shown that magnetic fields could also be the dominant source of collimation of jet in evolved stars. Here we report measurements of the polarization of water vapour masers that trace the precessing jet emanating from the asymptotic giant branch star W43A at 2.6 kpc from the Sun, which is undergoing rapid evolution into a planetary nebula. The masers occur in two clusters at opposing tips of the jets, 1,000 AU from the star. We find direct evidence that the magnetic field is collimating the jet.

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Search for radiative pumping lines of OH masers. I. The 34.6 μm absorption line towards 1612 MHz OH maser sources.

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The 1612 MHz hydroxyl maser in circumstellar envelopes has long been thought to be pumped by 34.6 μm photons.

Only recently, the Infrared Space Observatory has made possible spectroscopic observations which enable the direct confirmation of this pumping mechanism in a few cases. To look for the presence of this pumping line, we have searched the Infrared Space Observatory Data Archive and found 178 spectra with data around 34.6 μm for 87 galactic 1612 MHz masers. The analysis performed showed that the noise level and the spectral resolution of the spectra are the most important factors affecting the detection of the 34.6 μm absorption line. Only 5 objects from the sample (3 red supergiants and 2 galactic center sources) are found to show clear 34.6 μm absorption (all of them already known) while two additional objects only tentatively show this line. The 3 supergiants show similar pump rates and their masers might be purely radiatively pumped. The pump rates of OH masers in late type stars are found to be about 0.05, only 1/5 of the theoretical value of 0.25 derived by Elitzur (1992). We have also found 16 maser sources which, according to the analysis assuming Elitzur's pump rate, should show the 34.6 μm absorption line but do not. These non-detections can be tentatively explained by far-infrared photon pumping, clumpy nature of the OH masing region or a limb-filling emission effect in the OH shell.

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Searching for radiative pumping lines of OH masers: II. The 53.3 μm absorption line towards 1612 MHz OH maser sources.

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This is the second paper in a series aiming at searching for infrared pumping lines for galactic 1612 MHz OH masers. Our paper I is devoted to the 34.6 μm absorption lines in ISO SWS spectra towards a large sample of galactic OH/IR sources. This paper analyzes the 53.3 μm line in the ISO LWS spectra towards a similar sample of OH/IR sources. A search with position radius of 1 arcmin in ISO Data Archive (IDA) results in 137 LWS spectra covering 53.3 μm associated with 47 galactic OH/IR sources and 4 ones associated with megamasers Arp 220 and NGC 253. (These two magamasers are included for comparison purpose only.) Ten of these galactic OH/IR sources are found to show and another 5 ones tentatively show the 53.3 μm absorption while another 7 sources (our group U1 and U2 sources) highly probably do not show this line. The source class is found to be correlated with the type of spectral profile: red supergiants (RSGs) and AGB stars tend to show strong blue-shifted filling emission in their 53.3 μm absorption line profiles while H II regions tend to show a weak red-shifted filling emission in the line profile. GC sources and megamasers mainly show symmetrical profile in the line core while megamasers tend to show an additional absorption tail on the blue side of the line profile. It is argued that the filling emission might be the manifestation of an unresolved half emission half absorption profile of the 53.3 μm doublet which might be produced by the transitions among the two levels: $^2\Pi_{1/2}(J = 3/2)$ and $^2\Pi_{1/2}(J = 5/2)$ and their closely related levels. The 53.3 to 34.6 μm equivalent width (EW) ratio is close to unity for RSGs but much larger than unity for GC sources and megamasers while H II regions only show the 53.3 μm line. The pump rate defined as maser to IR photon flux ratio is approximately 5% for RSGs. The pump rates of GC sources are three order of magnitude smaller. Both the large 53.3 to 34.6 μm EW ratio and the small pump rate of the GC OH masers reflect that the two detected 'pumping lines' in these sources are actually of interstellar origin. The pump rate of Arp 220 is 32% — much larger than that of RSGs, which indicates that the contribution of other pumping mechanisms to this megamaser is important. A handful of non-detections of the 34.6 or 53.3 μm line or both can be explained partly by the genuinely weakness of the OH masers and partly by some other mechanisms weakening the IR pumping lines, such as clumpy OH shell or limb filling emission.

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The first star generations: the dominant effect of rotation on the CNO yields

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We examine the role of rotation on the evolution and chemical yields of very metal poor stars, with several sequences of 60 $M_\odot$ star models at metallicities $Z \simeq 10^{-8}$ and 10^{-5}, with and without rotation.
The models include the same physics, which was applied successfully at the solar Z and for the SMC, in particular shear diffusion, meridional circulation, horizontal turbulence and rotationally enhanced mass loss.
Noticeably, models of very low Z experience in all phases a much stronger internal mixing than at solar Z. Also, rotating models at very low Z, contrarily to usual considerations, show a large mass loss, which results from different effects in the various phases of evolution: –1. During the MS phase, even models with an average initial rotation reach break–up velocity and the star progressively loses the unbound layers. –2. The efficient mixing of products of the 3α reaction into the H–burning shell allows convective dredge–up to enrich the stellar surface in heavy elements during the red supergiant phase. This favors a large mass loss by stellar winds, especially more as rotation also increases the duration of this phase. –3. On the way back to the blue, the contraction of the convective envelope brings the star to the $\Omega\Gamma$-limit, where the combined effects of a high luminosity and rotation favors heavy mass loss. –4. Finally, the star becomes a Wolf–Rayet star. On the whole, the low Z stars may lose about half of their mass. Massive stars initially rotating at the half of their critical velocity are likely to avoid the pair–instability supernova. The chemical composition of the rotationally enhanced winds of very low Z stars is very peculiar. The winds show large CNO enhancements by factors of 10^3 to 10^7, together with large excesses of ^{13}C and ^{17}O and moderate amounts of Na and Al. The excesses of primary N are particularly striking. When these ejecta from the rotationally enhanced winds are diluted with the supernova ejecta from the corresponding CO cores, we find [C/Fe], [N/Fe],[O/Fe] abundance ratios very similar to those observed in the C–rich extremely metal poor stars (CEMP). We show that rotating AGB stars and rotating massive stars have about the same effects on the CNO enhancements. Abundances of s-process elements and the $^{12}C/^{13}C$ ratio could help us to distinguish between contributions from AGB and massive stars.
On the whole, we emphasize the dominant effects of rotation for the chemical yields of **extremely metal poor stars. Rotation has much more effects than changes of Z.**

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A Spitzer mid-infrared spectral survey of mass-losing carbon stars in the Large Magellanic Cloud

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We present a *Spitzer Space Telescope* spectroscopic survey of mass-losing carbon stars (and one oxygen-rich star) in

the Large Magellanic Cloud. The stars represent the superwind phase on the Asymptotic Giant Branch, which forms a major source of dust for the interstellar medium in galaxies. The spectra cover the wavelength range 5–38 μm. They show varying combinations of dust continuum, dust emission features (SiC, MgS) and molecular absorption bands (C_2H_2, HCN). A set of four narrow bands, dubbed the Manchester system, is used to define the infrared continuum for dusty carbon stars. The relations between the continuum colours and the strength of the dust and molecular features are studied, and are compared to Galactic stars of similar colours. The circumstellar 7-μm C_2H_2 band is found to be stronger at lower metallicity, from a comparison of stars in the Galaxy, the LMC and the SMC. This is explained by dredge-up of carbon, causing higher C/O ratios at low metallicity (less O). A possible 10-μm absorption feature seen in our spectra may be due to C_3. This band has also been identified with interstellar silicate or silicon-nitrite dust. We investigate the strength and central wavelength of the SiC and MgS dust bands as function of colour and metallicity. The line-to-continuum ratio of these bands shows some indication of being lower at low metallicity. The MgS band is only seen at dust temperatures below 600 K. We discuss the selection of carbon versus oxygen-rich AGB stars using the J−K vs. K−A colours, and show that these colours are relatively insensitive to chemical type. Metal-poor carbon stars form amorphous carbon dust from self-produced carbon. This type of dust forms more readily in the presence of a higher C/O ratio. Low metallicity carbon dust may contain a smaller fraction of SiC and MgS constituents, which do depend on metallicity. The formation efficiency of oxygen-rich dust depends more strongly on metallicity. We suggest that in lower-metallicity environments, the dust input into the Interstellar Medium by AGB stars is efficient but may be strongly biassed towards carbonaceous dust, as compared to the Galaxy.

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AGB stars in the Magellanic Clouds. III. The rate of star formation across the SMC.

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This article compares the Ks magnitude distribution of Small Magellanic Cloud asymptotic giant branch stars obtained from the DENIS and 2MASS data with theoretical distributions. Theoretical Ks magnitude distributions have been constructed using up-to-date stellar evolution calculations for low and intermediate-mass stars, and in particular for thermally pulsing asymptotic giant branch stars. Separate fits of the magnitude distributions of carbon- and oxygen-rich stars allowed us to constrain the metallicity distribution across the galaxy and its star formation rate. The Small Magellanic Cloud stellar population is found to be on average 7-9 Gyr old but older stars are present at its periphery and younger stars are present in the direction of the companion galaxy the Large Magellanic Cloud. The metallicity distribution traces a ring-like structure that is more metal rich than the inner region of the galaxy. The C/M ratio discussed in Paper I is a tracer of the metallicity distribution only if the underlying stellar population is of intermediate-age.

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Observed Planetary Nebulae as descendants of interacting binary systems

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We examine recent studies on the formation rate of planetary nebulae and find this rate to be about one-third of the formation rate of white dwarfs. This implies than only about one-third of all planetary nebulae that evolve to form white dwarfs are actually bright enough to be observed. This finding corresponds with the claim that it is necessary for a binary companion to interact with the asymptotic giant branch stellar progenitor for the descendant planetary nebulae to be bright enough to be detected. The finding about the formation rate also strengthens De Marcos conjecture that the majority of observed planetary nebulae harbor binary systems. In other words, single stars almost never form observed planetary nebulae.

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Available from astro-ph by 6 March 2006. For preprints till then: soker@physics.technion.ac.il

Imaging the circumstellar envelopes of AGB stars

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We report the results of an exploratory program to image the extended circumstellar envelopes of asymptotic giant branch (AGB) stars in dust-scattered galactic light. The goal is to characterize the morphology of the envelopes as a probe of the mass-loss process. The observations consist of short exposures with the VLT and longer exposures with 1–2 m telescopes, augmented with archival images from the Hubble Space Telescope. We observed 12 AGB stars and detected the circumstellar envelopes in 7. The detected envelopes have mass loss rates $\gtrsim 5 \times 10^{-6}\,M_\odot\,\mathrm{yr}^{-1}$, and they can be seen out to distances $\gtrsim 1$ kpc. The observations provide information on the mass loss history on time scales up to $\sim 10,000$ yr. For the five AGB envelopes in which the circumstellar geometry is well determined by scattered light observations, all except one (OH348.2−19.7) show deviations from spherical symmetry. Two (IRC+10216 and IRC+10011) show roughly spherical envelopes at large radii but asymmetry or bipolarity close to the star; one (AFGL 2514) shows an extended, elliptical envelope, and one (AFGL 3068) shows a spiral pattern. The non-spherical structures are all consistent with the effects of binary interactions. Our observations are in accord with a scenario in which binary companions play a role in shaping planetary nebulae, and show that the circumstellar gas is already partly shaped on the AGB, before evolution to the proto-planetary nebula phase.

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The Detection of $^3He^+$ in a Planetary Nebula Using the VLA

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We used the VLA to search for $^3He^+$ emission from two Galactic planetary nebulae (PNe): NGC6572 and J320. Standard stellar models predict that the ^{3}He/H abundance ratios for PNe should be 1-2 orders of magnitude higher than the primordial value (^{3}He/H $\sim 10^{-5}$ by number) determined from Galactic HII region abundances and confirmed

by WMAP cosmic microwave background results. Chemical evolution models suggest that fewer than 5% of all PNe enrich the interstellar medium (ISM) with ^{3}He at the level of standard stellar models. Our target PNe are therefore anomalous in that they were selected from a sample deliberately biased to contain objects with properties that maximized the likelihood of a ^{3}He detection by the VLA. We have detected the 8.665 GHz hyperfine $^3He^+$ transition in J320 at the $4\,\sigma$ level. The ^{3}He/H abundance ratio is 1.9×10^{-3} with roughly a factor of two uncertainty. For NGC6572 we find an upper limit of $^3\mathrm{He/H} < 10^{-3}$. This detection of ^{3}He in J320 makes it the second PN known to have an anomalously high ^{3}He abundance confirming that at least some low-mass stars produce significant amounts of ^{3}He that survives to the PN stage and enriches the ISM.

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Dust Extinction in Compact Planetary Nebulae

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The effects of dust extinction on the departure from axisymmetry in the morphology of planetary nebulae (PNs) are investigated through a comparison of the radio free-free emission and hydrogen recombination line images. The dust exctinction maps of five compact PNs are derived using high-resolution ($\sim 0''.1$) Hα and radio images maps of the *HST* and VLA. These extinction maps are then analyzed by an ellipsoidal shell ionization model including the effects of dust extinction to infer the nebulae's intrinsic structure and orientation in the sky. This method provides a quantitative analysis of the morphological structure of PNs and represents a step beyond qualitative classification of morphological types of PNs.

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A New Population of Planetary Nebulae Discovered in the Large Magellanic Cloud (I) : Preliminary Sample.

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We report our initial discovery of 73 new planetary nebulae (PNe) in the Large Magellanic Cloud (LMC) following confirmatory two-degree Field (2dF) spectroscopy on the Anglo-Australian Telescope (AAT). Preliminary candidate sources come from a 10 per cent sub-area of our new deep, high resolution H-alpha map of the central 25° square of the LMC obtained with the UK Schmidt Telescope (UKST). The depth of the high resolution map was extended to $R_{equiv} \sim 22$ for Hα (4.5×10^{-17} ergs cm^{-2} s^{-1} Å^{-1}) by a process of multi-exposure median co-addition of a dozen 2-hour Hα exposures. The resulting map is at least 1-magnitude deeper than the best wide-field narrow-band LMC images currently available. This depth, combined with our selection technique, has also led to the discovery of extended AGB halos around many new and previously known LMC PNe for the first time. Once complete, our new survey is expected to triple the LMC PN population and have significant implications for the LMC PN luminosity function, kinematics, abundance gradients chemical evolution and, via study of the AGB halos, the initial to final mass relation for low to intermediate mass stars.

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Discovery of Lyα Pumped Molecular Hydrogen Emission in the Planetary Nebulae NGC 6853 and NGC 3132

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We report the first observation of Lyα pumped molecular hydrogen emission lines in planetary nebulae. The H_2 emission observed in the ultraviolet spectra of NGC 6853 and NGC 3132 can be explained by excitation of vibrationally hot H_2 by Lyα photons. Constraints are placed on the nebular Lyα emission profile, as well as the molecular hydrogen temperature, column density and turbulent motion. These parameters are similar for the two nebulae, pointing to similar physical conditions in these objects. The ro-vibrational cascade following Lyα pumping is predicted to have low surface brightness signatures in the visible and near infrared.

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Available from astro-ph/0602547

Toward a Working Model for the Abundance Variations in Stars within Globular Clusters

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A popular self-enrichment scenario for the formation of globular clusters assumes that the abundance anomalies seen in the stars in many clusters are due to a second stage of star formation occurring from the matter lost by the winds of massive asymptotic giant branch (AGB) stars. Until today, the modelings of the AGB evolution by several different groups has failed, for different reasons, to account for the patterns of chemical anomalies. Here we show that our own modeling can provide a consistent picture if we constrain the three main parameters that regulate AGB evolution, by (1) adopting a high efficiency convection model, (2) adopting rates of mass loss with a high dependence on the stellar luminosity, and (3) assuming a very small overshooting below the formal convective regions during the thermal pulse (TP) phase. The first assumption is needed to obtain an efficient oxygen depletion in the AGB envelopes, and the second is needed to lose the whole stellar envelope within few thermal pulses, so that the sum of CNO elements does not increase too much, consistent with observations. The third assumption is needed to fully understand the sodium production. We also show that the Mg-Al anticorrelation can be explained by adopting the higher limit of the NACRE rates for proton captures by ^{25}Mg and ^{26}Mg; the models are consistent with the recently discovered F-Al correlation. Problems remain in fully explaining the observed Mg isotope ratios.

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New Evolutionary Calculations for the Born Again Scenario

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We present evolutionary calculations aimed at describing the born-again scenario for post-AGB remnant stars of 0.5842 and 0.5885 $M_\odot$. Results are based on a detailed treatment of the physical processes responsible for the chemical abundance changes. We considered two theories of convection: the standard mixing length theory (MLT) and the double-diffusive GNA convection developed by Grossman et al. The latter accounts for the effect of the chemical gradient ($\nabla\mu$) in the mixing processes and in the transport of energy. We also explore the dependence of the born-again evolution on some physical hypothesis, such as the effect of the existence of non-zero chemical gradients, the prescription for the velocity of the convective elements and the size of the overshooting zones. Attention is given

to the behavior of the born-again times and to the chemical evolution during the ingestion of protons. We find that in our calculations born again times are dependent on time resolution. In particular when the minimum allowed time step is below 5×10^{-5} yr we obtain, with the standard mixing length theory, born again times of 5-10 yr. This is true without altering the prescription for the efficiency of convective mixing during the proton ingestion. On the other hand we find that the inclusion of the chemical gradients in the calculation of the mixing velocity tend to increase the born again times by about a factor of two. In addition we find that proton ingestion can be seriously altered if the occurrence of overshooting is modified by the $\nabla\mu$-barrier at the H-He interface, strongly altering born again times.

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The dark lane of the planetary nebula NGC 6302

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The butterfly-shaped planetary nebula, NGC 6302, shows a unique, dense equatorial dark lane, which is presumably a dusty disc, obscuring an unobserved, very hot central star. We trace the structure of this disc using Hubble Space Telescope (HST) Halpha and [NII] images, Very Large Telescope (VLT) L- and M-band images at 0.4-arcsec resolution, including Bralpha and PAH images, and a JCMT 450 μm image. Extinction maps are derived from these images. Within the disc, the extinction is $A_{H\alpha}$ = 5-7 mag and $A_{Br\alpha}$ = 1-2mag. The 450 μm map shows a north-south elongated central core, tracing the massive dust disc, and extended emission from dust in the bipolar flows. A fit to the SED yields the disc dust mass of 0.03 $M_\odot$. The innermost region shows an ionized shell. The orientation of the polar axis shows a marked change between shell, disc and inner and outer outflow. The structures are well described by the warped-disc model of Icke (2003). PAH images are presented: PAH emission is found in the shell but avoids the disc. An infrared source is found close to the expected location of the central star.

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The symmetric dust shell and the central star of the bipolar planetary nebula NGC 6537

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We present high-resolution images of the strongly bipolar planetary nebula NGC 6537, obtained with Hubble Space Telescope and with the infrared adaptive optics system on the Very Large Telescope. The central star is detected for the first time. Using the multi-band photometry and constraints from the dynamical age of the nebula, we derive a temperature in the range 1.5-2.5 $\times 10^5$ K, a luminosity $\sim 10^3$ $L_\odot$, and a core mass $M_c \sim$ 0.7-0.9 $M_\odot$. The progenitor mass is probably in the range M_i = 3-7 $M_\odot$. The extinction map shows a largely symmetric, and compact dust

structure, which is most likely a shell, located at the neck of the bipolar flow, only 2-4 arcsec from the star. The dust shell traces a short-lived phase of very high mass loss at the end of the AGB. The dynamical age of the shell and bipolar lobes are very similar but the morphologies are very different. The data suggests that the mass loss during the ejection of the compact shell was largely spherically symmetric, and the pronounced bipolarity formed afterwards. The dynamical ages of the bipolar lobes and dust shell are similar, which is consistent with suggestions that bipolar structures form in a run-away event at the very last stages of the AGB mass loss. The inner edge of the dust shell is ionized, and PAH emission is seen just outside the ionized gas. We associate the PAH emission with the photo-dissociation region of the molecular shell.

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Three-micron spectra of AGB stars and supergiants in nearby galaxies

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The dependence of stellar molecular bands on the metallicity is studied using infrared L-band spectra of AGB stars (both carbon-rich and oxygen-rich) and M-type supergiants in the Large and Small Magellanic Clouds (LMC and SMC) and in the Sagittarius Dwarf Spheroidal Galaxy. The spectra cover SiO bands for oxygen-rich stars, and acetylene (C_2H_2), CH and HCN bands for carbon-rich AGB stars.

The equivalent width of acetylene is found to be high even at low metallicity. The high C_2H_2 abundance can be explained with a high carbon-to-oxygen (C/O) ratio for lower metallicity carbon stars. In contrast, the HCN equivalent width is low: fewer than half of the extra-galactic carbon stars show the 3.5 μm HCN band, and only a few LMC stars show high HCN equivalent width. HCN abundances are limited by both nitrogen and carbon elemental abundances. The amount of synthesized nitrogen depends on the initial mass, and stars with high luminosity (i.e. high initial mass) could have a high HCN abundance. CH bands are found in both the extra-galactic and Galactic carbon stars.

One SMC post-AGB star, SMC-S2, shows the 3.3 μm PAH band. This first detection of a PAH band from an SMC post-AGB star confirms PAHs can form in these low-metallicity stars.

None of the oxygen-rich LMC stars show SiO bands, except one possible detection in a low quality spectrum. The limits on the equivalent widths of the SiO bands are below the expectation of up to 30 Å for LMC metallicity. Several possible explanations are discussed, mostly based on the effect of pulsation and circumstellar dust.

The observations imply that LMC and SMC carbon stars could reach mass-loss rates as high as their Galactic counterparts, because there are more carbon atoms available and more carbonaceous dust can be formed. On the other hand, the lack of SiO suggests less dust and lower mass-loss rates in low-metallicity oxygen-rich stars. The effect on the ISM dust enrichment is discussed.

Published in 2005, A&A 434, 691

Faculty position

To enhance its world-ranked research astrophysics programme, the University of Manchester seeks to fill a faculty position in astronomy. The position will be based within the Jodrell Bank Centre for Astrophysics and will be in the general area of molecular astrophysics, astrochemistry and/or submillimetre astronomy, or a closely related area. Associated research areas currently addressed by the group include the origin and evolution of stars, circumstellar material and dust, and astrochemistry. Suitably qualified candidates with observational and/or theoretical interests in one or more of these areas or related areas are encouraged to apply. With this appointment the group expects to strengthen its ability to exploit upcoming instruments and missions including SCUBA2, HARP-B, ALMA, JWST and Herschel.

The Jodrell Bank Centre for Astrophysics is part of the School of Physics and Astronomy. The Centre is located on the main campus of the University in central Manchester and operates the Jodrell Bank Observatory which hosts the eMERLIN National Facility. In addition to other activities, members of the Centre are involved in the technical development for both ALMA and SKA.

The 22 tenure-track astronomers form one of the largest groups in the UK with further significant growth planned. The interests of group members range from pulsars to particle astrophysics. There are also astronomy-related groups in the School of Electrical & Electronic Engineering and in the Cosmochemistry centre in the School of Earth Sciences. Informal enquiries concerning this position can be made to Prof. Albert Zijlstra, email: Albert.Zijlstra@manchester.ac.uk, or to Dr. Gary Fuller, email: Gary.Fuller@manchester.ac.uk

Application forms and further details may be downloaded by visiting the website: www/manchester.ac.uk/vacancies.

Applicants should submit a completed University application form, a full curriculum vitae, a research plan, and the names of three referees and the Equal Opportunities Monitoring form. These should be marked "Confidential-Staff Application"; and returned by 15 APRIL 2006 to Anne O'Neill, The University of Manchester, Faculty of Engineering and Physical Sciences, Sackville Street Building, Manchester, M60 1QD, UK

See also http://jupiter.phy.umist.ac.uk/

Postdoctoral Fellow

The physics department of the University of Hong Kong has an opening for a postdoctoral fellow in the field of planetary nebulae and/or interstellar chemistry. Current projects include the analysis of data from the Spitzer GLIMPSE survey, mid-infrared imaging at the Gemini Telescopes, and planning for observations with the SOFIA mission. We seek a recent Ph.D. in astronomy or physics with experience or interest in pursuing theoretical or observational studies of AGB stars, proto-planetary nebulae, and planetary nebulae. Previous experience in the analysis of imaging and spectroscopic data is desirable but not required.

The current salary scales for postdoctoral fellows at the University of Hong Kong range from $19,860-38,282$ HKD per month, or approximately $30,554-58,900$ USD per annum. The successful candidate will be appointed for an initial period of two years, with the possibility of renewal for a 3rd year subject to satisfactory performance and the availability of funds.

Please send a curriculum vitae, a statement of research interest, and names of three references to Prof. Sun Kwok, Dean, Faculty of Science, University of Hong Kong, Hong Kong (or by email to sunkwok@hku.hk).

See also www.physics.hku.hk/about/index.html

ASTRONOMICAL IMAGE PROCESSING WORKSHOP

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ASTRONOMICAL IMAGE PROCESSING WORKSHOP

Sep 4-9, 2006, Dubrovnik, Croatia

THE WORKSHOP OBJECTIVES - The workshop will provide participants with the skills needed to understand the outputs of current and next-generation surveys, and to be in a position to contribute to the algorithm development needed to make new data-intensive projects, such as LSST and Pan-STARRS, a reality. The workshop will include lectures by leaders in the field and presentations by participants, if requested.

For more information, please see http://www.astro.washington.edu/aipw

Registration deadline: March 30, 2006.

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See also http://www.astro.washington.edu/aipw